



ENGINEERING DESIGN GUIDELINES

July 2016

REVISION HISTORY

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/ Rev 0		Review of the Engineering Guidelines following public exhibition	Executive	October 2014
Ed 1/ Rev 1	0042 Section 2.5	Insert requirement to seek Council approval for new pavement materials	SDSG	8/02/2016
Ed 1/ Rev 2	0042 Section 3.1	Exclude the surfacing thickness from the minimum pavement thickness to be consistent with minimum base and subbase thicknesses	Manager, Asset Management	11/07/2016
	0074 Section 3.6	Require minimum Class 3 pipes for longitudinal pipes and Class 4 pipes for transverse pipes		
	0074 Section 3.9	Require sewer grade SN4 pipe for PVC interallotment drainage pipes		

Note: SDSG is the Standard Drawings Steering Group

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0010 QUALITY REQUIREMENTS FOR DESIGN

1 GENERAL

1.1 RESPONSIBILITIES

Objective

General: Provide a Quality Management System (QMS) for the execution and recording of design processes.

Performance

Requirements: ~~[complete/delete]~~

- Demonstrate the QMS by providing records of the design process.
- Provide documentation relevant to asset management.

Design qualifications

Designer: ~~[complete/delete]~~

Authority requirements: ~~[complete/delete]~~

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

~~Related worksections: [complete/delete]~~

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

Standards

AS/NZS 1170-Variou	Structural design actions
AS 1684-Variou	Residential timber-framed construction
AS 1742-Variou	Manual of uniform traffic control devices
AS 1742.2-2009	Traffic control devices for general use
AS 3600-2009	Concrete structures
AS 4100-1998	Steel structures
AS 5100-Variou	Bridge design
AS/NZS ISO-9000:2006	Quality management systems - Fundamentals and vocabulary
AS/NZS ISO-9001:2008	Quality management systems - Requirements
AS ISO-10013:2003	Guidelines for quality management system documentation
AS/NZS ISO-19011:2003	Guidelines for quality and/or environments management systems auditing
SAA HB 90.3-2000	The Construction Industry - Guide to ISO 9001:2000

Other publications

Engineers Australia

Australian Rainfall and Runoff (AR&R) – 1997

WSAA

WSA 02: 2002

Sewerage Code of Australia WSA 02

WSA 03: 2011

Water Reticulation Code of Australia Version 3.1

1.4 STANDARDS

General

Standard: To AS/NZS ISO 9001.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- BCA: Building Code of Australia.
- QMP: Quality Management Plan.

- QMS: Quality Management System.

Definitions

General: For the purposes of this worksection the definitions given in AS/NZS ISO 9000 and the following apply:

- Accreditation: Certification by a statutory or approved authority of the facilities, capabilities, objectivity, competence and integrity of an organisation or individual to provide a specified service and/or required operation.
- Certification: Assertion, in writing, of facts.
- Hold point: A defined position in the different stages of the Contract beyond which work can not proceed without mandatory verification and acceptance by the Superintendent.
- Non-conformance: Non fulfilment of a requirement, need or expectation that is stated, generally implied or obligatory.
- Professional engineer: A person who is listed or eligible for listing on the National Professional Engineers Register (NPER) and has appropriate experience and competence in the relevant discipline at the relevant time.
- Quality design check lists: Forms completed during the design process verifying key steps, and records.
- Records: Documents and data which are no longer subject to alteration and provide evidence of activities performed.
- Validation: Confirmation, through the provision of objective evidence, that requirements for a specific intended use or application have been fulfilled.
- Verification: Provision of evidence or proof that a performance requirement has been met or a default exists.
- Witness point: A nominated position in the different stages of the Contract where the option of attendance may be exercised by the Superintendent, after notification of the requirement.

2 QUALITY MANAGEMENT SYSTEM FOR DESIGN

2.1 GENERAL REQUIREMENTS

Design organisation's quality plan

Requirements: Provide a Quality Plan in conformance with AS/NZS ISO 9001, to include the following:

- Quality manual including the organisation's Quality Policy.
- Responsibilities for the implementation of the Quality Policy for the project.
- A commitment from top management to the development and implementation of the QMS.
- Evidence of the resources, infrastructure and work environment for the project.
- Policy for evaluating and selecting Subconsultants.

~~[complete/delete]~~

2.2 DESIGN PLANNING

General

Collaboration: Coordinate the different groups involved in the development of the design to ensure effective communication and clear assignment of responsibility.

Integrated planning with Subconsultants: Verify and incorporate inputs into the design process.

Design quality plan

Requirement: Provide a design Quality Plan, to include the following:

- Design stages.
- Review, verification and validation for each stage (Design program and procedures).
- Responsibilities and authorities for design.
- Define the design team, including Subconsultants, names of team members, roles and technical interfaces.

- Details of the resources assigned to the project.
- Organisation chart including communication paths with the Superintendent, the Principal, other Consultants and Contractors.
- For the construction phase, reference the Contractor's program for review and verification such as site inspections.
- Design inputs such as requirements and acceptable criteria.
- Any Witness Points or Hold Points for the design.
- Programmed approvals/consultations with regulatory authorities.
- Any third party review/verification/validation required by the Principal or regulating authority.
- Proposed design documentation.
- Procedure for managing design changes of project audits.
- Sign off of activities and record using the checklists in the **Annexures**.

~~—[complete/delete]~~

2.3 DESIGN INPUT AND OUTPUT

Design input

Input to AS/NZS ISO 9001 clause 7.3.2: Identify, document and review for adequacy the following:

~~Principal's brief: [complete/delete]~~

~~Site information: [complete/delete]~~

~~Codes of practice: [complete/delete]~~

~~Regulatory and statutory requirements: [complete/delete]~~

~~Performance criteria: [complete/delete]~~

~~Design criteria: [complete/delete]~~

~~Materials: [complete/delete]~~

Requirement: Give notice if the design inputs do not provide sufficient information for verification.

Review: Submit design proposals for approval by the Principal at appropriate stages.

Design output

Output to AS/NZS ISO 9001 clause 7.3.3: To include the following, produced at various stages:

- Advice.
- Calculations.
- Drawings.
- Models.
- Other contract documents.
- Reports.
- Schedules of quantities.
- Sketches for shop drawings.
- Specifications.

Design checklist: Provide a quality record of the design processes and integrate additional criteria, as required, in the design checklists in **Annexure A**.

Acceptance criteria: Define on drawings or in the specification the acceptance criteria for standards of workmanship and other design requirements.

Define: Key characteristics e.g. safety signs.

2.4 REVIEW, VERIFICATION AND VALIDATION

Design review

Design meetings: Minute design meetings with all relevant parties in attendance and make sure the following considerations are included in the agenda:

- Principal's requirements.
- Sequence of design activities.
- Conformance with the design brief.
- Identification and control of design interfaces.
- Construction processes.
- Safety methods.
- Methods of verification.
- Consultation including Council or authority approvals, public input and existing utilities.

Method of quality recording: Provide and maintain quality records by notation on documents, minutes and checklists signed off by the review leader.

Design verification

Verification: At the end of each design stage examine the result of a given activity for conformance with the specified input requirements for that activity, include the following:

- Document the process.
- Identify responsibilities.
- Maintain adequate records of the verification.
- Site investigation and reporting.

~~Independent design verification: [complete/delete]~~

Design validation

Validation: Following completion of design, validation shall be performed to make sure the design has met the specified requirements, include the following:

- Document the process.
- Identify responsibilities.
- Maintain adequate records of the validation.

~~Outcome: [complete/delete]~~

Audit

Notice: Provide all reasonable assistance for the inspection of records of designs submitted to Council for acceptance. Provide access to the designer's premises on a 24 hour notice basis.

2.5 CONTROL OF DESIGN CHANGES

Design changes

Requirement: Review and amend the design quality plan as necessary during the course of the design, include the following:

- Manage, identify, record any design changes.
- Identify who can make and approve changes.
- Procedure for review of wider implications of design changes.

Process for changing documents after issue for construction: Once documents are issued for construction, any changes must go through the review, verification and approval process prior to re-release for construction.

~~Principal approval required for design changes to documents after issued for construction: [complete/delete]~~

Record: Maintain a register of design changes.

2.6 CONTROL OF DOCUMENTATION

Documentation

Distribution control: Maintain a master list of controlled documents, to include the following information:

- The source of data used in calculations and on drawings.
- Record of the personnel authorised to review, approve and change documents.

Design documentation and data: Provide calculations, sketches, drawings (including those retained for reference or circulated outside the design team), data sheets and specifications.

Requirement: Control and retain documents and data relating to the project e.g. from the Principal, other Consultants or Subconsultants and suppliers.

Design change register: Record changes made to any documents after they have been issued for construction.

Certification

Certification Report: Submit for approval a Certification Report signed by the designer accompanied by drawings and specifications. Conform with the design certificate and checklists included in **Annexure A**.

Certification of preliminary drawings: Submit a Certification Report with all preliminary drawings. Submit an updated Certification Report with the submission of final drawings. A Certification Report is not required when submitting sketch plans or concept plans.

Drawing requirements

Drawings: Define and set out the design concepts on design drawings in conformance with the following:

- Prepare all design drawings on a Council approved standard sheet and clearly number with each sheet numbered as part of a set. **Annexure B** provides guidelines for grouping information in design drawings.
- Refer to design worksections for documentation requirements.
- Provide a space in the bottom right hand corner of each drawing for an assigned number provided by Council.
- Do not overcrowd the drawings with information.
- Do not use colour to distinguish information.
- Use A1 or A2 size sheets, suitable for black and white copying and reduction to A3 paper size without loss of clarity.

2.7 CONTROL OF RECORDS

Records

Requirement: Retain appropriate design records in a format which can be understood readily with no prior knowledge of the particular design.

Copies of records: Make copies of records available to Council upon request without charge.

Design file: Maintain a design file containing records of calculations, approvals and decisions, geotechnical data and other design data that could be relevant in reviewing aspects of the design or planning future maintenance responsibilities.

Calculation record retention: Keep all calculations for the duration of the construction maintenance period.

Hydrologic and hydraulic design records: To *0074 Stormwater drainage (Design)*.

2.8 CONTROL OF NON-CONFORMANCE

Design variations

Record: Identify on the Certification Report checklists any aspects of the design which do not meet the requirements or tolerances set out in this worksection and other applicable Council design and construction specifications.

3 ANNEXURE A

3.1 CERTIFICATION REPORT

Design Certificate

Project Title: _____

Documentation No: _____

Designer: _____

I certify that the documentation noted above represents a design for which the attached design check lists provide a valid record.

I certify that this design conforms to current Australian or International standards, industry guidelines, Council’s design specifications, Council’s DCP 2012 and specific instructions received with the exception of departures cited in the attached design checklists.

I certify that this design will not significantly impact on the environmental factors of the area as interpreted under Part IV of the NSW Environmental Planning and Assessment Act.

I certify that this Design is in strict compliance with the development consent conditions and where a variance to the consent is found, written confirmation has been received from Council approving of the variance prior to the lodgement of Design Drawings (this includes designs for staged construction).

I certify that all structural/civil/hydraulic elements have been designed by an engineer suitably experienced in the relevant field and who has or is eligible for NPER registration with Engineers Australia

Contact Phone: _____

Design Engineer/Surveyor Date

Contact Postal Address: _____

Qualifications

A.B.N.

3.2 DESIGN CHECKLIST 1 - DOCUMENTATION OF EXISTING SITE FEATURES

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
1.1 Check detail survey by site inspection for existing drainage./...../...	<input type="checkbox"/>
	
1.2 Check detail survey by site inspection for existing property descriptions, boundaries and accesses./...../...	<input type="checkbox"/>
	
1.3 Check detail survey of contours as representative of site terrain./...../...	<input type="checkbox"/>
	
1.4 Document trees and significant environmental features affected by the works./...../...	<input type="checkbox"/>
	
1.5 Document significant features to heritage within the Works boundaries./...../...	<input type="checkbox"/>
	
1.6 Document existing public and private property likely to be affected by the design./...../...	<input type="checkbox"/>
	
1.7 Document survey and bench-marks./...../...	<input type="checkbox"/>
	
<i>1.8 Check LMCC Significant Tree Register. Consulted with Tree Officer and incorporated requirements in the Design Documentation.</i>/...../...	<input type="checkbox"/>
	

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.3 DESIGN CHECKLIST 2 - HORIZONTAL ROAD ALIGNMENT

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
2.1 Check that alignment is compatible with design speeds./...../...	<input type="checkbox"/>
2.2 Check that alignment is adequate in relation to clearance of roadside hazards.	<input type="checkbox"/>
2.3 Check that there is adequate horizontal sight distance for drivers and pedestrians./...../...	<input type="checkbox"/>
2.4 Check that there is minimum conflict with existing services.	<input type="checkbox"/>
2.5 Check that road widths and lanes conform to Council and traffic design requirements./...../...	<input type="checkbox"/>
2.6 Check that bridge alignment is compatible with the road alignment.	<input type="checkbox"/>
2.7 Check for adequate pedestrian, pram, bicycle and parking provisions./...../...	<input type="checkbox"/>
2.8 Check for adequate provision for large vehicles such as buses, garbage trucks and emergency vehicles.	<input type="checkbox"/>
2.9 Check that intersections conform to the turning requirements of design traffic, including emergency vehicles./...../...	<input type="checkbox"/>
2.10 Check adequate pavement width tapers and merges.	<input type="checkbox"/>
2.11 Identify and resolve any conflict with existing public utility services./...../...	<input type="checkbox"/>
2.12 Document horizontal road alignment set out data./...../...	<input type="checkbox"/>

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.4 DESIGN CHECKLIST 3 - VERTICAL ROAD ALIGNMENT

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
3.1 Check that grades conform to maximum and minimum requirements./.../...	<input type="checkbox"/>
3.2 Check that vertical clearances to bridges and services conform to standards.	<input type="checkbox"/>
3.3 Check that there is adequate vertical sight distance for drivers and pedestrians./.../...	<input type="checkbox"/>
3.4 Check that there is adequate cover to drainage structures or services./.../...	<input type="checkbox"/>
3.5 Check that there is adequate vertical alignment for disposal of surface drainage from properties and road.	<input type="checkbox"/>
3.6 Check that grades conform to 1:100 year flood levels./.../...	<input type="checkbox"/>
3.7 Check that vertical alignment is compatible with property access./.../...	<input type="checkbox"/>
3.8 Check that gradients on intersecting roads do not exceed the cross slope of the through pavement and no greater than 3% at give way and stop signs./.../...	<input type="checkbox"/>
3.9 Check that there is acceptable sight distance for all accesses to roundabouts./.../...	<input type="checkbox"/>
3.10 Check that alignment coordination with horizontal alignment is in conformance with the Austroads design guides referenced in the AUS-SPEC specifications./.../...	<input type="checkbox"/>
3.11 Identify and resolve conflict with existing public utility services./.../...	<input type="checkbox"/>
3.12 Document vertical road alignment set out data on the longitudinal sections./.../...	<input type="checkbox"/>

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.5 DESIGN CHECKLIST 4 - ROAD CROSS-SECTIONS

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
4.1 Document complete dimensions on typical cross-sections have./...../...	<input type="checkbox"/>
4.2 Document kerb & gutter, road safety barrier and surface drainage on typical cross-sections./...../...	<input type="checkbox"/>
4.3 Document batter slopes and batter treatment where appropriate./...../...	<input type="checkbox"/>
4.4 Document pavement description and surface treatment./...../...	<input type="checkbox"/>
4.5 Document property boundaries, service allocations and location of known existing underground services and pathway treatments./...../...	<input type="checkbox"/>
4.6 Document cross-sections to define all variations and width transitions./...../...	<input type="checkbox"/>
4.7 Document cross-sections allowing for assessment of impact of road level on adjoining property./...../...	<input type="checkbox"/>
4.8 Verify the stability of embankment slopes, batters and retaining walls as satisfactory./...../...	<input type="checkbox"/>
4.9 Check that cross section reference level conforms with vertical road alignment./...../...	<input type="checkbox"/>

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.6 DESIGN CHECKLIST 5 - ROAD AND INTERALLOTMENT DRAINAGE**Checkpoints**

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
5.1 Document existing surface drainage./...../...	<input type="checkbox"/>
5.2 Check that hydrological data is current.	<input type="checkbox"/>
5.3 Make hydrologic and hydraulic design calculations available for audit./...../...	<input type="checkbox"/>
5.4 Check that underground drainage and structures do not conflict with public utility services./...../...	<input type="checkbox"/>
5.5 Check that the designed drainage lines are compatible with existing incoming lines and outgoing lines.	<input type="checkbox"/>
5.6 Document pipeline length, type, size, class and bedding requirements for each drainage line./...../...	<input type="checkbox"/>
5.7 Check that height of fill over drainage lines is within allowable limits./...../...	<input type="checkbox"/>
5.8 Document drainage provisions for local depressions, e.g. median areas or areas adjacent to fills./...../...	<input type="checkbox"/>
5.9 Check that the effect of headwater and back-up water on private property is satisfactory./...../...	<input type="checkbox"/>
5.10 Document subsurface drainage by line and level if required./...../...	<input type="checkbox"/>
5.11 Document batter drains for fills and cuttings if required./...../...	<input type="checkbox"/>
5.12 Consider the height and energy level of downstream drainage./...../...	<input type="checkbox"/>
5.13 Locate drainage structures and flowpaths to ensure safe vehicular and pedestrian transit./...../...	<input type="checkbox"/>
5.14 Document drainage structure number, set out, type and pipe on the drainage plans and schedule of drainage elements.	<input type="checkbox"/>
5.15 Locate emergency flowpaths to minimise impact on private property./...../...	<input type="checkbox"/>
5.16 Check that road drainage conforms with Council's drainage design criteria./...../...	<input type="checkbox"/>
5.17 Check that interallotment drains conform with Council's Specification and Australian Rainfall and Runoff (AR&R) rainfall data./...../...	<input type="checkbox"/>
5.18 Document appropriate land stabilisation and velocity controls to pipe systems, open channels and embankments.	<input type="checkbox"/>
5.19 For flood controlled allotments ensure, the floor height controls are compatible with road and drainage levels./...../...	<input type="checkbox"/>

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.7 DESIGN CHECKLIST 6 - SIGNS AND MARKINGS

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
6.1 Conform to the documented Traffic Management Plan./...../...	<input type="checkbox"/>
6.2 Document sign types, sizes, locations and support structure details to conform with AS 1742 (All parts).	<input type="checkbox"/>
6.3 Document pavement linemarking, pavement marking type and set out to conform to AS 1742.2./...../...	<input type="checkbox"/>
6.4 Document signs and linemarking to conform to Council's policies.	<input type="checkbox"/>

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.8 DESIGN CHECKLIST 7 - PAVEMENT DESIGN

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
7.1 Document pavement design and surface treatment on the typical road and/or pathways and cycleways cross-sections. /...../...			
Document any variations on the specific cross-sections.			<input type="checkbox"/>
7.2 Check that the pavement design conforms to 0042 <i>Pavement design</i> and/or 0044 <i>Pathways and cycleways</i> for adequacy. /...../...			<input type="checkbox"/>
7.3 Assess geotechnical data and keep records of design calculations.			<input type="checkbox"/>
<i>7.4 Pavement design is in accordance with any conditions of development consent.</i> /...../...			<input type="checkbox"/>

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.9 DESIGN CHECKLIST 8 - BRIDGE/MAJOR CULVERT DESIGN

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
8.1 Check that the design engineer is suitably experienced in the relevant field and who has or is eligible for NPER registration with Engineers Australia./...../...	<input type="checkbox"/>
8.2 Assess geotechnical data for adequacy and keep records./...../...	<input type="checkbox"/>
8.3 Check that the type and functional dimensions of the bridges conform to AS 5100, AS 4100, AS 3600, AS 1684, AS/NZS 1170./...../...	<input type="checkbox"/>
8.4 Document the type and class of all materials./...../...	<input type="checkbox"/>
8.5 Keep records of all significant design calculations and make available for audit./...../...	<input type="checkbox"/>
8.6 <i>Bridge design complies with any conditions of development consent.</i>/...../...	<input type="checkbox"/>

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.10 DESIGN CHECKLIST 9 - EROSION AND SEDIMENTATION CONTROL PLANS

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
9.1 Check that the concept erosion control plan conforms to <i>0075 Control of erosion and sedimentation (Design)</i>/...../	<input type="checkbox"/>
9.2 Check that the erosion and sedimentation control conforms to development consent conditions and environmental legislations./...../	<input type="checkbox"/>
9.3 Check that the erosion and sedimentation control plan conforms to <i>0075 Control of erosion and sedimentation (Design)</i> .			
9.3 Check that the soil and water management plan conforms to <i>1102 Control of erosion and sedimentation (Construction)</i>/...../.....	<input type="checkbox"/>

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.11 DESIGN CHECKLIST 10 - WATER SUPPLY

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
10.1 Check that the design engineer is suitably experienced in the relevant field and who has or is eligible for NPER registration with Engineers Australia. /... /...	.	..	<input type="checkbox"/>
10.2 Check that a practicing registered Surveyor performed the survey. /... /...	.	..	<input type="checkbox"/>
10.3 Assess geotechnical data for adequacy and keep records. /... /...	.	..	<input type="checkbox"/>
10.4 Check that the type and functional dimensions of the reticulation and any pump station meet the State Department of Public Works and Services guidelines and the appropriate Australian Standards, and are compatible with the Water Reticulation Code of Australia WSA 03. /... /...	.	..	<input type="checkbox"/>
10.5 Document the type and class of all materials, fittings, joints, and plant, pumps special requirements for crossings and protection. /... /...	.	..	<input type="checkbox"/>
10.6 Keep records of all significant design calculations and make available for audit. /... /...	.	..	<input type="checkbox"/>
10.7 Check that the design conforms to requirements of all Statutory Authorities. /... /...	.	..	<input type="checkbox"/>
10.8 Check the design conforms to any development consent conditions. /... /...	.	..	<input type="checkbox"/>

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

3.12 DESIGN CHECKLIST 11 - SEWERAGE SYSTEM

Checkpoints

Initial and date the following checkpoints or tick box if not applicable.

	By	Date	NA
11.1 Check that the design engineer is suitably experienced in the relevant field and who has or is eligible for NPER registration with Engineers Australia./...../.....	<input type="checkbox"/>
11.2 Check that a practicing registered Surveyor performed the survey./...../.....	<input type="checkbox"/>
11.3 Assess geotechnical data for adequacy and keep records./...../.....	<input type="checkbox"/>
11.4 Check that the type and functional dimensions of the reticulation and any pump station meet state Department of Public Works and Services guidelines and the appropriate Australian Standards, and are compatible with the Sewerage Code of Australia WSA 02./...../.....	<input type="checkbox"/>
11.5 Document the type and class of all materials, fittings, joints, plant, pumps and special requirements for crossings and protection./...../.....	<input type="checkbox"/>
11.6 Keep records of all significant design calculations and make available for audit./...../.....	<input type="checkbox"/>
11.7 Check that the design conforms to requirements of all Statutory Authorities./...../.....	<input type="checkbox"/>
11.8 Check that the design conforms to development consent conditions./...../.....	<input type="checkbox"/>

Certified documents

Include the following certified documents:

List additional certified documents provided.

Non-conformance

Describe any special features of the project and document any variations from Council or State Road Authority requirements.

4 ANNEXURE B

4.1 EXAMPLE COMPILATION OF DRAWINGS

Sequence of drawing sheets: The following sequence is acceptable to Council in the compilation of a full set of roadworks drawings.

Sheet No **Topic**

1. Development consent number (if applicable), project title, locality drawing and index of sheets.
2. General layout plan with contour details and extent of work.
3. Typical road cross-sections showing road widths, pavement (design) configuration, batter slopes, kerb and gutter types.
4. Plan and longitudinal section of each road showing set out data, road safety barrier locations, guide posts and services.
5. Drainage plan and schedule of drainage elements (pipe lines and structures).
6. Drainage profiles.
7. Drainage structure details.
8. Road cross-sections.
9. Intersection layout details.
10. Pavement marking and signposting.
11. Erosion and sedimentation control concept plans (short term and long term treatment).
12. Structure details - bridges, retaining walls, etc.

Multiple sheets: A set of roadworks plans may require more than 1 sheet for each of the topics listed and may also require supplementary sheets for site specific details.

Scale: Nominate scales on all drawings.

North point: Show on all plan views.

0021 SITE REGRADING

1 GENERAL

1.1 RESPONSIBILITIES

Objective

General: Provide design and documentation of site regrading works to meet the following requirements:

- Provide an efficient and economical design.
- Enhance the environment of the site whilst maintaining the site's natural features.
- Provide safe conditions for construction.
- Provide equal building conditions for all residential development allotments.
- Minimise impact on adjoining properties and other works.
- Maintain or improve drainage and overland flow paths.

Performance

Requirements: ~~[complete/delete]~~

Authority requirements: ~~[complete/delete]~~

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- 0010 Quality requirements for design.
- 0012 Waterfront development.
- 0041 Geometric road layout.
- 0074 Stormwater drainage (Design).
- 0075 Control of erosion and sedimentation (Design).
- 0257 Landscape – Roadways and street trees.
- 1102 Control of erosion and sedimentation (Construction).
- 1111 Clearing and grubbing.
- 1112 Earthworks (Roadways).

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian Standards

AS 3798:2007 Guidelines on earthworks for commercial and residential developments

AS 4970:2009 Protection of trees on development sites

Austroroads

AGPT08-2009 Guide to Pavement Technology - Pavement construction

AGRD07-2008 Guide to Road Design - Geotechnical investigation and design

1.4 INTERPRETATION

Abbreviations

General: For the purposes of this worksection, the following abbreviations apply:

- ARI: Average recurrence interval.
- EPA: Environmental protection agency.
- WAE: Work-as-executed.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Site suitability

Improvement: The natural state of a site may not be suitable for the intended function.

Site regrading may be required to:

- Alleviate flooding.
- Fill gullies or create emergency flowpaths after installation of underground stormwater systems.
- Improve stormwater runoff.
- Reduce excessively steep slopes, to allow construction of economical foundation solutions.
- Allow effective recreational use or provide improved access.
- Fill local unwanted depressions.
- Improve ground conditions in areas where existing soils have plastic/reactive properties.

Contours: Review the natural surface contours and design finished surface levels to confirm land will be suitably prepared for use.

Land use restrictions

Constraints: Identify all constraints, natural or otherwise, which may apply to the site.

2.2 CONSULTATION

Council and other Authorities

Responsibility: Consult with Council prior to commencement of design to identify any design requirements in addition to the requirements of this worksection.

Haul routes: Consult with Council to define acceptable routes for haulage with applicable load limits.

Bond: Council will confirm if payment of a bond is required. This may be necessary where concerns exist regarding the ability of a haul road to sustain the loads without undue damage or maintenance requirements.

Tree preservation officer: Consult with Council's tree preservation officer to identify requirements relating to tree protection and clearing of the site.

Salinity: Consult the relevant land and water resource Authority and advise Council/Developer of areas requiring action to prevent salinity development.

Utilities services plans

Existing services: Obtain service plans from all relevant public utilities Authorities and other organisations whose services exist within the site area. Plot these services on the relevant drawings, including the plan and cross-sectional views.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

3 DESIGN

3.1 GENERAL

Considerations

Natural environment: Consider the implications of site regrading for the existing natural environment. Minimise site regrading in heavily treed areas.

Watercourses and riparian zones: Design site regrading Works that preserve and do not degrade existing watercourses and riparian zones. Refer to worksection *0012 Waterfront development* if new waterways are proposed.

Haulage: Design areas for site regrading in conjunction with the roadworks design, with the objective of balancing cut to fill, achieving an economical works and minimising the haulage of imported fill or spoil. Bulk haulage has an adverse effect on adjacent

development, and infrastructure. Refer to *0041 Geometric road layout* worksection and AGRD07 clause 4.3.2.

Salinity prevention

Existing conditions: Evaluate existing soil salinity conditions in known salt affected areas, or areas found to be salt affected by the geotechnical investigations.

Groundwater table: Implement appropriate strategies aimed at lowering the groundwater table where necessary, together with primary measures to prevent extension of salinity problems.

Approval

EPA: ~~[complete/delete]~~

Measures: Make enquiries with EPA and subsequently obtain Council approval for any proposed sediment, siltation, erosion or salinity control devices/measures.

Agreement: Obtain written agreement from adjoining property owners prior to carrying out any construction work on their property. Submit all agreements to Council.

3.2 DRAINAGE AND RUNOFF

General

Underground drainage: Regrade areas to minimise the need for surface inlet pits and, where practical, allow surface water to flow naturally to roads or drainage reserves without excessive concentration.

Overland flow: Provide depressions at low points and over major drainage lines, to direct stormwater for storms of up to a 100 year ARI.

Inundation areas: In areas known to be affected by stormwater flows, investigate the existing conditions as they relate to the proposed Works. Submit all data obtained to Council and recommend appropriate contour adjustments.

Level requirements

Areas abutting 100 year ARI flood levels: Regrade to a minimum level of 0.5 m above the 100 year ARI flood levels. Do not cause flooding of other areas as a consequence of such regrading.

Building areas: Regrade in the direction of the catchment area drainage system as follows:

- Desirable surface grading: 1.5%.
- Minimum surface grading: 1.0%.

Steep building areas: For building areas with natural ground slopes greater than 15% obtain confirmation of the compatibility of the proposed Works from a geotechnical engineer. Document any specific requirements on the Drawings.

Piped gullies or depressions: Design finished surface levels of piped gullies or depressions to provide adequate cover depth over pipelines (if piped) and direct surface stormwater flow to inlet pits.

Temporary diversion drains

Drawings: Identify the location of any temporary drains required to divert surface flows away from the regrading area, including any erosion or sedimentation control treatment. Size temporary drains to accommodate the volume of water to be diverted.

Erosion and sedimentation control

Objective: Minimise soil disturbance and material loss off site.

Control measures: Provide measures including, but not limited to the following:

- Trench stops at 30 m spacing along a trench. Direct overtopping to the kerb.
- Blue metal bags placed along kerb and gutter at maximum 30 m spacing.
- Blue metal bags placed around downstream drainage pits.

Additional requirements: Conform to *0075 Control of erosion and sedimentation (Design)* and *1102 Control of erosion and sedimentation (Construction)*.

Adjoining properties

Easement: Create drainage easement rights in conformance with *0074 Stormwater drainage (Design)* if it is proposed to divert or direct piped stormwater into adjoining properties.

3.3 SITE**Clearing**

Worksection: Conform to *1111 Clearing and grubbing*.

Requirement: Clear the site of the following:

- Low scrub.
- Fallen timber.
- Debris.
- Stumps.
- Large rocks.
- All roots and loose timber which may contribute to drain blockage.
- Any trees which Council has deemed approaching the end of their functional life or dangerous/hazardous to normal use of site.

~~Special requirements: [complete/delete]-~~

Document: Indicate special requirements of Council on the Drawings.

Disposal

Requirement: Document the removal and legal disposal of all materials cleared from the site.

Spoil: Submit for approval all proposed locations for disposal of excavated material.

Trees

Overfilling: Do not fill over butts of trees in areas that require filling. Document clearing of all trees in such areas and relocating/replanting with advanced species. Submit the number and type of which for approval by Council.

Relocating: Relocate clear of probable future building locations. Document future positions on Drawings and note that replanting cannot commence until filling has been completed and graded.

Preservation: Document approved preservation measures for selected trees, to prevent destruction caused by placement of fill or any other action within the tree drip zone. Refer to AS 4970 for further guidance.

Tree register: Check Significant Tree Register for the existence of any significant trees.

Requirement: Consult with LMCC's Tree Preservation Officer and Development Planner – Flora and Fauna. Requirements to be shown on Drawings.

Fill

Type: Sound clean material and free from large rock, stumps, organic matter and other debris.

Commencement: Obtain approval from council prior to commencement of fill placement over prepared areas. Document this requirement on relevant Drawings.

Quality and compaction: Conform to AS 3798, the requirements of *1112 Earthworks (Roadways)* worksection and AGPT08 section 4.

Restricted fill: Submit for approval by Council a proposal for the use of restricted fill material comprising natural sands or industrial wastes/by-products. Include details of the material type and its intended location for use.

Top dressing

Landscaping: Document dressing of all areas where fill will be placed, with clean arable topsoil, fertilised and sown with suitable grasses. Conform to *0257 Landscape – roadways and street trees*.

Re-use: If possible, retain existing topsoil from the site and document its re-use in the same location.

~~Topsoil stockpile period: [complete/delete]~~

Retaining walls

Worksections: Refer to *0292 Masonry walls* and *0293 Crib retaining walls*.

Boundary: Design retaining walls to sit fully inside the site, when filling to site boundary. Submit design for approval by Council.

Design: Use an appropriately qualified and experienced structural engineer to design and certify all retaining walls.

Adjacent services: Design wall so that no imposed loads are applied directly to adjacent service infrastructure and that services are located outside the zone of influence of the wall.

4 DOCUMENTATION

4.1 GENERAL

Approvals

~~Authorities: [complete/delete]~~

Requirements

Standard: Refer to AS 3798 Section 3 for guidelines on the documentation requirements for earthworks design.

Design reports

Requirement: Provide a report documenting all geotechnical requirements, including the following:

- Site preparation and compaction requirements.
- Recommendation for the minimum acceptable quality of fill to be used.

Report guidelines: Refer to AGRD07 section 2.5 for further guidelines on report content.

Other documentation

Watercourses: Provide documentation necessary from relevant Authorities to support the filling of dams and watercourses.

4.2 DRAWINGS

~~Requirements: [complete/delete]~~

Site regrading plan

Features: Define the location of features by distance to corner boundaries, monuments, etc for the purpose of relocation at the geotechnical testing stage and for WAE Drawings.

Annotation: Annotate with the following text unless otherwise approved by Council:

- Retain all topsoil on site and utilise effectively to encourage appropriate revegetation.

Geotechnical requirements: Incorporate all geotechnical requirements and recommendations.

EPA requirements: Document specific requirements of the EPA. Incorporate any sediment, siltation, erosion or salinity control devices/measures with specific reference to the stage at which these are to be provided.

Haulage routes: Document details of all haulage routes including the load limits applicable to each route.

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

~~Final certification of completed works: [complete/delete]~~

Geotechnical report

Certification: Provide a geotechnical report certifying the works to be suitable for the intended purpose. Include any other geotechnical certification, test results and survey data required to conform to the specification.

0041 GEOMETRIC ROAD LAYOUT

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

General: Design and document a road system to provide the following:

- Improved urban structure and revitalisation.
- Convenient and safe access for pedestrians, vehicles and cyclists.
- Appropriate access for buses, emergency and service vehicles.
- A quality road network that minimises maintenance costs.
- A convenient zone for public utilities.
- An opportunity for street landscaping.
- Convenient parking.
- Conformance to the Disability Discrimination Act.
- An appropriate response to climate, geology and topography, existing built fabric, heritage and cultural context of the area.
- Phasing of construction to suit access and funding.
- Drainage of elements within the roadway reserve.
- Street lighting.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- 0010 *Quality requirements for design.*

Related worksections: The following worksections are related to this worksection:

- 0021 *Site regrading.*
- 0042 *Pavement design.*
- 0043 *Subsurface drainage (Design).*
- 0044 *Pathways and cycleways.*
- 0061 *Bridges and other structures.*
- 0074 *Stormwater drainage (Design).*
- 0075 *Control of erosion and sedimentation (Design).*

Workgroup

11 *Construction - Roadways*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian standards

AS 1348-2002	Glossary of terms - Roads and traffic engineering
AS/NZS 2890	Parking facilities
AS/NZS 2890.1:2004	Off-street car parking
AS 2890.5-1993	On-street car parking
AS/NZS 2890.6:2009	Off-street parking for people with disabilities
AS/NZS 3845: 1999	Road safety barrier systems

Austroads

AGRD01-2010	Guide to road design - Introduction to road design
AGRD02-2006	Guide to road design - Design Considerations
AGRD03-2010	Guide to road design – Geometric design
AGRD04-2009	Guide to road design – Intersections and crossings

AGRD04A-2010	Guide to road design – Unsignalised and Signalised Intersections
AGRD04B-2011	Guide to road design - Roundabouts
AGRD06-2009	Guide to road design – Roadside design, safety and barriers
AGRD06A-2009	Guide to road design – Pedestrian and cycle paths
AGRD07-2008	Guide to road design - Geotechnical investigation and design
AGRD08-2009	Guide to road design - Part 8 Process and documentation
AGTM03-2009	Guide to traffic management Part 3 - Traffic studies and analysis
AGTM05-2008	Guide to traffic management Part 5: Road management
AGTM06-2007	Guide to traffic management Part 6: Intersections, interchanges and crossings
AGTM07-2009	Guide to traffic management Part 7: Traffic management in activity centres
AGTM08-2008	Guide to traffic management Part 8: Local area traffic management
AGTM11-2008	Guide to traffic management Part 11: Parking
AGTM12-2009	Guide to traffic management Part 12: Traffic impacts of development
AP-G34-2006	Design vehicles and turning path templates

*Lake Macquarie City Council
Current Development Control Plan (DCP)*

1.4 STANDARDS

General

Road design: To AGRD01 and AGRD02.

Geometric design: To AGRD03.

Intersection design: To AGRD04, AGRD04A.

Geotechnical investigation and design: To AGRD07.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- AADT: Average Annual Daily Traffic.
- ASD: Approach Sight Distance.
- AU: Auxiliary.
- BA: Basic.
- CH: Channelised.
- DDA: Disability Discrimination Act
- EDD: Extended Design Domain.
- HOV: High occupancy vehicle.
- LATM: Local Area Traffic Management.
- MGSD: Minimum gap sight distance.
- NDD: Normal Design Domain.
- SISD: Safe Intersection Sight Distance.

Definitions

General: For the purpose of this worksection, the definitions of terms used to define the components of the road reserve are in conformance with AS 1348, Glossary of Austroads Terms and AGRD03.

The words 'street' and 'road' are interchangeable throughout all parts of this worksection.

- Activity centre: Urban planning term for those places that are vibrant hubs where people shop work, meet, relax and often live.
- Approach sight distance: Relates to the ability of drivers to observe the roadway layout at an anticipated approach speed.
- Batter: Surfaces which connect carriageways or other elements of cross-sections to the natural surface. Batter provides a recovery area for errant vehicles and is used for landscaping and access for maintenance vehicles.

- Carriageway: That portion of the road or bridge devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes.
- Crossfall: The slope of the surface of a carriageway measured normal to the design or road centreline.
- Cycleway: Portion of a road or footpath for the exclusive use of cyclists.
- Extended Design Domain (EDD): The design domain for the assessment of existing roads. EDD is a range of values below the lower bound of the NDD.
- Footpath: A public way reserved for the movement of pedestrians and of manually propelled vehicles. The paved section of a pathway.
- Horizontal alignment: The bringing together of the straights and curves in the plan view of a carriageway. It is a series of tangents and curves that may or may not be connected by transition curves.
- Landform: The type and shape of terrain, usually including topography, geological characteristics, coastlines, rivers and water bodies.
- Legibility distance: The maximum distance that the various types of traffic control signs or devices can clearly be seen under normal operating conditions and where there is no restriction to the line of sight.
- Minimum gap sight distance: Relates to the critical acceptance gap that drivers are prepared to accept when undertaking a crossing or turning manoeuvre at intersections.
- Minor road: All roads which become part of the public road system and are supplementary to arterial and sub-arterial roads. Minor roads may include local sub-arterial roads, collector roads, local roads, and access streets. The terminology of road hierarchy may be different in different states. Refer to the relevant State Road Authorities for more information.
- Normal Design Domain (NDD): The design domain for a new road is referred to as the Normal Design Domain. The extent of NDD defines the normal limits for the values of parameters that have traditionally been selected for new roads.
- Outer separator: It is the portion of the road reserve separating a through carriageway from a service road.
- Pathway: See footpath.
- Pavement: The portion of a carriageway placed above the subgrade for the support of, and to form a running surface for, vehicular traffic.
- Plan transition: The length over which widening and shift is developed from the 'tangent-spiral' point to the 'spiral-curve' point; i.e. the length between the tangent and the curve.
- Reaction time: The time taken for a driver to perceive and react to a particular stimulus and take appropriate action. It is measured in seconds.
- Road network: A framework for movement by other modes, including pedestrian, bicycle and bus and plays a vital role in supporting neighbourhoods and town centres.
- Road reserve: The strip of public land between abutting property boundaries, specifically gazetted for the provision of public right of way. It includes the road carriageway, as well as footpaths, verges and landscape.
- Roundabout: A form of intersection channelization in which traffic circulates clockwise around a central island and all entering traffic is required to give way to traffic on the circulating roadway.
- Service road: A roadway parallel to and separated from an arterial road to service adjacent property. They are usually continuous.
- Shoulder: The portion of formed carriageway that is adjacent to the traffic lanes and flush with the surface of the pavement.
- Shoulder width: The measurement taken from the outer edge of the traffic lane to the edge of usable carriageway and excludes any berm, verge, rounding or extra width provided to accommodate guideposts and guard fencing.
- Side friction factor (f): A measure of the frictional force between the pavement and the vehicle tyre.
- Safe intersection sight distance (SISD): Relates to an overall check that vehicles utilising the intersection have sufficient visibility to allow reaction and deceleration so as to provide adequate stopping distance in potential collision situations.

- Speed (85th percentile): The speed at or below which 85% of the vehicles travel:
 - . Design speed: A speed fixed for the design and correlation of those geometric features of a carriageway that influence vehicle operation.
 - . Desired speed/Operating speed: The speed over a section of a road adopted by a driver as influenced by the road geometry and other environmental factors.
- Sight distance: The distance, measured along the carriageway, over which the visibility occurs between the driver and an object or between two drivers at specific heights above the carriageway in their lane of travel.
- Stopping Sight Distance: The sum of the braking distance and the distance the vehicle travels at a design speed during a reaction time of 2.5 seconds.
- Superelevation: A slope on a curved pavement selected so as to enhance forces assisting a vehicle to maintain a circular path.
- Traffic lane: That part of the roadway set aside for one-way movement of a single stream of vehicles.
- Traffic lane width: Traffic lanes are measured to the face of the kerb or to the lane line for multi-lane roads or roads with shoulders.
- Verge: The section of the road formation that joins the shoulder with the batter. It may accommodate public utilities, stormwater flows, street lighting poles, guide posts, road safety barriers and plantings.
- Vertical alignment: The longitudinal profile along the centreline of a road consisting of series of grades and vertical curves.

1.6 HIERARCHICAL ROAD NETWORK

Road functions

Requirement: Design the network such that the predominant function of the road is conveyed to the motorists. Note that each class of road in the network serves a distinct set of functions and a hierarchical road network is essential to maximise road safety, residential amenity and legibility. Refer to the **Typical road hierarchy diagram**.

Access management categories: Conform to AGTM05.

Traffic management objectives: Conform to AGTM06.

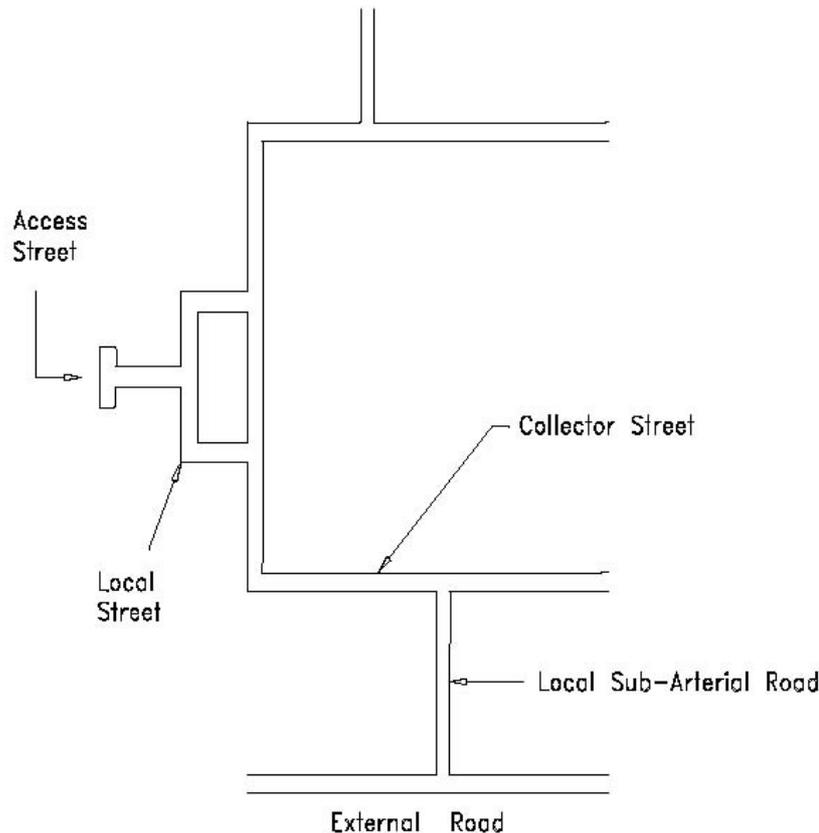
Road function and traffic hierarchy: Conform to AGTM08.

Subdivision layout: To Figure 5 of Section 3.20 (Movement System) of Part 8 (Subdivision Development) of the current DCP.

Terminology: Change as follows:

- *access street and local street with local road*
- *collector street with collector road*

and apply this terminology throughout the guideline.



Typical road hierarchy diagram

Classification

Terminology: The terminology used to describe each class of road varies from state to state. This worksection uses the functional categories common to the majority of states.

Functional classification of urban roads: To AGRD02 Table 2.2.

Functional classification of rural roads: To AGRD02 Table 2.3.

Levels of roads: The four generic distinct levels of roads are Access Street, Local Street, Collector Street and Local Sub-Arterial Road.

Emergency access

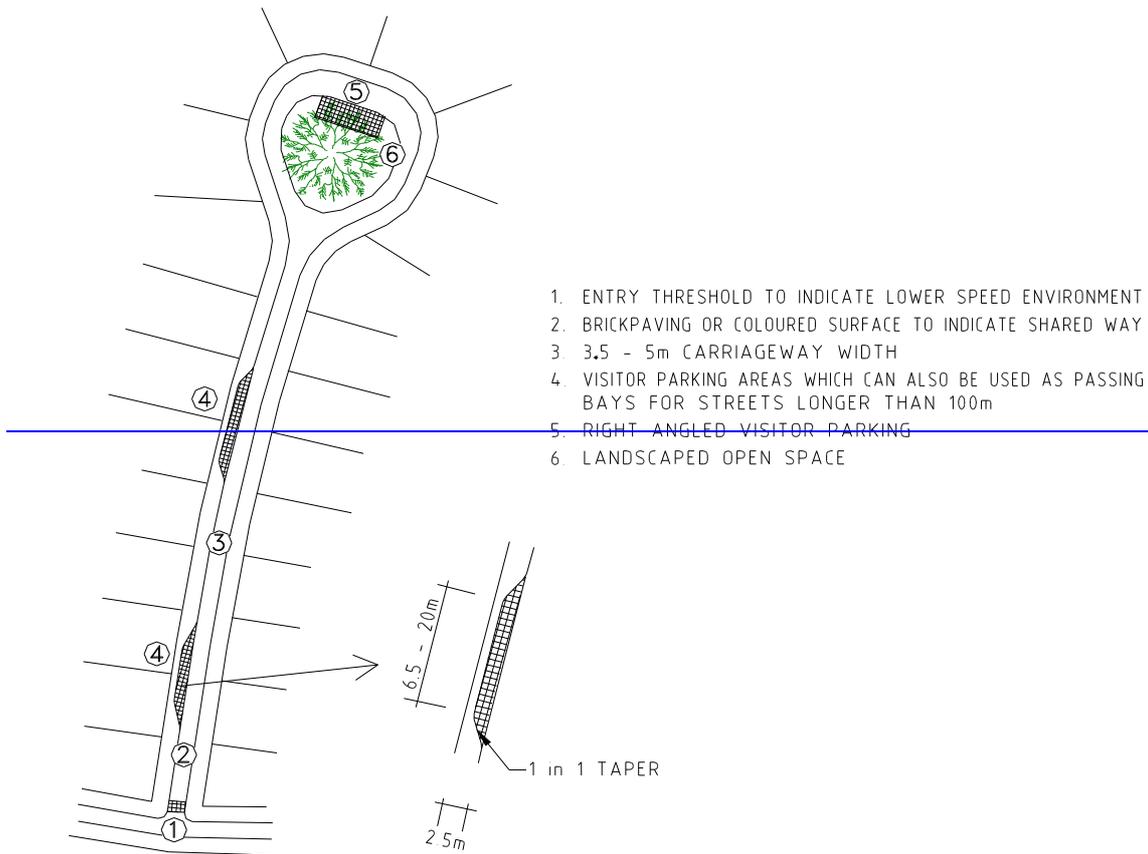
Requirement: Provide at least two access routes for emergency access for each street type in all subdivisions.

Traffic calming: Provide calming geometry to conform with AGTM08.

Access street

Identification: Access street is the lowest order road.

Description: The primary function is residential with amenity features which facilitate pedestrian and cycle movements. Vehicular traffic is compliant, in terms of speed and volume, to amenities, pedestrians and cyclists. [The features of an example of an access street are shown in the Typical access street layout.](#)

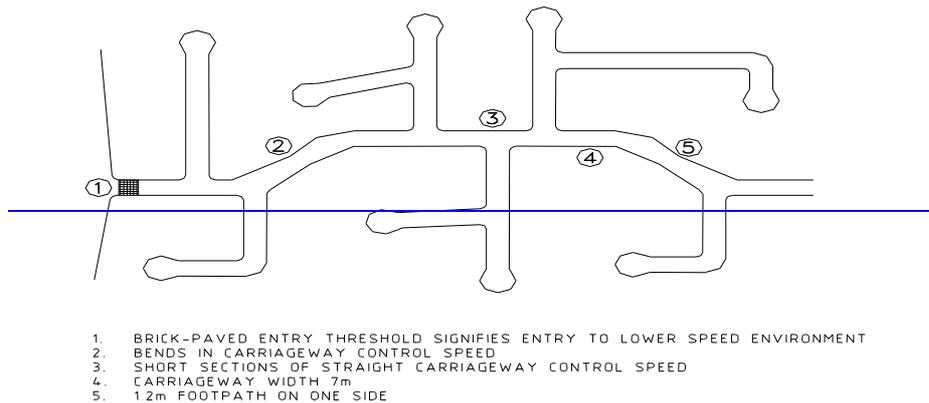


Typical Access street layout

Local street

Identification: Local street is the second lowest order road.

Description: A local residential street, balancing the status of the street in terms of access with residential amenity functions. Resident safety and amenity are dominant but to a lesser degree than access streets. Typically, local streets link access streets with collector streets. [Refer to the Typical local street layout.](#)



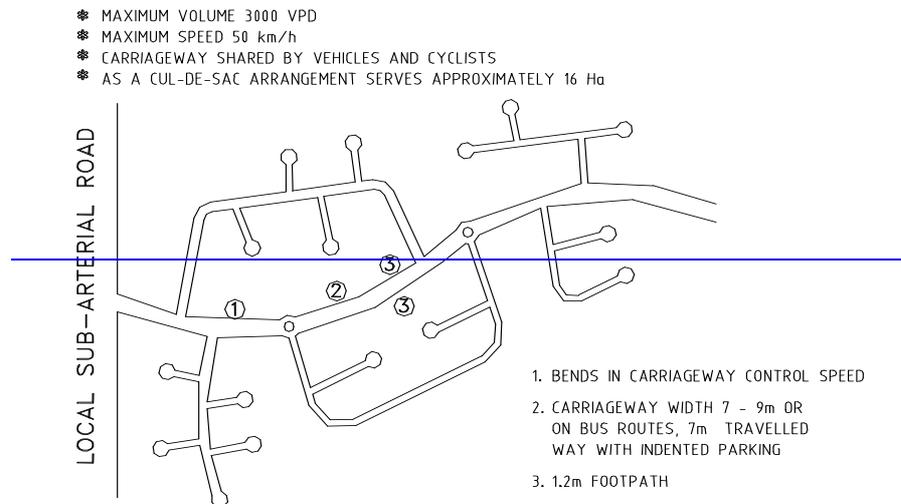
Typical Local street layout

Collector street

Identification: Collector street is the third lowest order road.

Description: It has a residential function but also carries higher volumes of traffic collected from local streets and connects to local sub-arterial roads and provides for community transport and business access. There is a reasonable level of residential amenity and safety through restrictions of traffic volumes and speeds. However, amenity

and resident safety do not have the same priority as in access streets or local streets. Refer to a [Typical collector street layout](#).

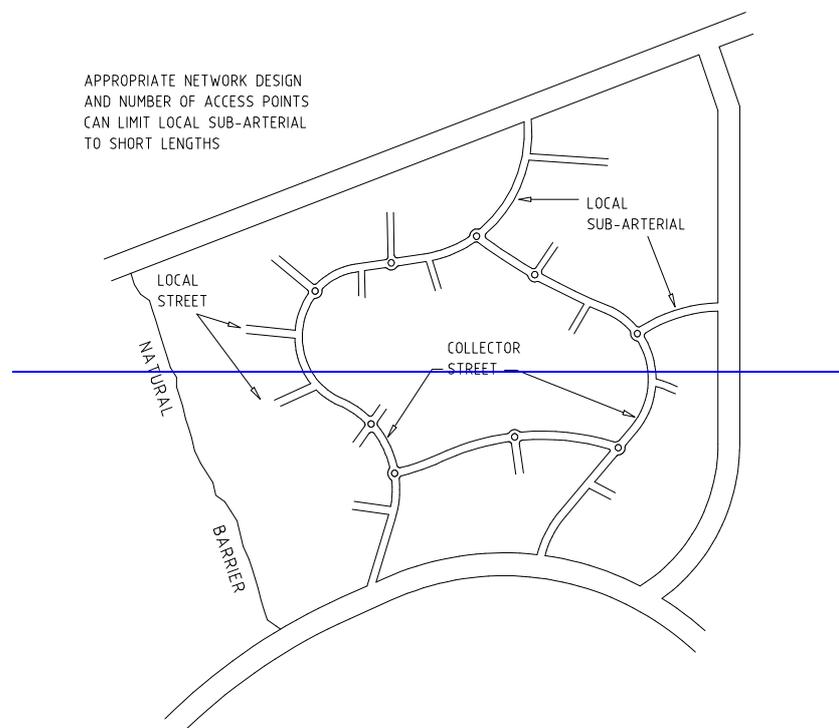


Typical Collector street layout

Local sub-arterial road

Identification: Local sub-arterial road is the highest order road within a residential development.

Description: Its main function is to provide convenient and safe distribution of traffic generated by the development. It provides direct access for single dwelling allotments and access for multi-unit developments and non-residential land uses as appropriate. The local sub-arterial road serves only the development and does not attract through traffic. Refer to [typical Sub-arterial road layout showing also connection to external roads and minor streets](#).



Local sub-arterial road layout

2 PRE-DESIGN PLANNING

2.1 PLANNING

Road hierarchy

Requirement: In new areas, as distinct from established areas with a pre-existing road pattern, ensure each class of route reflects its role in the road hierarchy by its visual appearance and physical design. Routes differ in alignment and design according to the volume of traffic they are intended to carry, the desirable traffic speed, and other relevant factors. Most road authorities have developed a functional hierarchy.

Integrated design principles

Requirement: Integrate all design principles in the development of the road network to provide a balance between maximising amenity, safety and convenience considerations and those related to the drivers' perception of appropriate driving practices.

Preparation for design: Design development inputs to conform to AGRD08.

Acceptable vehicle speed

Requirement: Determine the acceptable vehicle speed for the particular section of road to AGRD03 clause 2.2.4.

Intersection turning movements

Requirement: Minimise the number of turning movements at intersections or junctions that a driver is required to undertake to reach a particular property within the development.

Conformance with Development Control Plan

Pattern and width: Conform to any relevant Development Control Plan (DCP). In areas not covered by such a plan, pattern and width(s) are determined by Council.

Reference: To Section 3.21 (Road Design) of Part 8 (Subdivision Development) of the current DCP.

Legibility

General: Design for clear legibility in conformance with the following:

- Differentiation: Reinforce legibility by providing sufficient differentiation between the road functions. (see **Classifications**)
- Landmark features: Emphasise distinct landmark features such as watercourses, mature vegetation or ridge lines within the structural layout so as to enhance the legibility.
- Introduced features: Provide the necessary legibility, by the inherent design and functional distinction of the road network in addition to introduced physical features such as pavement and lighting details

Environmental considerations

Requirement: Evaluate the environmental considerations including topography, existing public utility services, visual intrusion, noise, vibration and pollution in the road design to AGRD03 clause 2.2.6. Noise reduction: Consider vertical alignment adjacent to intersections and/or sensitive areas (e.g. schools, hospitals) to minimize braking noise.

Salinity prevention

Design constraints: For the design of roads through or adjacent to land known to be salt affected, take the following actions:

- Consultation: Consult with the relevant land and water resource authority.
- Early planning: Consider adjustments in horizontal and vertical line to avoid detrimental interference to and recharge of subsurface water within or adjacent to the road reserve.
- Landscaping: Select appropriate native deep-rooted species for plantings in association with road reserve works. Provide for plantations of sufficient size and density, multiple row belts and relatively close spacings, to lower the groundwater table.

Heritage considerations

Requirement: Heritage sites are recorded in the State heritage asset register. Some sites may contain archaeological sites relating to Aboriginal or non-Aboriginal occupation. Plan for the management of heritage assets.

Council taking responsibility for maintenance

General: Council may take responsibility for the maintenance of a road that is currently used for access but is not maintained by Council if it is upgraded to the standard prescribed by the Engineering Guidelines. Where a property owner is to upgrade an access road for traffic volumes less than 20 vehicles per day and where Council is not required to take responsibility for ongoing maintenance, consideration will be given to a provisional standard.

Provisional standard: To the standard prescribed in Drawing EGSD-702 of the Roadway Standard Drawings.

2.2 CONSULTATION**Council and other Authorities**

Requirements: Consult with the Council and other relevant authorities during the preparation of design. In addition to the requirements of this worksection, identify the specific design requirements of these authorities.

Public consultation

~~Requirements: [complete/delete]~~

Public consultation of design proposals is required as part of the Council policy. Mention any specific requirements here.

Utilities service plans

Existing services: Obtain service plans from all relevant utilities and other organisations whose services exist within the area of the proposed development. Plot these services on the relevant drawings including the plan and cross-sectional views.

Requirements for utility services: To Streets Opening Conference *Guides to codes and practices for street openings*.

3 DESIGN**3.1 DESIGN CRITERIA****Design domain**

~~Design domain to AGRD02 clause 2: [complete/delete]~~

Location

~~Road network location: [complete/delete]~~

Traffic volume and composition

Requirements: Determine the AADT to AGTM03.

3.2 ROAD NETWORK DESIGN CRITERIA**General**

Routing: Provide routing as follows:

- Avoid through routes in the internal road system that are more convenient than the external road network in conformance with AGTM08.
- Design and locate the external road network to provide routes that are more convenient for potential through traffic within the network.
- Provide access to major roads at intervals of no more than 1.5 km, of adequate capacity to accommodate through network movements.

Road links: Provide for road links as follows:

- Hierarchy: Except in exceptional circumstances, do not link one road with another that is more than two levels higher or lower in the hierarchy.

- Restriction: Avoid access from Access streets or Local streets to an access-controlled arterial road.

Traffic volumes and speeds: Ensure that the traffic volumes and speeds on any road are compatible with the residential functions of that road.

Road layout: Conform to the requirements of the external road network and satisfy the transport provisions of an outline development plan.

Travel time: Minimise the time required for drivers to travel on all streets within the development.

Internal road connections: Provide for intersections of internal roads as T-junctions or controlled by roundabouts.

Access street: Restrict the maximum length of an Access street to ensure that its status within a residential place is retained. Adopt design speed and volume to enable the integration of pedestrian, bicycle and vehicular movements without impairing residential convenience.

Local sub-arterial road: Minimise the length of local sub-arterial road within a development.

Pedestrian or bicycle network: Where Access streets form part of a pedestrian or bicycle network, provide for access links with adjoining access streets or open space systems to ensure functional efficiency of the pedestrian and bicycle network.

Traffic management in Activity Centres: Conform to AGTM07.

Traffic impacts of developments: Conform to AGTM12.

3.3 DESIGN SPEED

General

State Road Authority guidelines: Use design speed as the basic parameter in road design. It is dependent on the functional classification of the road, topography, land use and abutting development and desired speed of drivers.

Design speed values for urban roads

Requirement: Conform to the following operating speeds:

- Access street: 25 km/h.
- Local street: 50 km/h.
- Collector street: 60 km/h.
- Local sub-arterial road: 60/80 km/h.
- Speed limits: To AGTM05 Table 5.4.
- Typical urban operating speeds: To AGRD03 Table 3.1.

Operating speed model

Model: Determine the operating speed using the operating speed model to AGRD03 clause 3.5 to predict the operating speed of cars along the length of the road where the operating speed varies with the horizontal curvature and is also dependent on the driver behaviour, road and the vehicle characteristics.

Hazard reduction

Low speeds: Adopt a low design speed to discourage speeding. Avoid vertical or horizontal curves of low design speed located in otherwise high-speed sections to minimise the risk of creating a potentially dangerous section of road. Recognise that in low design speed roads, operating speeds may be in excess of posted speed limits.

Hazardous features: Make hazardous features visible to the driver. Adopt traffic engineering measures that help a driver avoid errors of judgement.

Road safety barriers: Assess and design road safety barriers to AS/NZS 3845.

Design speed values for rural roads

Criteria: Determine the minimum design speed value for other elements for Council Works on the concept of a 'speed environment' as outlined in AGRD03 clause 3.4 and Table 3.2.

Requirement: Conform to the following operating speeds:

- High speed rural roads: > 90 km/h.
- Intermediate speed rural roads: 70-90 km/h.
- Low speed rural roads: 50-70 km/h.

Restricted access to major roads: Design all rural subdivisions to control access to major roads. Limit access to one point on to local, collector, local sub-arterial or arterial road networks.

3.4 CROSS-SECTION**Road reserve characteristics**

Cross section: Provide for all road functions including the following:

- Safe and efficient movement of all users.
- Provision for parked vehicles. Give particular attention to access for disabled persons in conformance with the Disability Discrimination Act.
- Access to public transport.
- Buffer from traffic acoustic nuisance for residents.
- Provision of public utilities
- Streetscaping.
- Requirements of Disability Discrimination Act.

Operational aspects: Conform to the following:

- Allow vehicles to proceed safely at the operating speed intended for that level of road in the network with only minor delays in the peak period.
- Take into consideration the restrictions caused by parked vehicles where it is intended or likely that this will occur on the carriageway.
- Vehicles include trucks, emergency vehicles and, on some roads, buses. (Refer to **Bus route criteria table**).

Type of cross-section

General: Determine the type of cross-section considering the following factors:

Location: ~~[complete/delete]~~

Function of the road: ~~[complete/delete]~~

Type of road: ~~[complete/delete]~~

Traffic volume: ~~[complete/delete]~~

Public transport: ~~[complete/delete]~~

Environmental constraints: ~~[complete/delete]~~

Availability of construction materials: ~~[complete/delete]~~

Design life: To AGRD03 Table 4.1.

Pedestrians and cyclists: Provide for the safety of pedestrians and cyclists where it is intended they use the carriageway by providing sufficient width and control of landscaping to provide sight distances.

Access to allotments: Adopt a carriageway width to provide for unobstructed access to individual allotments. Provide for drivers to comfortably enter or reverse from an allotment in a single movement, taking into consideration the possibility of a vehicle being parked on the carriageway opposite the driveway.

Reference: To Table 2 of Section 3.21 (Road Design) of Part 8 (Subdivision Development) of the current DCP.

Traffic lanes

General: Determine the number and width of the traffic lanes required depending upon the traffic volume, presence of cyclists, available road reserve width and the side friction constrained by abutting access.

Standard traffic lane width for urban and rural roads: 3.5 m.

Reduced lane width: If there are site constraints the traffic lane width may be reduced to 3.2 m subject to the approval of the relevant road authority.

Urban arterial road widths: To AGRD03 Table 4.3.

Single carriageway rural road widths: To AGRD03 Table 4.5.

Dual carriageway rural road widths: To AGRD03 Table 4.6.

Plan transitions

Restrictions: In urban road design it is often impracticable to use plan transitions as kerb lines are fixed in plan and any shift requires carriageway widening. Widening on horizontal curves compensates for differential tracking of front and rear wheels of vehicles, overhang of vehicles, and transition paths. If proposed roads are curved, consider the adequacy of carriageway width.

Crossfall changes: To avoid abrupt changes in crossfall, which can cause discomfort in travel and create a visible kink in the kerb line, conform to the following:

- The wider the pavement the longer the transition.
- Use superelevation transitions at all changes in crossfall, not just for curves. Drainage problems can arise with superelevation transitions which may require extra gully pits and steeper gutter crossfalls.
- Where crossfalls change at intersections, draw profiles of the kerb line. Calculated points can be adjusted to present a smooth curve.

Crossfall

General: Desirably, crown the roads on centerline. Provide crossfall to drain the carriageway on straights and curves and to provide superelevation on horizontal curves. Provide pavement crossfalls on straight roads for various pavement types to the

Pavement crossfall on straights table.**Pavement crossfall on straights table**

Type of pavement	Crossfall (%)
Earth, loam	5
Gravel, water bound Macadam	4
Bituminous sprayed seal	3
Asphalt	2.5 – 3
Concrete	2 - 3

Recommended minimum crossfall: 2%.

Rate of change: Do not exceed the rate of change of crossfall in the following conditions:

- Through traffic: 6% per 30 m.
- Free flowing turning movements: 8% per 30 m.
- Turning movements for which all vehicles are required to stop: 12% per 30 m.

Precedence of crossfall over grade: Conform to the following:

- The crossfall on a Collector street or Local sub-arterial road will take precedence over the grade in Local or Access streets. Maintain the crossfall on the major road and adjust the local street levels to suit.
- A rate of change of grade of 2 % in the kerb line of the side street relative to the centre line grading is a reasonable level.

Shoulders

Function: Design road shoulders to carry out the following functions:

- Structural: Provide lateral support to the road pavement layers.

- Traffic: Provide an initial recovery for an errant vehicle, emergency use, a refuge for stopped vehicles and space for cyclists.

Shoulder width: Provide the following:

- Generally: 1.5 – 2 m.
- For higher volume roads: 2.5 – 3 m.

Shoulder sealing: Seal the shoulders partially or wholly to reduce maintenance costs and to improve moisture conditions under pavements. Conform to the following sealed widths:

- Minimum width of shoulder seal for AADT < 1000: 0.5 m.
- For wet areas where moisture control is required:
 - . Desirable shoulder seal width: 0.5 m.
 - . Preferred shoulder seal width: 1 m.
- For discretionary stopping of cars: 2.5 m.
- For bicycles, minimum sealed width: 2 – 3 m.

Shoulder crossfall: Provide the following shoulder crossfall:

- For earth and loam: 5 – 6%.
- For gravel or crushed rock: 4 – 5%.
- For concrete and for full depth pavement with bitumen seal or asphalt wearing course: Match with the traffic lane.

Verge

General: Design the verge to perform the following functions:

- A traversable transition between the shoulder and the batter slopes.
- A firm surface for stopped vehicles.
- Space for installation of guideposts and road safety barriers.
- Reduce scouring due to stormwater run-off.

Minimum width: To AGRD03 Table 4.9.

Verge rounding: Provide verge and batter toe rounding to minimise rollover accidents to AGRD03 Table 4.10.

Verge slope: Provide verge slopes for local roads or behind kerb and channel in cut:

- Without rounding: 5%.
- With rounding: Initial slope same as abutting shoulder.

Verges and property access

Criteria: Design the verge with consideration of utility services, the footpath width, access to adjoining properties, likely pedestrian usage and preservation of trees.

Restriction: If normal crossfalls are impracticable adopt low level footpaths.

Crossfalls in footpath paving: < 2.5% to AGRD06A.

Longitudinal grade: Conform to the following:

- Parallel to the longitudinal grade of the road.
- Limit: May be steeper than 5%.

Driveway profile: Conform to the following:

- Provide a vehicular driveway centreline profile for the property access.
- Check the design using critical car templates, available from the Council.
- Design driveway profiles so that vehicles can use the driveway satisfactorily.

Batters

Requirement: Accommodate differences in level across the road between road reserve boundaries by the following measures used individually or combined:

- Cutting at the boundary on the high side and providing the verge at normal level and crossfall.
- Battering at the boundary over half the verge width with the half against the kerb constructed at standard crossfall.

Batter slopes: Design the batter slopes considering the following factors:

- Recommendations of geotechnical investigations.
- Batter stability and safety.
- Available width of road reserve.
- Landscape requirements.
- Maintenance costs and accessibility requirements. Preferred maximum batter slope for a slasher is 4:1.

Design batter slopes: To AGRD03 Table 4.12.

Benches: Provide benches for high batters > 10 m vertical height or batters on unstable ground. Provide benches as shown in AGRD03 Figure 4.7.

- Minimum width of bench: 3 m.
- Maximum crossfall: 10%.
- Preferred bench width for road safety, maintenance and drainage: 5 m.

Roadside drainage

General: Provide drains to remove water from the road and its surroundings and to maintain road safety and pavement strength. Provide table drains, catch drains, median drains or kerbs and channels.

Table drain: Provide a dish drain, or similar structure along the invert of table drains, seal the outer edges of the pavement, the shoulder verges and the drain lining where scour is likely to occur to AGRD03 Figure 4.8. Provide the following slopes:

- Side slopes: < 4H:1V.
- Desirable slope: 6H:1V.

Catch drains: Provide catch drains to prevent overloading of the table drain and scour of the batter face at least 2 m from the edge of cuttings to minimise possible undercutting of the top of the batter.

Median drains: Provide median drains with side slopes 10H:1V to reduce the chance of vehicle overturning. Provide a depressed median of minimum 10 m width. Place the invert of the median drain below subgrade level to facilitate drainage of pavement layers.

Kerb and channel: Provide kerb and channel to perform the following:

- Collect and convey surface drainage to a discharge point.
- Delineate the edges of the carriageway.
- Separate carriageways from areas dedicated to footpath users.
- Support the edge of the base course of the pavement.
- Reduce the width of cut by substituting an underground drainage system in place of table drains.

Kerb type and placement: Determine the type of kerb and placement to AGRD03 clause 4.6 and the following:

- Provide barrier kerb for lightly trafficked Local roads, adjacent to parking lanes and parking areas and bus bays to reduce the risk to pedestrians.
- Provide layback kerb on minor roads to allow for off-road parking and for continuous access to property.

Location: Place kerb and channel with the clearance between the face of the kerb and edge of the traffic lane to AGRD03 Table 4.13.

Scour protection

Requirement: Provide scour protection of roadside drainage and table drains. The level of protection will depend on the nature of the soils, road gradients and volume of stormwater runoff.

Protection of the works: Provide concrete lined channels, turfing, rock pitching, grass seeding, individually or in combination. Carry out geotechnical investigations to determine the level and extent of any protection works before proceeding to final design stage.

Medians

General: Provide medians to improve the safety and operation of urban and rural roads with multiple lanes.

Median width: Minimum median width to AGRD03 Table 4.14.

Median slopes: Provide median slopes to AGRD03 Table 4.15.

Bicycle lanes

General: Consider provisions for cyclists in the road design and provide adequate space for cyclists to share the road safely and comfortably by providing on-road bicycle facilities in the form of the following:

- Separate bicycle lanes: Provide separation from other motor traffic with exclusive bicycle lane on the left side of the road by pavement markings and signs.
- Road shoulders.
- Widened lanes for joint use by bicycles and other vehicles.

Bicycle lane width: To Bicycle lane widths table.

Restriction: Provide a minimum bicycle width of 2 m in congested areas.

Bicycle lane widths table

Lane width (m)	Speed limit (km/h)		
	60	80	100
Desirable	1.5	2.0	2.5
Acceptable	1.2 - 2.5	1.8 - 2.7	2.0 - 3.0

Minimum clearance with adjacent traffic on local roads: 1 m.

High occupancy vehicle (HOV) lanes

General: If there are any public transport services proposed in the route, provide HOV priority lanes for public transport in conformance with the following:

- Shoulder width: 3.5 m.
- Intermittent bays: Provide bays with appropriate length tapers to provide safe movement of vehicles.
- Provide access to public transport in conformance with the Disability Discrimination Act.

Bus lane width: On new roads, conform to the following:

- To AGRD03 Table 4.21.
- Minimum width between the kerbs:
 - . If bicycle lanes are provided: 15 m.
 - . If bicycle lanes are not provided: 11.6 m.
- Kerbside width of bus lanes: To AGRD03 Table 4.22.

On-site parking

On-site: Design on-site parking by determining the demand for parking to AGTM11, including the following:

- Accommodate on-site parking requirements for normal levels of activity associated with any land use.
- Ensure that the through traffic is not impeded.
- Locate all on-site parking of dimensions that allow convenient and safe access and usage.
- Number of on-site parking spaces for non-residential land uses: Conform to parking standards as determined by the relevant authority.
- The layout and access arrangements for parking areas for non-residential land uses: To AS/NZS 2890.1.
- On-site parking for people with disabilities: To AS/NZS 2890.6 and to the Disability Discrimination Act.

Number of on-site residential spaces: Conform to the following:

- Provide two car parking spaces (which may be in tandem) on-site for each single dwelling allotment.
- Provide three spaces on-site for each two dwelling units for multi-unit residential developments.

Minimum dimension: Include one space for each residential unit within the allowable building area and with a minimum dimension of 5.0 m by 3.0 m.

On-street parking

Standards: To AS 2890.5, AGRD03 clause 4.10 and AGTM11.

Road reserve parking: Provide adequate parking within the road reserve for visitors, service vehicles and any excess resident parking since a particular dwelling may generate a high demand for parking.

Future spaces: On single lane carriageways, provide one space for each two allotments on the verge within 25 m of each allotment, with scope to provide one additional space for single dwelling allotments or for each two units in a multi-unit development if required at a future time.

Short term truck parking: On single lane carriageways, combine a number of verge spaces to provide for short term truck parking within 40 m of any allotment.

Verge and carriageway parking: On single lane access streets, provide parking spaces within the verge. Provide verge and carriageway parking in conformance with the following:

- Adequate dimensions.
- Convenient and safe to access.
- Well defined with traffic control devices.
- All-weather surface.
- No restriction to the safe passage of vehicular, disabled and pedestrian traffic.

Joint use: For non-residential land uses, provide the opportunity for maximum joint use of shared parking by a number of complementary uses.

On-street parking dimensions: Conform to the following:

- Single (car) space: 6.5 m x 2.5 m
- Combined spaces for two cars: 13.0 m x 2.5 m
- Truck parking: 20 m x 2.8 m with adequate tapers at both ends to allow parking manoeuvres determined to AP-G34.

Material: Construct all verge spaces and indented parking areas of concrete, interlocking pavers, lawn pavers, bitumen with crushed rock or other suitable base material designed to withstand the loads and manoeuvring stresses of vehicles expected to use those spaces.

Right-angled parking: Provide right-angled parking only on Access streets and Local streets where speeds do not exceed 40 km/h.

Angled parking space widths: To AS 2890.5 Table 2.2.

Service roads and footpath

General: Service roads provide access to the abutting property or control access to the arterial road from the abutting property.

Minimum service road lane width: To AGRD03 Table 4.25.

Minimum service road carriageway width for roads with low traffic volumes: To AGRD03 Table 4.26.

Operating speed: 40-60 km/h.

Outer separator width: To AGRD03 Table 4.27

Urban border: Provide urban borders comprising of a pedestrian path and the nature strip to AGRD03 Table 4.28, to ensure the following:

- Separate pedestrians from vehicular traffic.
- Provide off-road bicycle facilities.
- Provide for indented bus bays.

- Take up level differences between the carriageway and the boundaries of the adjacent properties.
- Provide for public utility services and drainage.

Typical urban border slopes: Conform to the following:

- For footpaths
 - . Desirable: 1%
 - . Maximum: 2.5%
- Nature strip:
 - . Grassed soil: 4-10%
- Determine minimum slope on urban borders by considering the drainage.
- Determine the maximum slope by considering the terrain and provision of access at driveways.

Footpaths: Provide footpaths either adjacent to the roadway or separated from it by a nature strip.

Standard: To AGRD06A.

Minimum desirable width: 1.2 m.

Reference: To Table 2 in Section 3.21 (Road Design) of Part 8 (Subdivision Development) of the current DCP.

Pavement type: Concrete reinforced with mesh steel.

Crossfall: Varies from flat to 2.5%.

Bus stops

New bus stops: In conformance with the requirements of the Disability Discrimination Act (Australian government 1992) and other road authorities and transport agency disability standards which outline the requirements of the access paths, manoeuvring areas, ramps, waiting areas, surfaces and tactile ground surface indicators.

Urban bus stops: To AGRD03 Figure 4.39 provides a typical bus bay layout.

Rural bus stops: Locate bus stops in the road shoulder between the carriageway and table drain.

Minimum shoulder width for a bus stopping area: 3 m.

Minimum length of bus stopping area: 15 m.

For intermediate speed environments provide a longer sealed distance: 30-50 m.

3.5 SIGHT DISTANCE

General

Stopping and sight distance: Provide stopping and sight distance at all points on the road conforming to AGRD03 Section 5.

Sight distance parameters: To AGRD03 Table 5.1 and the following:

- Object cut-off height: 0.2 m.
- Driver eye height: Adopt the following:
 - . For cars: 1.1 m.
 - . For commercial vehicles: 2.4 m.
- Driver reaction time: Adopt reaction time of 2.5 seconds for all roads. If 1.5 seconds and 2 seconds reaction times are required, arrange approvals from the State Road Authority. AGRD03 Table 5.2 provides further details on reaction times.

Stopping sight distance: Conform to the following:

- General: To AGRD03 clause 5.3, measured from an eye height of 1.15 m to an object height of 0.20 m.
- On sealed roads: Car stopping sight distance to AGRD03 Table 5.4.
- On horizontal curves: To AGRD03 Figure 5.4.
- On horizontal curves with roadside barriers: Provide minimum shoulder widths and manoeuvre times for sight distances over roadside safety barriers on horizontal curves to AGRD03 Table 5.6.

Horizontal curve perception sight distance: Provide sufficient sight distance by adopting larger crests for a horizontal curve. Do not provide a horizontal curve starting over a crest. Check sufficient visibility is provided for the curve by providing:

- Clear driver eye height: 1.1 m.
- A zero object height such that the driver can see the road surface in order to perceive the curvature.
- Driver visibility of a minimum of:
 - . 5 degrees of arc.
 - . 80 m of arc.
 - . The whole curve.

3.6 COORDINATION OF HORIZONTAL AND VERTICAL ALIGNMENT

Horizontal and vertical alignment coordination

General: The 3 dimensional coordination of the horizontal and the vertical alignment on the road aims to increase efficiency, safety, encourage uniform speed, improve aesthetics, provide harmony with the landform and drainage.

Requirement: Conform to the following:

- Avoid the use of minimum radius horizontal curves with crest vertical curves.
- Contain the crest vertical curves within horizontal curves to enhance the appearance of the crest by reducing the three dimensional rate of change of direction and to improve safety.
- Provide the same design speed of the road in both horizontal and vertical planes.
- Avoid sharp horizontal curves at or near the top of a crest vertical curve.
- Consider three dimensional combined horizontal and vertical stopping sight distance and minimum sight distance.
- Provide a horizontal curve to indicate the change in direction before introduction of vertical curve in both directions of travel.
- Be aware that a short vertical curve on a long horizontal curve or a short tangent in the grade-line between sag curves may adversely affect the road's symmetry and appearance.

Aesthetic consideration: Conform to the following:

- Provide horizontal curves slightly longer than the vertical curve, such that the curves fits with the terrain and are coincident.
- Provide long horizontal curves to short curves such that:
 - . The overtaking opportunities are not reduced.
 - . Small deflection angles avoid the appearance of a kink.
 - . Best appearance is provided for deviations around obstructions.
 - . The far tangent point is beyond the driver's point of concentrated vision for curves located at the end of long straights.

Drainage consideration: To ensure pavement drainage and to reduce the risk of aquaplaning, avoid very long crest and sag curves, that result in long sections of flat grades at the top and the bottom of the curves.

3.7 HORIZONTAL ALIGNMENT

General

Requirement: Provide horizontal alignment for safe and continuous vehicle operation at a uniform travel speed. Include the following:

- For low and intermediate speed rural roads and minor urban roads, where physical restrictions curve radii cannot be overcome, introduce curvature of a lower standard than the design speed of the project to AGRD03 Table 7.1.
- Provide tangents of suitable length as frequently as the terrain permits to facilitate overtaking manoeuvres.
- Determine the horizontal alignment from the design speeds for a particular street within the road hierarchy (see **Design Speed**).

Horizontal curves

Types of horizontal curves: Conform to the following:

- Compound curves: Provide a smaller curve preceding a larger curve. Avoid diminishing radii at steep downgrades.
- Reverse curves: Do not use reverse curves unless there is sufficient distance between the curves to introduce full superelevation of the two curves without exceeding the standard rate of change of crossfall for a particular design speed.
- Transition curves: Join the straight and circular curves to smooth the travel of vehicles within the traffic lane. Transition the horizontal curves with the transition length based on the superelevation runoff length for the recommended combination of speed, radius and superelevation. Avoid transition curves for large radius horizontal curves and where operating speed is less than 60 km/h. Where lane width is ≤ 3.5 m, provide transition paths for trucks.

Horizontal curves and tangent lengths

Speed/radius relation: Conform to the following:

- For a given design speed, utilise the minimum radius of curvature that ensures that drivers can safely negotiate the curve.
- Avoid curves that progressively tighten (e.g. parabolic curves) and sudden reverse curves that drivers cannot anticipate as they have the potential to produce an uncomfortable sense of disorientation and alarm.

Speed restriction: Where speed restriction is provided by curves in a street, conform to the relationship between the radius of the curve and the desired vehicle speed.

Tangents: Determine appropriate lengths for tangents between speed restrictions, which may be curves, narrow sections or other obstructions.

Sight distance: Determine the sight distance on curves to AGRD03 clause 5.4.

Desired curve radii for the design of low speed local roads: To the following table.

<i>Desired Vehicle Speed (km/h)</i>	<i>Curve Radii (m) on Road Centreline</i>	
	<i>Curvilinear Alignment (no tangents)</i>	<i>Isolated Curve Alignment (with tangent sections)</i>
<i>20 or less</i>	<i>20</i>	<i>20</i>
<i>25</i>	<i>20</i>	<i>20</i>
<i>30</i>	<i>30</i>	<i>20</i>
<i>35</i>	<i>50</i>	<i>30</i>
<i>40</i>	<i>90</i>	<i>40</i>
<i>45</i>	<i>105</i>	<i>50</i>
<i>50</i>	<i>120</i>	<i>60</i>
<i>55</i>	<i>140</i>	<i>70</i>
<i>60</i>	<i>160</i>	<i>80</i>

Desired maximum tangent length between curves or restrictions for the design of low speed local roads: To the following table.

Desired Vehicle Speed in Curve (km/h)	Maximum Advisable Tangent Length (m) between Curves or Restrictions Appropriate to a Selected Design Speed.						
	Design Speed						
	25	30	35	40	45	50	60
<= 20	40	75	100	120	140	155	180
25	-	45	75	100	120	140	165
30	-	-	45	80	100	120	150
35	-	-	-	50	80	100	135
40	-	-	-	-	55	80	120
45	-	-	-	-	-	60	105

Side friction and minimum curve size

Recommended side friction factors: To AGRD03 Table 7.4.

Minimum radii for horizontal curves based on superelevation and side friction: To AGRD03 Table 7.5.

Maximum allowable deflection angles without horizontal curves: To AGRD03 Table 7.6.

Superelevation

Requirement: Use of superelevation in association with horizontal curves for geometric design of roads with all design speeds.

Criteria: Determine the superelevation by including the following:

- Operating speed of the curve.
- Difference between the inner and outer formation levels in flat or urban areas
- Stability of high vehicles when adverse crossfall is considered.
- Length available to introduce the necessary superelevation.

Minimum radius of curves: Determine from the following:

- Design speed.
- Minimum superelevation (or maximum adverse crossfall) at any point on the circular portion of the curve.

Low design speed and crowned pavement: Conform to the following:

- Access and Local streets: For design speeds of 50 km/h or less, and curves of 60 m radius or less, generally have the pavement crowned on a curve instead of superelevation.

Superelevation in rural roads: Design superelevation, widening and centreline shift and transitions in conformance with the AGRD03 clause 7.7.

High design speed: Conform to the following:

- Maximum superelevation for urban roads of higher design speeds: 6%.
- Maximum values for different road types: To AGRD03 Table 7.7.
- Avoid any increase in the longitudinal grade leading to excessive crossfall at intersections.
- While it is desirable to superelevate all curves, limit adverse crossfall to 3%.

Length of superelevation: Design superelevation development lengths to satisfy both rate of rotation and relative grade criteria to AGRD03 Table 7.9.

Transitions: Conform to the following:

- Planning: Plan transitions on superelevated curves for appearance and to provide sufficient length in which to apply the superelevation.

- Urban roads: Superelevation may be conveniently applied to the road cross section by shifting the crown to 2 m from the outer kerb, as long as the road is not too wide.
- Access to adjacent properties: The axis of rotation of the cross section for urban roads is normally the kerb grading on either side which best enables access to adjacent properties and intersections.
- On the outside of superelevation, or where the longitudinal grade of the gutter is < 0.5%, adopt a crossfall of 63 mm in a 450 mm wide gutter.

Curves with adverse crossfall

General: Avoid adverse crossfall greater than 3% except for curves with an operating speed ≤ 70 km/h in constrained areas and for intersection turns and roundabouts.

Minimum radii with adverse crossfall: *Seek advice from Council.*

Adverse superelevation: Provide adverse superelevation at the following:

- Property access controls.
- Channel drainage controls.
- Grading restrictions.
- Intersections to maintain visibility of the road surface.

Pavement widening on horizontal curves

Widening: Provide pavement widening on curves to AGRD03 Table 7.11 to maintain lateral clearance between vehicles taking into account the following factors:

- Radius of the curve.
- Width of lane on a straight road.
- Vehicle length and width.
- Vehicle clearance.

3.8 VERTICAL ALIGNMENT

General

Documentation: Show vertical alignment on a longitudinal section with a vertical scale of 10H:1V.

Vertical controls

Requirement: Consider the effect of the following features on the vertical geometric design:

- Existing topography.
- Geotechnical conditions.
- Existing intersections.
- Property entrances.
- Pedestrian access.
- Service utility assets.
- Median openings.

Minimum clearance above flood levels and water tables: As defined by the relevant road authority.

Vertical clearances

General: Provide minimum vertical clearances over roadways and pedestrian/cycle paths to AGRD03 Table 8.1.

Precedence: If there is a conflict the following order takes precedence:

- Policies of the road owning authority e.g. Council, State Road Authority.
- Requirements of the authority that owns the object e.g. rail authority.

Underground services

Clearance requirements: Consult the relevant authority to determine the minimum clearance requirements for:

- Gas mains.
- Water mains.

- Stormwater drains.
- Sewer outfall.
- Telecommunication cables.
- Underground electrical cables.
- Road authority assets e.g. traffic signals and street lighting.

Longitudinal gradient

General: Provide grades as flat as possible, consistent with longitudinal drainage requirements such that all vehicles operate at the same speed. Conform to the following minimum grades:

- Road with kerb and channel:
 - . Minimum desirable grade: 1%
 - . Absolute minimum grade: 0.3%.
- Roads in cut:
 - . Unlined drains: 0.5%.
 - . Lined drains: 0.3%.
- Roads without kerb and channel and not in cut: 0%.
- Minimum gradient of 0.5%.
- In very flat conditions: Reduce grade to 0.3%.
- If underground drainage with gully pits or other special works are used: Consider near level grades. Provide variable crossfall to achieve the required grade in the gutter.

Maximum grade: To AGRD03 Table 8.3.

Intersections: Conform to the following:

- Longitudinal grade of the minor street on the approach to an intersection: < 4%.
- Design actual gradient dependent on the type of terrain.
- Interrelate the design of the road alignments and the grades used.
- Avoid a steep grade on a minor side street if vehicles have to stand waiting for traffic in the major road.

Maximum grade in cul-de-sacs and turning circles: < 5 %.

Steep gradient: Provide concrete pavement where gradient exceeds 16%.

Vertical curves

Criteria: Design vertical curves in conformance with the following:

- Provide vertical curves like simple parabolas on all changes of grade exceeding 1%.
- Desirable minimum design speed: 40 km/h.
- The length of the crest vertical curve for Stopping Sight Distance: To AGRD03 Table 8.7.
- Limit the length of crest curve with 0.3% to 0.5% grade: 30 to 50 m.

Sag curves: Provide the lengths of sag vertical curves to AGRD03 clause 8.6.4 and the following:

- For kerbed roads: Limit the maximum length of sag curves with less than 0.3% grade to 30 m.
- Maintain a minimum grade of 0.5% in the kerb and gutter. This may require some warping of road cross sections at sag points.

Sag vertical curves: As residential roads are usually lit at night, the criterion for designing sag vertical curves is a vertical acceleration of the following:

- For desirable riding comfort: 0.05 g.
- For minimum riding comfort: 0.10 g.

Side road intersections: Locate intersections of roads at a safe distance from a crest, determined by visibility from the side road. If it is proposed to locate intersections of a side road where a crest occurs, provide details with justifications.

Design of vertical curves for low speed local roads: To Annexure A.

3.9 AUXILIARY LANES

General

Requirement: Provide auxiliary lanes adjacent to the through traffic lanes to enhance traffic flow and maintain the required level of service where an Arterial road meets with the Sub-arterial, Collector or Local roads.

Types of auxiliary lanes

Speed change lanes: Provide speed change (acceleration or deceleration) lanes at intersections or interchanges to allow an entering vehicle to access the traffic stream at a speed approaching or equal to 85th percentile speed of the through traffic.

Overtaking lanes/climbing lanes: Provide overtaking lane lengths to AGRD03 Table 9.2 and merge sight distance at the end of overtaking to AGRD03 Table 9.3.

Slow vehicle turnouts: Provide a short section of paved shoulder to allow vehicles to pull aside and be overtaken. Provide turnout lengths of 60 – 160 m for average approach speed of 30 – 90 km/h and a width of 3.7 m.

Cross-section

Auxiliary lane width: Provide auxiliary lane width not less than the normal width for that section of the road.

Shoulder width: 1 m.

Crossfall: Provide same crossfall of the auxiliary lane as the adjacent lane.

3.10 INTERSECTIONS

Design criteria

Requirement: Consider the following factors in the location and design of intersections:

- Alignment and grade of approach road.
- Provision of drainage.
- Interference with public utilities.
- Property access.
- Topography.
- Natural and built environment.

Urban and rural intersections: To AGRD04 Table 4.1.

Road users considerations: To AGRD04 Table 3.2.

Design criteria: Design intersections to AGTM06.

Intersection types

Traffic management: Select the type of intersections for traffic management in conformance with AGTM06 Table 2.4.

The basic forms of an intersection may include the following:

- Signalised, unsignalised or a roundabout.
- Channelised (i.e. has traffic islands and/or medians) to develop specific types of intersections, or unchannelised.
- Flared, to provide additional through and/or turning lanes, or unflared.
- An urban or rural intersection to which different driver expectations and hence different design and traffic management guidelines may apply.

Location

Requirement: Locate intersections to AGRD04 Table 4.2 and the following:

- Streets intersection: Preferably at right-angles and not less than 70°.
- Landform: Allowing clear sight distance on each of the approach legs of the intersection.
- Minor street: Intersect the convex side of the major street.
- Vertical grade lines at the intersection: Conform to the following:
 - . Provide a desirable grade of 3% with a maximum of 5%.
 - . Allow for any direct surface drainage.

- For a left turn, where two minor side streets intersect a major street in a staggered pattern, provide to have a minimum centreline spacing of 40 m.

Traffic volumes: Design for all movements to occur safely without undue delay. Use projected traffic volumes in designing all intersections or junctions on Local sub-arterial roads.

State roads and national highways: Design intersections for the junction of Council's roads with existing state rural or urban roads and national highways to AGRD04.

Approval of State Road Authority: Design intersections with state roads or national highways in conformance with the requirements of the State Road Authority.

Sight distance: Provide adequate stopping and sight distances for horizontal and vertical curves at all intersections.

Parking: Where required, make appropriate provision for vehicles to park safely.

Drainage: Design the road reserve cross-section profile to satisfy the drainage function of the carriageway and/or road reserve.

Turning movements: Accommodate all vehicle turning movements in conformance with AP-G34 and the following:

- For intersection turning movements involving Local sub-arterial roads: Provide for the 'design semi-trailer' with turning path radius 19.0 m.
- For intersection turning movements involving Local streets or Collector streets, but not Local sub-arterial roads: Provide for the 'design single unit' bus with turning path radius 12.5 m.
- For intersection turning movements on access streets but not involving local sub-arterial roads, collector streets or local streets: Provide for the garbage collection vehicle used by the local authority.
- For turning movements at the head of cul-de-sac access streets: Provide for sufficient area for the 'design single unit' truck to make a three-point turn or, if the length of the cul-de-sac is less than 60 m, for the 'design car' to make a three-point turn. If driveway entrances are used for turning movements, design the required area to withstand the relevant loads.

Turning radii at intersections or driveways on Local sub-arterial road: Design for the intended movements within desired speeds to be exceeded to AGRD04 Table 5.1.

Bus facilities: Provide minimum length required for bus lane on an intersection to AGRD04 Table 6.1.

Minimum width of bicycle and bus lanes: To AGRD04 Table 6.2.

Sight distance

Sight distance: Provide adequate horizontal and vertical sight distance at intersections.

Examine each intersection location for conformance with the criteria for Approach Sight Distance (ASD), Minimum gap sight distance (MGSD) and Safe Intersection Sight Distance (SISD). Ensure ASD and SISD are achieved for all intersections, and MGSD where appropriate. Reposition an intersection if required to obtain conformance with the following sight distance criteria:

- ASD: To AGRD04A Table 3.1 and grade corrections to AGTM06 Table 3.3 for sealed roads.
- MGSD: To AGRD04A Table 3.5 for various speeds.
- SISD: Provide SISD for sealed roads to AGRD04A Table 3.2.

Type of turn treatments

General: Provide the appropriate type of right-turn and left-turn treatments from the following:

- Basic turn treatment (Type BA)
 - . Rural basic (BA) turn treatment: To AGRD04A Figure 4.1.
 - . Rural basic left-turn treatment for minor roads: To AGRD04A Figure 8.2, width minimum length of widened parallel shoulder to AGRD04A Table 8.1.
 - . Urban basic (BA) turn treatment: To AGRD04A Figure 4.2.

- Auxiliary lane turn treatment (Type AU): Provide short lengths of auxiliary lane to improve safety on high speed roads where an arterial road meets with sub-arterial, collector or local roads. Provide the following turn treatments as appropriate:
 - . Rural auxiliary lane turn treatments: To AGRD04A Figure 4.5.
 - . Urban auxiliary lane turn treatments: To AGRD04A Figure 4.6.
 - . Urban auxiliary left-turn treatment – Short turn lane (AUL(S)) major road: To AGRD04A Figure 8.10 with setting out details of the left turn geometry to AGRD04A Table 8.4 and with minimum kerb radii for low speed environment to AGRD04A Table 8.3.
- AUR right turn treatments: Not as safe as a channelised treatment at unsignalised intersections. Prefer not to use and many state and territories do not approve.
- Channelized turn treatment (Type CH):
 - . Rural channelised (CH) intersection turn treatment: Layout to AGRD04A Figure 4.7 and design details to AGRD04A Figure 8.5 and Figure 8.6.
 - . Urban channelised (CH) intersection turn treatment: Layout to AGRD04A Figure 4.8 and design details with a high entry angle left-turn island to AGRD04A Figure 8.12 and Urban CHL with acceleration lane to AGRD04A Figure 8.13.

Staggered T-intersections: Rural staggered T intersections may be ‘right to left’ or ‘left to right’ type to AGRD04A Section 4.11. Each type has either safety or cost advantages. Consider traffic volumes and available width in design selection. Provide staggered T-intersections by:

- Setting out the alignment of the minor roads on new major roads to form a staggered T-intersection.
- Realigning one or both minor road legs of an existing intersection.

3.11 ROAD NETWORK ELEMENTS

Roundabouts

Design criteria: To AGRD04B and AGTM 06 Section 4. If alternative criteria is proposed, submit alternative criteria for consideration.

General: Provide the following:

- Functional design: To achieve safety of all users and traffic performance.
- Entry width: To provide adequate capacity.
- Adequate circulation width: Compatible with the entry widths and design vehicles (eg. buses, trucks, cars).
- Central islands: Of diameter sufficient only to give drivers guidance on the manoeuvres expected.
- Deflection of traffic to the left on entry: To promote gyratory movement.
- Adequate deflection of crossing movements to ensure low traffic speeds.
- A simple, clear and conspicuous layout.
- Design to ensure that the speed of all vehicles approaching the intersection will be less than 50 km/h.

Approval: Obtain approval of roundabouts from the Council and the relevant State Road Authority.

Traffic calming

Design criteria: Calming devices (e.g. thresholds, slowpoints, speed humps, chicanes and splitter islands) to AGTM08. Select the type of local area traffic management devices from AGTM08 Table 7.1.

Local area traffic management(LATM) devices: Conform to the following:

- Streetscape:
 - . Reduce the linearity of the street by segmentation.
 - . Avoid continuous long straight lines (e.g. kerb lines).
 - . Enhance existing landscape character.
 - . Maximise continuity between existing and new landscape areas.

- Location of devices/changes:
 - . Other than at intersections, maintain consistency with streetscape requirements.
 - . For compatibility with existing street lighting, drainage pits, driveways, and services.
 - . Slowing devices optimally at spacings of 100 m to 150 m.
- Design vehicles:
 - . Ensure emergency vehicles are able to reach all residences and properties.
 - . Local streets with a 'feeding' function between arterial roads and minor local streets may be designed to AP – G34 templates.
 - . Bus routes: Allow buses to pass without mounting kerbs and with minimal discomfort to passengers.
 - . Provide for building construction traffic in newly developing areas where street systems are being developed in line with LATM principles.
- Control of vehicle speeds:
 - . Reduce speed using devices which shift vehicle paths laterally (slow points, roundabouts, corners) or vertically (humps, platform intersections, platform pedestrian/school/bicycle crossings).
 - . Create a visual environment conducive to lower speeds. This can be achieved by 'segmenting' streets into relatively short lengths (less than 300 m), using appropriate devices, streetscapes, or street alignment to create short sight lines.
- Visibility requirements (sight distance):
 - . Provide critical sight distances so that evasive action may be taken by either party in a potential conflict situation. Relate sight distances to likely operating speeds.
 - . Consider sight distance to include those of and for drivers, pedestrians and cyclists.
 - . Ensure night time visibility of street features. Locate speed control devices near existing street lighting if practicable and delineate all street features/furniture for night time operation. Provide additional street lighting at proposed new speed control devices located away from existing street lighting.
- Safety: Provide roadside design that conforms with AGRD06 including:
 - . Safety barriers.
 - . Treatment options.
 - . Steep down grades.

Critical dimensions.

Dimensions: Conform to the following:

- Pavement narrowings:
 - . Single lane between kerbs: 3.50 m.
 - . Single lane between obstructions: 3.75 m.
 - . Two lane between kerbs: Minimum 5.50 m.
- Plateau or platform areas: 75 mm to 150 mm height maximum, with 1 in 15 ramp slope relative to road grade.
- Width of clear sight path through slowing devices: 1.0 m maximum (i.e. the width of the portion of carriageway which does not have its line of sight through the device blocked by streetscape materials, usually vegetation).
- Mountable areas required for the passage of large vehicles: To appropriate turning templates.

Approval: Obtain approval of traffic calming devices from the Council.

Bus routes

Criteria: Conform to the following:

- Design the road hierarchy to cater for buses on routes identified by the Council.
- Location of bus routes and bus stops: Arrange so that no more than 5% of residents have to walk in excess of 400 metres to catch a bus.
- Design roads above the Local street level in the network hierarchy as bus routes.

Dimensions: To the **Bus route criteria table**.

Bus route criteria table

Road	Carriageway Width (min)	Stops (Spacing)	Bays
Collector*	9 m	400 m**	Single
Local sub-arterial	11 m	400 m	Shelters
Arterial	13 m	400 m	Shelters and bays
* Collector roads not identified as bus routes may have 7 m carriageways. ** Loop roads with single entry/exit only require stops and bays on one side road. *** Shelters are subject to Council's requirements.			

4 DOCUMENTATION

4.1 GENERAL

Design process

System: Develop a flow chart to incorporate the brief, consultation, selection of design parameters, approvals and critical dates.

Design review, verification and validation: Provide design documentation that conforms with AGRD08.

Design calculations

Calculations: Provide results and reference software used for relevant distance or curvature calculations. If friction is a factor in layout/geometry, note the pavement type assumed for surface conditions and noise minimisation.

Approvals

Authorities: Drawings are signed by the *Developer's Authorised Person* and where required by Council, certify as complying with the appropriate design worksections.

Certificate format: To *0010 Quality requirements for design*.

4.2 DRAWINGS

Drawing sheets

Requirement: Provide separate sheets for the following:

- Cover.
- Plan views.
- Longitudinal sections.
- Cross sections.
- Structural details.
- Standard drawings.

Drawing presentation

Plain English: Drawings form part of the permanent record and are legal documents.

Keep terminology in plain English, enabling drawings to be easily read and understood by those involved in the construction of the Works.

Drawings: Present drawings on A1 sheets unless otherwise authorised. Prepare clear and legible drawings with consistent lettering and style, and clearly referenced with notations and tables as appropriate.

Compliance

Consistency: Provide drawing sheets consistent with the scope and sequence of the example provided in Annexure B of *0010 Quality requirements for design*.

Drawings content

Drawing scale: Conform to the following:

- All plans for Council works: 1:500. However, rural plans may be 1:1000.
- Longitudinal sections: 1:500 Horizontal and 1:100 Vertical.

- Cross Sections: 1:100 Natural.

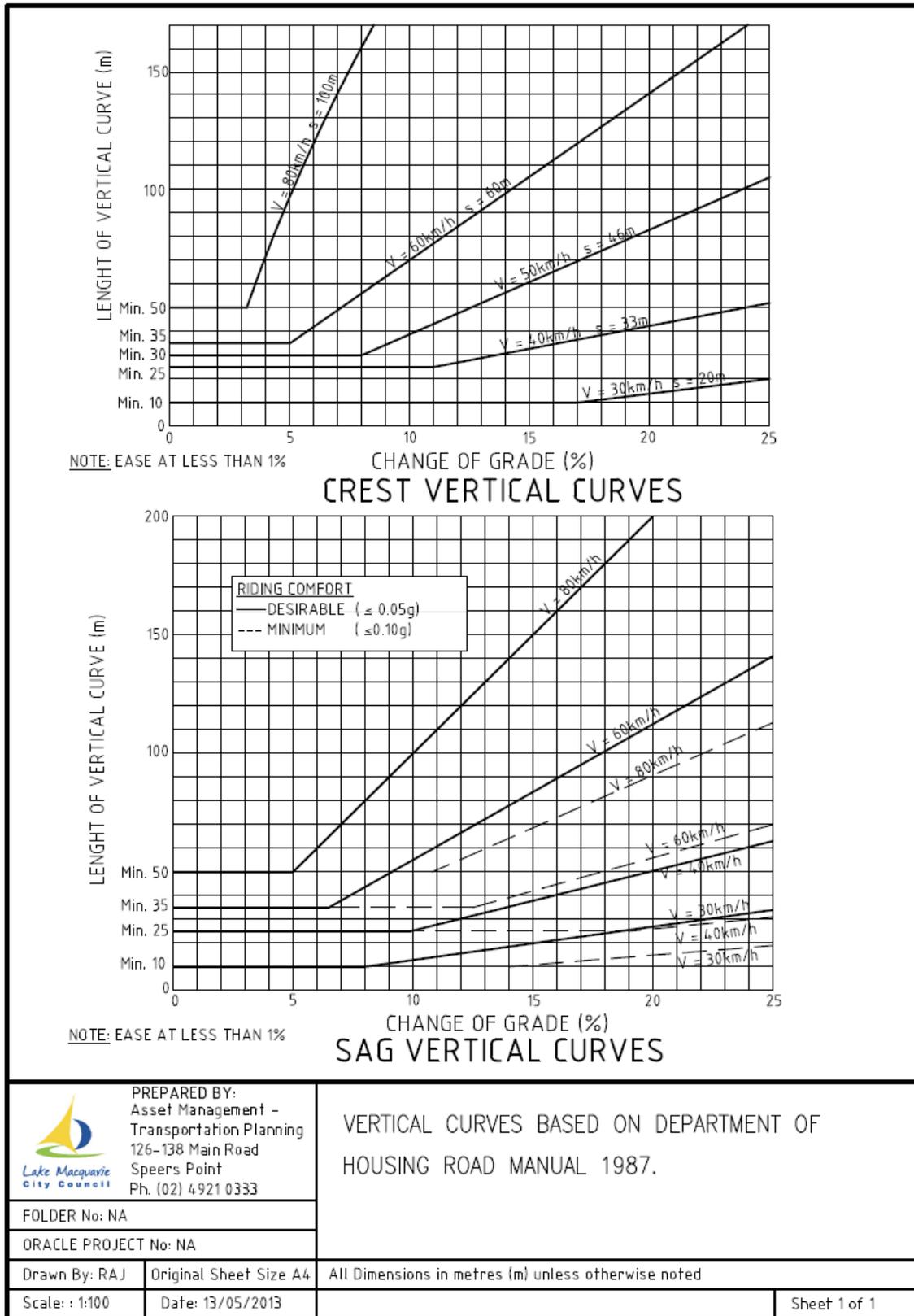
4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

~~Final certification of completed works: [complete/delete]~~

Annexure A – Design graphs for vertical curves for low trafficked roads



0042 PAVEMENT DESIGN

1 GENERAL

1.1 RESPONSIBILITIES

Objective

General: Select appropriate pavement and surfacing materials, types, layer thicknesses and configurations to ensure that the pavement performs to its design functions and requires minimal maintenance under the anticipated traffic loading for the design life adopted.

Criteria: This worksection covers the design of road pavement to meet the required design life, based on the subgrade strength, traffic loading, climatic conditions, environmental factors, and includes the selection of appropriate materials for subgrade, subbase, base and wearing surface.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- 0010 Quality requirements for design.
- 0043 Subsurface drainage (Design).
- 1131 Rolled concrete subbase.
- 1132 Lean mix concrete subbase.
- 1133 Plain or reinforced concrete base.
- 1134 Steel fibre reinforced concrete base.
- 1135 Continuously reinforced concrete base.
- 1141 Flexible pavement base and subbase.
- 1143 Sprayed bituminous surfacing.
- 1144 Asphaltic concrete (Roadways).
- 1145 Segmental paving.
- 1146 Bituminous slurry surfacing.

Related worksections: The following worksection is related to this worksection:

- 0041 Geometric road layout.

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Austrroads

AGPT01:2009 Guide to Pavement Technology – Part 1 Introduction to Pavement Technology.

AGPT02:2012 Guide to Pavement Technology – Part 2 Pavement structural design.

AGPT04C:2009 Guide to Pavement Technology – Part 4C Materials for Concrete Road Pavements.

AGPT05:2008 Guide to Pavement Technology – Part 5 Pavement Evaluation and Treatment Design.

AGPT06:2009 Guide to Pavement Technology – Part 6 Unsealed Pavements.

AGPT07:2009 Guide to Pavement Technology – Part 6 Pavement Maintenance.

AGPT08:2009 Guide to Pavement Technology – Part 8 Pavement Construction.

AGRD01: 2006 Guide to Road Design Part1: Introduction to Road Design.

AGRD02: 2006 Guide to Road Design Part 2: Design considerations.

AGRD08:2009 Guide to Road Design - Part 8 Process and Documentation

AP-T85:2007 Optimum use of granular bases: material selection for detailed performance evaluation.

AP-T68:2006 Update of the Austrroads sprayed seal design method.

Other publications*Roads and Maritime Services**QA Specification R116 – Heavy Duty Dense Graded Asphalt**Concrete Roundabout Pavements – A Guide to their Design and Construction**Cement Concrete Aggregates Australia (CCAA)*

T51: 2004 Guide to Residential Streets and Paths.

Concrete Masonry Association of Australia (CMAA)

T45: 1997 Concrete Segmental Pavements—Design guide for residential access ways and roads.

Clay Brick and Paver Institute (CBPI)

Manual 1 Clay paving design and construction 2003.

Techniques 15-1995 – Design Considerations for Clay Paved Roadways.

1.4 STANDARDS**General**

Standard: Road design to Austroads AGRD01 and AGRD02.

Design considerations: To AGRD02 Table 3.1.

Pavement structural design: To AGPT02.

2 DESIGN CRITERIA**2.1 PAVEMENT****General**

Pavement types: To AGPT01.

Design variables

All proposed road pavements: Consider the following input variables for Urban and rural roads:

- Design traffic.
- Subgrade evaluation.
- Climatic conditions (For climatic zones see www.bom.gov.au).
- Environment – surface noise considerations (To AGPT02 Section 4).
- Pavement and surfacing materials – note any exclusions of local aggregates commonly available.
- Construction and maintenance considerations (To AGPT02 Section 3).

The design variables may be different in different states. Refer to the relevant design manuals of State Road Authorities for more information.

2.2 TRAFFIC**Standards**

General: To AGPT02 Section 7 and Section 12.

Minimum pavement design life

General: Select the design life to suit the design traffic conditions based on the following minimum design lives of pavement. Alternatively calculate the ‘whole of life’ costs and adopt an appropriate ‘first cost’ to select the pavement:

- Flexible, unbound granular: **30 years**.
- Flexible, containing one or more bound layers: **30 years**.
- Rigid (concrete): **40 years**.
- Segmental block: 25 years.

Equivalent standard axles (ESA)

General: Calculate design traffic in equivalent standard axles (ESAs) for the applicable design life of the pavement, taking into account present and predicted commercial traffic volumes, axle loadings and configurations, commercial traffic growth and street capacity.

AGPT02 Table 7.4 provides the values of cumulative growth factor for a range of annual growth rates and design period.

Interlocking concrete segmental pavements: The simplification of replacing ESA's with the number of commercial vehicles exceeding 3 tonne gross contained in CMAA—T45 is acceptable up to a design traffic of 10^6 . Beyond this, calculate ESAs.

Traffic data

Pavement design: Include all traffic data and/or assumptions made in the calculation of the design traffic. Consider the width of structural pavement beyond the trafficked lanes to suit edge conditions and traffic movements.

Design traffic volumes

Calculation of design traffic volumes for lightly trafficked roads: To AGPT02 Section 12. Calculation of design traffic volumes approaching or exceeding 10^6 ESAs: To AGPT02 Section 12.7.

Guide to design ESAs

Traffic values (in ESAs): To AGPT02 Table 12.2 for lightly trafficked urban streets and to **Design ESA's 30 year design life table** subject to variation depending on the circumstances for the particular project.

Design ESA's 30 year design life table

Road type	Design ESA's – 30 year design life*
<i>Local Road – Urban Access Place or Cul-de-sac</i>	7×10^4
<i>Local Road – Urban Primary or Secondary</i>	4×10^5
<i>Local Road – Non Urban</i>	4×10^5
<i>Collector Road</i>	4×10^6
<i>Sub-Arterial Road</i>	7×10^6
<i>Industrial</i>	1×10^7
<i>Commercial</i>	6×10^6

** For Collector, Sub-Arterial, Industrial and Commercial Roads, consideration will be given to a lower design ESA where supported by an appropriate traffic study.*

2.3 SUBGRADE EVALUATION

Design considerations

Design strength/stiffness of the subgrade: Consider the following factors:

- Sequence of earthworks construction.
- The compaction moisture content and field density specified for construction.
- Moisture changes during service life.
- Susceptibility to flooding.
- Subgrade variability.
- The presence or otherwise of weak layers below the design subgrade level.
- Stabilisation requirements.
- Dispersive soils.
- Plasticity parameters.
- Swell characteristics.
- Salinity.

California Bearing Ratio (CBR)

Except where a mechanistic design approach is employed using AGPT02 (or software designed for this purpose), as the measure of subgrade support, use the California Bearing Ratio (CBR).

Where a mechanistic design approach using linear elastic theory is employed for flexible pavements, the measure of subgrade support is in terms of the elastic parameters (modulus, Poisson's ratio).

Design CBR considerations

Adopted subgrade Design CBR: Consider the effect of moisture changes in the pavement and subgrade during the service life involving the following:

- Provision of subsurface drainage in the estimation of equilibrium in-situ CBRs.
- Design of the pavement structure.

Subsurface drainage: Refer to *0043 Subsurface drainage (Design)*. If subsurface drainage is not proposed, the Design CBR must allow for a greater variability in subgrade moisture content during the service life of the pavement with a design moisture content above the optimum moisture content.

Calculation of design CBR

Criteria: Conform to the following:

- Field determination of subgrade CBR (To AGPT02 Section 5.5)
 - . In situ CBR test.
 - . Cone penetrometers.
- Laboratory determination of CBR and elastic parameters (To AGPT02 Section 5.6)
- Presumptive values for lightly trafficked roads. (To AGPT02 Section 5.7, Table 5.4)

Field confirmation

Testing: Confirm the Design CBR obtained from laboratory testing by site testing performed on existing road pavements near to the job site under equivalent conditions and displaying similar subgrades. Consider the use of dynamic cone penetrometer (DCP) in test pits within the subgrade for use in conjunction with CBR testing.

Summary of results

Pavement design: Include a summary of all laboratory and field test results and assumptions and/or calculations made in the assessment of Design CBR.

2.4 ENVIRONMENT**Environmental factors**

Pavement design: Include all considerations for environmental factors, and any assumptions made that would reduce or increase design subgrade strength, or affect the choice of pavement and surfacing materials.

Moisture and temperature

General: Consider moisture and temperature at the design stage of the pavement. Refer to AGPT02 Section 4.

Moisture considerations

Significant factors: Consider the following factors relating to moisture environment in determining the design subgrade strength/stiffness and in the choice of pavement and surfacing materials:

- Rainfall/evaporation pattern.
- Permeability of wearing surface.
- Depth of water table and salinity problems.
- Relative permeability of pavement layers.
- Whether shoulders are sealed or not.
- Pavement type (boxed or full width).

Design moisture content

Changes in moisture content: Evaluate the design subgrade strength parameters (i.e., CBR or modulus) at the highest moisture content likely to occur during the design life, i.e., the design moisture content.

Temperature changes

Asphalt wearing surfaces and bound or concrete layers: Consider the effect of maximum/minimum seasonal variations in temperature in the design of pavements, particularly if traffic loading occurs at night when temperatures are low and cause a potential reduction in the fatigue life of thin asphalt surfacing.

Specific location effects

In selection of pavement, consider the following:

- Freezing.
- Snow/ice removal (use of chemicals/salt).
- Mine subsidence.
- Bushfire heat.
- Extreme temperatures.
- Industrial traffic spills.

Pavement evaluation and treatment design:

- Conform with AGPT05 for investigation of existing sealed road pavements and design of pavement treatment.

2.5 PAVEMENT AND SURFACING MATERIALS**Pavement classification**

Pavement materials: Adopted classification according to their fundamental behaviour under the effects of applied loadings:

- Unbound granular materials, including modified granular materials.
- Bound (cemented) granular materials.
- Asphaltic Concrete.
- Cement Concrete.

Conform to the following:

- To AGPT04C for concrete road pavements.
- To AGPT06 for unsealed pavements.

Surfacing classification

Surfacing materials: Adopted classification:

- Sprayed bituminous seals (flush seals).
- Asphaltic concrete and bituminous slurry surfacing (cold overlay).
- Cement concrete.
- Concrete segmental pavers.
- Clay segmental pavers.

Materials

Pavement materials: To AGPT02 Table 6.1 for pavement material categories and characteristics. **New pavement materials require prior approval of Council.**

Unbound granular materials including modified granular materials: To *1141 Flexible pavements*.

Bound (cemented) granular materials: To *1141 Flexible pavements*.

Asphaltic concrete: To *1144 Asphaltic concrete (Roadways)*.

Cement concrete: To *1131 Rolled concrete subbase, 1132 Mass concrete subbase, 1133 Plain or reinforced concrete base, 1134 Steel fibre reinforced concrete or 1135 Continuously reinforced concrete base*, as appropriate.

Sprayed bituminous seals: To *1143 Sprayed bituminous surfacing*.

Concrete and clay segmental pavers: To *1145 Segmental paving*.

Bituminous slurry surfacing (cold overlay): To *1146 Bituminous slurry surfacing*.

2.6 CONSTRUCTION AND MAINTENANCE

Considerations

Construction and maintenance factors: Consider the following for the type of pavement, choice of base and subbase materials, and the type of surfacing adopted:

- Documentation of joints incorporated in the design.
- Extent and type of drainage.
- Use of boxed or full width construction.
- Available equipment of the Contractor.
- Use of stabilisation.
- Aesthetic, environmental and safety requirements.
- Social considerations.
- Construction under traffic.
- Use of staged construction.
- Ongoing and long-term maintenance costs.

3 PAVEMENT THICKNESS DESIGN

3.1 PAVEMENT STRUCTURE

Minimum pavement thickness

Pavement thickness, *excluding* the thickness of surfacings:

- Roads with kerb and channel (gutter): **300 mm**.
- Unkerbed roads: 200 mm.
- Carparks: **200 mm**.

Final thickness of subbase and base layers:

- Flexible pavement: Subbase **150 mm**, base **150 mm**
- Rigid pavement: Subbase **150 mm**, base 150 mm

Subbase extent

Subbase layer: Minimum of 150 mm behind the rear face of any kerb and/or channel (gutter).

Base extent

Base and surfacing: To the face of any kerbing and/or channel (gutter).

Kerb conditions: If the top surface of the subbase layer is below the level of the underside of the kerb channel (gutter), extend the base layer a minimum of 150 mm behind the rear face of the kerb and/or channel (gutter).

Unkerbed roads: Extend the subbase and base layers at least to the nominated width of shoulder.

Carparks

Concentrations: Allow for traffic load concentrations within carpark areas (e.g. entrances/exits).

Drainage

Precautions: Make provision for pavement layer drainage on the assumption that during the service life of the pavement ingress of water will occur.

3.2 PAVEMENT DESIGN

Unbound granular flexible pavements – Bituminous surfaced

Criteria: Design unbound granular flexible pavements with thin bituminous surfacings, including those with cement or lime modified granular materials, with design traffic up to 10^6 ESAs to AGPT02 Figure 12.2.

For design traffic above 10^6 ESAs, use AGPT02 Figure 8.4 (or software designed for this purpose).

Designs for sub-arterial, industrial and commercial roads: Prior approval of Council
Flexible pavements containing bound layers – Bituminous surfaced

Criteria: Design flexible pavements containing one or more bound layers, including cement stabilised layers or asphaltic concrete layers other than thin asphalt surfacings, to AGPT02 Section 8 (or software designed for this purpose).

Minimum thickness over a bound cement stabilised layer: 150 mm of asphalt.

~~Alternatively for design traffic up to 10^6 ESAs: Assume bound layers to be equivalent to unbound layers of the same thickness, and design the pavement to AGPT02 Section 12.8.~~

Rigid pavements

Criteria: Design rigid (concrete) pavements, with design traffic up to 10^6 ESAs to either CCAA-T51 *Guide to residential streets and paths* or AGPT02 Section 12.9 (or software designed for this purpose).

Criteria: Design rigid (concrete) pavements for design traffic above 10^6 ESAs to AGPT02 Section 9 (or software designed for this purpose).

Concrete segmental pavements

Criteria: Design concrete segmental pavements with design traffic up to 10^6 estimated commercial vehicles exceeding 3 T gross to CMAA-T45.

Clay segmental pavements

Criteria: Design clay segmental pavements with design traffic up to 10^6 ESAs to *CBPI Manual 1 – Clay paving design and construction* and CBPI Techniques 15 - Design Considerations for Clay Paved Roadways.

Concrete roundabout pavements

Criteria: Design concrete roundabout pavements to AGPT02 and RMS Concrete Roundabout Pavements – A Guide to their Design and Construction. Steel fibres may be used as an alternative to mesh steel reinforcement but no other fibre types are acceptable.

4 SURFACING DESIGN

4.1 SURFACE TYPE

Roads

Wearing surface specifications: Bituminous wearing surface as follows except where the pavement is designed for concrete or segmental block surfacing:

Primer seal, plus asphalt.

Braking and turning zones

Alternatives: Provide ~~either bituminous slurry surfacing or~~ asphalt surfacing with suitable binders at intersection approaches and cul-de-sac turning circles on residential streets with flush seals, within the vehicle braking and turning zones. Consider surfacing materials in braking zones to provide additional wear and roughness properties.

4.2 SURFACE TYPE PROPERTIES

Sprayed bituminous seals (flush seals)

Criteria: Sprayed bituminous (flush) seals, including primer seals to *AP-T68 sprayed seal design method – 2006: Summary* or to the relevant State Road Authorities' Bituminous Surfacing Manual.

Primer seal: Indicate on the Drawings 7 mm primer seals below all flush seals, bituminous slurry surfacing, and asphalt surfacings. Conform to the following:

- Use size 5-7 mm aggregate < 200 v//d.
- Use 7-10 mm size aggregate > 200 v//d.

- If the conditions are either very hot and/or wet, and the traffic is in excess of 600 v/l/d, use size 10 mm aggregate.

Two-coat flush seals: Double-double seals, comprising a minimum of two coats binder and two coats of aggregate as follows:

- 1st coat—14 mm.
- 2nd coat—7 mm.

Single coat flush seal: If bituminous slurry surfacing (or asphaltic concrete) is to be applied as the finished surface, provide single coat flush seals either 14 mm or 10 mm thick.

Bituminous slurry surfacing (cold overlay)

~~Minimum thickness: 8 mm nominal compacted thickness.~~

~~Primer seal and single coat seal: Indicate on the Drawings a 7 mm primer seal and a single coat flush seal on the drawings below the bituminous slurry surfacing.~~

Asphaltic concrete

Design traffic up to 4×10^5 ESAs: Design the asphalt surface layer as a 10 mm gap graded mix to 1144 Asphaltic concrete (Roadways).

Design traffic exceeding 4×10^5 ESAs: Design the asphalt surface layer as a 14 mm dense graded mix to 1144 Asphaltic concrete (Roadways).

Minimum thickness: Design asphaltic concrete surfacing to provide a nominal compacted layer thickness:

- *On roads with design traffic up to 4×10^5 ESAs: 30 mm*
- *On roads with design traffic exceeding 4×10^5 ESAs: 45 mm*
- *On sub-arterial, industrial and commercial roads: Consistent with pavement design determined as per Section 3.2*

Primer seal: Indicate a 7 mm or 10 mm primer seal on the drawings below the asphalt surfacing.

Segmental pavers

Required: Prior approval of Council.

Size and shape: Conform to the following:

- Concrete segmental pavers: 80 mm thick, shape Type A, and designed to be paved in a herringbone pattern.
- Clay segmental pavers: 65 mm thick, Class 4, and designed to be paved in a herringbone pattern.

Edge restraint: Design the edges of all paving to be constrained by either kerbing and/or guttering, or by concrete edge strips.

5 DOCUMENTATION

5.1 GENERAL

Approvals

~~Authorities: [complete/delete]~~

Design reports

~~Requirements: [complete/delete]~~

Calculations

Requirements: Submit all considerations, assumptions, subgrade test results, and calculations with the pavement design for approval by Council.

Specifications

Construction documentation: Prepare technical specifications suitable for inclusion in the AUS-SPEC contract documentation system. Consider including Construction and Maintenance worksection *Templates* from the National Classification System workgroups 02, 03, 11, 13, 14-18.

Design certification

Requirement: Provide a signed and dated design certificate.

5.2 DRAWINGS

General

Requirements: Clearly indicate the structure, material types and layer thicknesses of the proposed pavement and surfacing.

5.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

~~Final certification of completed works: [complete/delete]~~

0043 SUBSURFACE DRAINAGE (DESIGN)
--

1 GENERAL

1.1 RESPONSIBILITIES

Objectives

Control moisture fluctuations: Design the subsurface drainage system to control moisture content fluctuations in the pavement and/or subgrade within the limits assumed in the pavement design.

Salinity prevention: In areas with a history of salinity problems, prescribe subsurface drainage to keep the groundwater table lower in the strata so as to avoid progressive deterioration of the health of topsoil and upper layers due to salinity levels increased by rising and/or fluctuating groundwater tables.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- 0010 Quality requirements for design.
- 1172 Subsoil and foundation drains.
- 1173 Pavement drains.
- 1174 Drainage mats.

[Related worksections: \[complete/delete\]](#)

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian standards

AS/NZS 1477: 2006	PVC pipes and fittings for pressure applications.
AS 2439	Perforated plastics drainage and effluent pipe and fittings.
AS 2439.1-2007	Perforated drainage pipe and associated fittings.

Austroads

AGPT10: 2009	Guide to Pavement Technology – Part 10: Subsurface drainage.
AGRD05:2010	Guide to Road Design – Part 5: Drainage design

Other publications

ARRB Australian Road Research Board.

ARR368: 2006	The collection and discharge of stormwater from road infrastructure.
--------------	--

1.4 STANDARDS

General

Standard: To AGPT10.

Drainage design: To AGRD05.

1.5 INTERPRETATION

Definitions

General: For the purposes of this worksection the following definitions based on functions apply:

Drainage types:

- Subsoil drains: are intended for the drainage of ground water or seepage from the subgrade and/or the subbase in cuttings and fill areas.

- Foundation drains: Foundation drains are intended for the drainage of seepage, springs and wet areas within and adjacent to the foundations of the road formation. Can also be termed 'formation drains'.
- Sub-pavement drains: are intended for the drainage of the base and subbase pavement layers in flexible pavements. They may also function to drain seepage or groundwater from the subgrade.

Drainage mats:

- Type A drainage mats: are intended to ensure continuity of a sheet flow of water under fills, to collect seepage from a wet seepage area, or for protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water. Can also be termed 'drainage blankets'.
- Type B drainage mats: are constructed to intercept water which would otherwise enter pavements by capillary action or by other means on fills and to intercept and control seepage water and springs in the floors of cuttings. Can also be termed 'drainage blankets'.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Geotechnical investigations

Investigations: Obtain an appropriate geotechnical investigation comprising sub-grade soil characteristics and ground water effects to enable selection of drainage units. Refer to AGPT10.

3 DESIGN

3.1 DESIGN CRITERIA

Subsoil and sub-pavement drains

Locations: Provide subsoil or sub-pavement drains on both sides of the formation in the following locations:

- Cut formations where the depth to finished subgrade level is equal to or greater than 400 mm below the natural surface level.
- Locations of known hillside seepage, high water table, isolated springs or salt affected areas.
- Irrigated, flood-prone or other poorly drained areas.
- Highly moisture susceptible subgrades, i.e., commonly displaying high plasticity or low soaked CBRs.
- Use of moisture susceptible pavement materials.
- Existing pavements with similar subgrade conditions displaying distress due to excess subsurface moisture.
- At cut to fill transitions.

Exceptions:

- Omit drains if the geotechnical report indicates the absence of subsurface moisture at the time of investigation and the likelihood that changes in the subsurface moisture environment will not occur within the design life of the pavement and/or the pavement has been specifically designed to allow for likely variations in subgrade and pavement moisture contents.
- If only one side of the formation is in cut, and the other side in fill, it may be sufficient to provide subsoil or sub-pavement drains only along the edge of the formation in cut.

Additional locations: The need for subsoil and sub-pavement drains may otherwise become apparent during the construction process, due to changes in site moisture conditions or to areas of poorer subgrade being uncovered that were not identified in the geotechnical investigation.

Drawings: Indicate the potential need for subsoil or sub-pavement drains in addition to those shown on the Drawings.

Layout, alignment and grade

Typical cross sections: Typical cross sections of subsoil and sub-pavement drains are shown in Figures 2.1 and 2.2.

Kerbed roads: In kerbed roads, the two acceptable alternative locations for the line of the trench are directly behind the kerblines. Pavement layers must extend to at least the line of the rear of the trench.

Unkerbed roads: In unkerbed roads, locate subsoil and sub-pavement drains within the shoulder, preferably at the edge of the pavement layers as shown in Figure 2.2.

Grade: The minimum longitudinal design grade is 1.0%. For non corrugated pipes, an absolute minimum grade of 0.5% is acceptable.

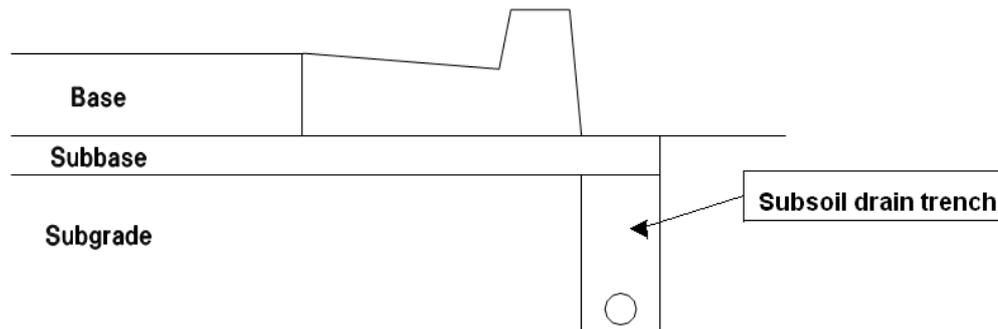


Figure 2.1 Typical subsoil drain

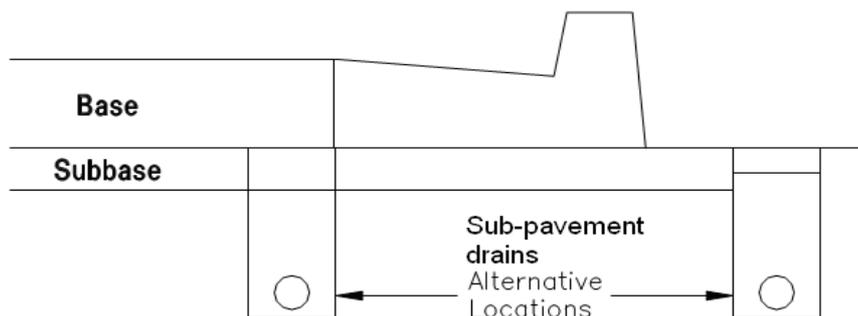


Figure 2.2 Typical sub-pavement drain

Trench dimensions and location:

- Trench widths - 300 mm minimum.
- Minimum depth below finished subgrade level:
 - . In earth 600 mm.
 - . In rock 450 mm.
- Locate below the invert level of any service crossings.

Outlets and salinity prevention: Space outlets at maximum intervals of 100 metres. Join into gully pits or outlet headwalls. As a salinity prevention measure and where practical, provide discharge on the downhill side of the embankment or in the cut-fill area so as to reduce the risk of recharge to the subsurface water table.

Unslotted plastic pipe: Unless otherwise authorised, if subsurface drains outlet through fill batters, specify unslotted plastic pipe of the same diameter as the main run.

Drain outlet: Install a small precast concrete headwall at the drain outlet with a marker post to assist maintenance and protect the end of the pipe.

Cleanouts: Provide cleanouts at the commencement of each run of drain, and at intervals not exceeding 80 metres. Locate cleanouts directly at the rear of kerb or at the edge of shoulder, as applicable.

Salinity prevention: In salinity affected areas, consider providing a separate drainage system for subsurface drains to discharge to a basin where controlled release or desiccation treatment and removal can be facilitated as a maintenance operation.

Saline subsurface drainage: Do not discharge directly into natural watercourses.

Reference to water quality targets: Refer to downstream watercourses quality targets - provide advice on discharge operations and maintenance compatible with water quality targets and the requirements of the relevant land and water resource authority.

Foundation drains (Formation drains)

Location: Foundation drains are designed to drain excessive ground water areas within the foundation of an embankment or the base of cutting, or to intercept water from entering these areas.

Drawings: The need to provide foundation drains may be apparent from the results of the geotechnical survey along the proposed road formation alignment, and in this case show the location on the Drawings. In addition, indicate on the Drawings the potential need for foundation drains at various locations typified as follows:

- Where the road formation traverses known swampy, flood-prone, salt affected areas or watercharged strata.
- Commonly, the need to provide foundation drains is determined during construction, and hence in this situation requirements and locations cannot be ascertained at the design stage.

Layout, alignment and grade

Typical cross section: Typical cross-sections of foundation drains are shown in Figure 2.3.

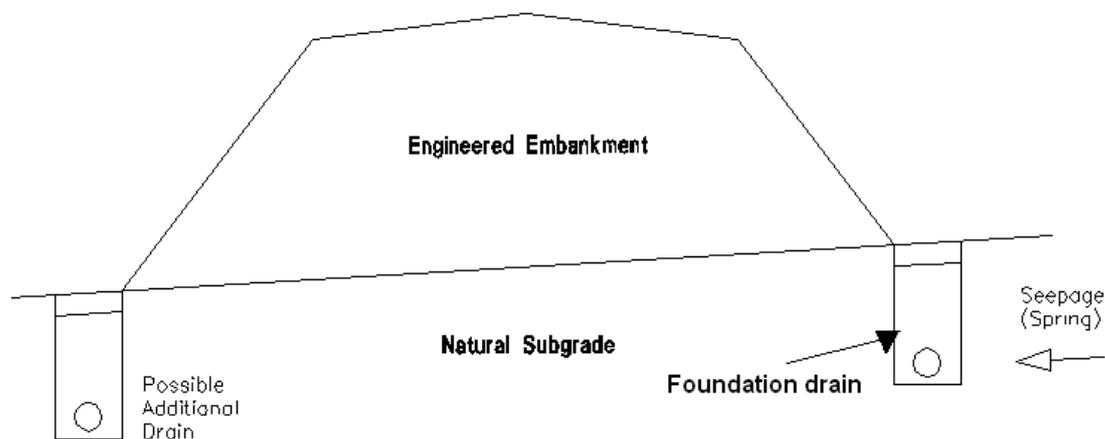


Figure 2.3 Foundation drains

Grade: The minimum design grade is 1.0%. For non corrugated pipes an absolute minimum grade of 0.5% is acceptable.

Trench dimensions: Conform to the following:

- Trench width - 300 mm minimum.
- Trench depth – vary to suit the application and ground conditions on site.

Outlets: Space outlets at maximum intervals of 150 metres or 100 metres if intermediate cleanouts are not provided.

Cleanouts: Where practicable, provide cleanouts at the commencement of each run of foundation drain and at intervals not exceeding 80 metres.

Drainage mats (Drainage blankets)

Requirement: Use the result of the geotechnical survey along the proposed road formation alignment to determine the need to design for the provision of drainage mats.

Type A mats: Select for the following functions:

- To ensure continuity of sheet flow of water under fills.
- To collect surface seepage from a wet seepage area.
- For protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water.

Timing: Construct Type A drainage mats after the site has been cleared and grubbed and before commencement of embankment construction.

Type B mats: Select for the following functions:

- To intercept water which would otherwise enter pavements by capillary action or by other means on fills.
- To intercept and control seepage water and springs in the floors of cuttings.

Timing: Construct Type B drainage mats after completion of the subgrade construction and before construction of the pavement.

3.2 MATERIALS**Subsoil and sub-pavement drain pipe**

Slotted pipe: Conform to the following:

- Location: As designated for subsoil, foundation and sub-pavement drains except for cleanouts and outlets through fill batters.
- Size: 100 mm diameter.
- Filter: Suitable geotextile filter tube.

Corrugated plastic pipe: To AS 2439.1.

Slotted rigid UPVC pipe: Type and class approved by Council.

Cleanouts and outlets: Provide 100 mm diameter unslotted pipe.

Joints, couplings, elbows, tees and caps: To AS 2439.1.

Selection criteria: Select the appropriate class of pipe on the basis of expected live loading at the surface.

Intra pavement drain pipe

Slotted thick walled UPVC pressure pipe: Conform to the following:

- Location:
 - . For pipes designated for intra pavement drains with crushed rock subbases having layer thicknesses neither less than 150 mm nor more than 200 mm.
 - . For pipes for use in Type B drainage mats.

Slotted pipe of a type and class approved by Council:

- Location: For pipes designated for intra pavement drains with crushed rock subbases having layer thicknesses exceeding 200 mm.

Standard: To AS/NZS 1477.

Filter material

Acceptable types of filter material and their use are as follows:

- Type A filter material: Use in subsoil, foundation, and sub-pavement (trench) drains and for Type B drainage mats.
- Type B filter material: Use in subsoil, foundation and sub-pavement (trench) drains.
- Type C filter material comprising crushed rock: Use in Type A drainage mats.
- Type D filter material comprising uncrushed river gravel: Use in Type A drainage mats.

Filter types: Material requirements and gradings for each type of filter material are included in the *1171 Subsurface drainage*.

Backfill filter material

Selection: The type of filter material specified to backfill the sub-surface drainage trenches (subsoil, foundation and sub-pavement drains) depends on the permeability of the pavement layers and/or subgrade and the expected flow rate.

Filter functions:

- Type A filter material is used for the drainage of highly permeable subgrade or pavement layers such as crushed rock or coarse sands.
- Type B filter material is used for the drainage of subgrade and pavement layers of lower permeability such as clays, silts or dense graded gravels.

Reference: Further guidance to the selection of appropriate filter material is contained in ARRB ARR368-*The collection and discharge of stormwater from the road infrastructure*.

Geotextile

Design criteria: Designate Geotextile to encapsulate the filter material to provide separation (i.e. prevent infiltration of fines) between the filter material in the trench and the subgrade or pavement material.

Requirements:

- Comply with the requirements included in *1171 Subsurface drainage*.
- Designate for both Type A and Type B Drainage Mats.

4 DOCUMENTATION

4.1 GENERAL**Approvals**

~~Authorities: [complete/delete]~~

Design reports

~~Requirements: [complete/delete]~~

Calculations

Authorities: Submit to Council for approval with the drawings assumptions and/or calculations made in the determination of the need or otherwise for subsurface drainage in special circumstances or as a variation to the requirements of this worksection.

Specifications

Construction documentation: Prepare technical specifications suitable for inclusion in the AUS-SPEC contract documentation system. Consider including Construction and Maintenance worksection *Templates* from the National Classification System workgroups 02, 03, 11, 13, 14-18.

Design certification

Requirement: Provide a signed and dated design certificate.

4.2 DRAWINGS**General**

Requirements: Indicate the following:

- The proposed location of all subsurface drains.
- The nominal depth and width of the trench.
- The location with respect to the line of the kerb/gutter or edge of pavement.
- The location of outlets and cleanouts.

Drawings content

~~Requirements: [complete/delete]~~

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

~~Final certification of completed works: [complete/delete]~~

0044 PATHWAYS AND CYCLEWAYS (DESIGN)

1 GENERAL

1.1 RESPONSIBILITIES

Objective

Activities: Provide design and documentation for cycleways and pathways to support the following objectives:

- Encourage walking and cycling for transportation, healthy lifestyle and recreational purposes.
- Provide safe walking and cycling, including for users with disabilities and limited mobility.
- Ensure satisfactory level of service for all pathway users.

Performance

~~Authority requirements: [complete/delete]~~

~~State legalisation: [complete/delete]~~

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- 0010 Quality requirements for design.

~~—Related worksections: [complete/delete]~~

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian standards

AS/NZS 1158	Lighting for roads and public spaces
AS/NZS 1158.3.1:2005	Pedestrian area (Category P) lighting - Performance and design requirements
AS 1158.5:2007	Tunnels and underpasses
AS 1428	Design for access and mobility
AS 1428.1-2009	General requirements for access - New building work
AS 1428.2-1992	Enhanced and additional requirements - Buildings and facilities
AS/NZS 1428.4.1: 2009	Means to assist the orientation of people with vision impairment - Tactile ground surface indicators
AS 1742	Manual of uniform traffic control devices
AS 1742.9-2000	Bicycle facilities
AS 1742.10-2009	Pedestrian control and protection
AS 1798-1992	Lighting poles and bracket arms-Preferred dimensions.
AS 2156	Walking Tracks
AS 2156.1-2001	Classification and signage
AS 2156.2-2001	Infrastructure design
AS 2890	Parking facilities
AS 2890.3-1993	Bicycle parking facilities

Austroroads

AP-G88:2011	Cycling aspects of Austroroads guides
AGRD06A:2009	Guide to Road Design – Pedestrian and cyclist paths
AGPT02:2012	Guide to pavement technology – Pavement structural design

Other publications

Concrete Institute of Australia

CIA Z15:2011 *Cracking in concrete slabs on ground and pavements*

Lake Macquarie City Council

Current Development Control Plan (DCP)

Cycling Strategy 2021 (June 2012)

1.4 STANDARDS

Design

Standards:

- General: To AGRD06A.
- Cycleways: To AP-G88.
- Walking tracks: To AS 2156.1 and AS 2156.2.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- AGPT: Austroads Guide to Pavement Design.
- AGRD: Austroads Guide to Road Design.
- ARRB: Australian Road Research Board.
- CBR: California Bearing Ratio.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Footpath: Any access way with a gradient no steeper than 1:20.
- Gradient: The rate of longitudinal rise or fall of a pathway with respect to the horizontal, expressed as a ratio or as a percentage.
- Ramp: An inclined access way that has a constant gradient anywhere between 1:14 and 1:20.

2 PRE-DESIGN PLANNING

2.1 PLANNING

General

~~Council's requirements: [complete/delete]~~

~~Pathway/cycleway concept: [complete/delete]~~

Funding

~~Government grant funds: [complete/delete]~~

~~Construction budget: [complete/delete]~~

2.2 CONSULTATION

Council and other Authorities

General: Consult with Council and other relevant Authorities during the preparation of design. In addition to the requirements of this worksection, conform to the requirements for cycleways and pathways in any applicable Council regional or local strategic bicycle plan or subdivision code.

Public consultation

Requirement: Undertake public consultation on designs in conformance with Council policy.

~~Council requirement: [complete/delete]~~

Utilities services plans

Existing services: Obtain service plans from all relevant public utility Authorities and other organisations whose services exist within the area of the proposed works.

Location: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

Heritage considerations

~~General: [complete/delete]~~

Requirement: Provide a plan for management of heritage assets.

Protection of existing structures

Existing plans: Obtain drawings of existing structures adjoining the site.

Dilapidation reports: Carry out inspections of all existing structures adjoining the site. Prepare a report on the existing structural condition including a photographic record of any defects.

Site investigations

General: Carry out a survey and geotechnical investigation and prepare reports.

CBR value for the subgrade: To the geotechnical investigation report.

Design consultants

General: Liaise with the following consultants before and during, the cycleway and pathway design:

- Landscape architect.
- Traffic engineer.
- Structural engineer.
- Geotechnical engineer.
- Streetscape artist.
- Environmental engineer.

3 DESIGN

3.1 LOCATION OF PATHS

Requirements

General: Locate the pathways and cycleways as follows:

- Along river frontages.
- On foreshores.
- Through parklands.
- Along railway reservations.
- Abutting bridges.
- Within the reservations of streets which have direct access to property.

Design considerations: Consider the following in the location of pathways and cycleways:

- Proper alignment for cyclists to travel safely at their chosen speed.
- Avoiding sharp horizontal curves at the bottom of steep downgrades.
- Adequate sight distance across the inside of curves.
- Access to emergency service and maintenance vehicles at path entrances.
- Landscaping and planting.

~~Location of pathways and cycleways in road reserves: [complete/delete]~~

3.2 DESIGN CRITERIA

General

~~Pavement design life: [complete/delete]~~

Maintenance considerations: Concrete pathways and cycleways to be reinforced with mesh steel or other appropriate reinforcing material approved by Council.

Cycleway and pathway types

~~Cycleway type: [complete/delete]~~

~~Pathway type: [complete/delete]~~

~~Footpath requirement: [complete/delete]~~

Geometric design

Design criteria: To the **Design criteria table**.

Design criteria table

Feature	Cycleway	Pathway	Shared use pathway	Separated paths	
				One-way	Two-way
Path width Desirable minimum (To AGRD06A clause 7.5)	Local access path: 2.5 m Major path: 3.0 m	Minimum width:1.2 m Absolute minimum: 1 m High pedestrian volume: 2.4 m Footway dining: 5 m	Local access: 2.5 m Commuter path: 3.0 m Recreational path: 3.5 m	Cycleway:1.5 m Pathway: 1.5 m	Cycleway: 2.5 m Pathway: 2.0 m
Path width Minimum – Maximum (To AGRD06A clause 7.5)	Local access path: 2.5 – 3 m Major path: 2.5 – 4 m	For disability access: 1.5 – 1.8 m	Local access: 2.5 - 3 m Commuter path: 2.5 - 4 m Recreational path: 3.0 - 4 m	Cycleway: 1.2 – 2 m Pathway: ≥ 1.2 m	Cycleway: 2.0 – 3 m Pathway: ≥ 1.5 m
Vertical clearance (To AS 1742.2- 2009 and AS 1428.2)	2.5 m	2.0 m	2.5 m	2.5 m	2.5 m
Crossfall	1:40	General: Flat – 2.5% (0 – 1:40) Sealed surfaces: 2%-4% (1:50 – 1:25) Unsealed surfaces: 5% (1:20)	Maximum: 2.5% (1:40)		
Gradient (To AGRD06A, Figure 7.1)	Desirable maximum: 3% Maximum: 5%	NA	2%		
Minimum radius for horizontal curves for cycleways and shared pathways	Without superelevation: To AGRD06A Tables 7.1 With superelevation: To AGRD06A Table 7.2.				
Minimum sight stopping distance for cycleways and shared pathways	To AGRD06A Figure 7.7				
Operating speed	Flat gradients: 35 km/h Moderate gradients: 50 km/h	Walking speed: 1m/s Walking speed at crossings: 1.2 m/s			

Drainage

~~Water sensitive design: [complete/delete]~~

~~Landscaping: [complete/delete]~~

Safety

~~General: [complete/delete]~~

Ramp and footpath landings: Conform to the **Landings table**.

Landings table

Type of path	Longitudinal gradient	Landing requirement
Ramp	1:14	Every 9 m
	1:20	Every 15 m
Footpath	1:20	Every 15 m
	1:33	Every 25 m
	Flatter than 1:33	No landing required

~~Maximum bicycle operating speed: [complete/delete]~~

Disabled access

Requirement: In conformance with To AS 1428.1, Council's policy on access and mobility and the Disability Discrimination Act.

Warning Tactile ground surface indicators: To AS/NZS 1428.4.1 and provide at top and bottom of ramps and stairs.

Provision at structures

Uninterrupted movement: Provide uninterrupted movement of cyclists and pedestrians at proposed and existing structures, such as bridges and underpasses.

Provision at road crossings

Requirement: Provide appropriate grades, width adjustment for waiting areas and kerb ramps at road crossings.

Lateral clearance: Minimum lateral clearance where a shared path way crosses a pedestrian bridge:

- 0.5 m on both sides where speed of cyclists is < 20 km/hr.
- 1.0 m on both sides where speed of cyclist is > 20 km/hr.

Signage and pavement marking

Sign posting: Provide signposting to indicate destinations and potential hazards.

Signs and pavement marking: To AS 1742.9 and AS 1742.10.

Facilities

Requirement: Provide design for the following facilities at common destinations of cyclists and pedestrians:

- Street furniture including seats, bins, drinking fountains and telephones.
- Standby areas.
- Secure bicycle parking to AP-G88 and fabricated to AS 2890.3.
- Picnic facilities and viewing platform facilities.
- Information stands/direction signs.
- Connection paths to public transport.
- Bicycle wheeling ramps.
- Bus stop shelter.
- Grates and covers flush with the adjacent path.

Lighting and lighting support structures

General: To AS/NZS 1158.3.1 and AS 1798.

Underpasses: To AS/NZS 1158.5.

Pavement design

Structural design: To AGPT02, Section 12.

Control of cracks: To CIA Z15.

~~Design traffic loading: [complete/delete]~~

~~Joints to existing pavement: [complete/delete]~~

3.3 MATERIALS**Environmental considerations**

Trees policy: Consider existing or planned trees policy when selecting pavement materials to minimise pavement maintenance and to limit environmental impact.

~~Recycled construction materials: [complete/delete]~~

Pavement

Materials: *Reinforced concrete to Standard Drawing EGSD-301 for footpaths and shared paths. Consideration will be given to replacing or rehabilitating an existing footpath to the existing standard.*

Maintenance considerations

General: Document low maintenance materials for pavements and street furniture.

Consider exposure conditions and appropriate durability requirements.

Protection of materials: Document protection methods for materials to satisfy durability requirements.

Miscellaneous

~~General: [complete/delete]~~

4 DOCUMENTATION

4.1 GENERAL**Approvals**

~~Authorities: [complete/delete]~~

Specifications

Construction documentation: Prepare specifications using the AUS-SPEC contract documentation system.

Design certification

Requirement: Provide a signed and dated design certificate.

4.2 DRAWINGS**General**

~~Design drawing format: [complete/delete]~~

Drawings content

General: Provide the following:

- Locality plan.
- Site plans showing cycleways and pathways at 1:500 scale.
- Part plans at 1:200 scale, showing merging details of new cycleways and pathways with existing roads.
- Longitudinal sections at scales of 1:500 horizontal and 1:50 vertical.
- Cross sections at 1:100 scale. Provide transition tables if cross falls vary.
- Design traffic loading and design CBR value for the natural subgrade material.
- Details of typical cross sections including pavement materials, pavement layer depths, edge details and details of any retaining walls, batters, fences and drainage works at 1:20 scale.
- Typical details of expansion joints, contraction joints and joints to existing pavements. Show details of additional joints at drainage pits, lighting poles and safety bollards.
- Details of handrails, safety bollards, street furniture, lighting poles and traffic signalling posts at 1:10 scale.

- Traffic management plan.

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

~~Work-as-executed drawing format: [complete/delete]~~

4.4 CERTIFICATION

General

~~Final certification of completed works: [complete/delete]~~

0061 BRIDGES AND RELATED STRUCTURES
--

1 GENERAL**1.1 RESPONSIBILITIES****Objective**

General: Provide design and documentation for the structures covered by this worksection.

~~Details of structures: [complete/delete]~~

~~Scope of design services: [complete/delete]~~

~~Designer's qualifications: [complete/delete]~~

Evidence of designer's qualifications and experience: Submit to Council Authorities.

~~State planning legislation: [complete/delete]~~

Federal legislation: Environment Protection and Biodiversity Conservation Act 1999.

1.2 CROSS REFERENCES

Requirement: Conform to the following worksection(s):

- 0010 Quality requirements for design.
- 0074 Stormwater drainage (Design).
- 0041 Geometric road layout.
- 0042 Pavement design.
- 0075 Control of erosion and sedimentation (Design).
- 1101 Control of traffic.
- 1351 Stormwater drainage (Construction)

1.3 REFERENCED DOCUMENTS**Standards**

General: The following documents are incorporated into this worksection by reference:

Australian Standards

AS 1100	Technical drawing
AS 1100.101-1992	General principals
AS 1158-various	Lighting for roads and public spaces
AS 1428	Design for access and mobility
AS 1428.1-2009	General requirements for access-New building work
AS/NZS 1428.4.1:2009	Means to assist the orientation of people with vision impairment-Tactile ground surface indicators
AS 1798-1992	Lighting poles and bracket arms-Preferred dimensions
AS 1926 various	Swimming pool safety
AS/NZS 2041 various	Buried corrugated metal structures
AS/NZS 3845:1999	Road safety barrier systems
AS 4678-2002	Earth-retaining structures
AS 5100	Bridge design
AS 5100.1-2004	Scope and general principals
AS 5100.2-2004	Design loads
AS 5100.3-2004	Foundations and soil supporting structures
AS 5100.4-2004	Bearings and deck joints
AS 5100.5-2004	Concrete
AS 5100.6-2004	Steel and composite construction
AS 5100.7-2004	Rating of existing bridges

Austroroads

AGBT01-2009	Guide to bridge technology - Introduction and bridge performance
AGBT02-2009	Guide to bridge technology - Materials

AGBT03-2009	Guide to bridge technology - Typical superstructures, substructures and components
AGBT04-2009	Guide to bridge technology - Design procurement and concept design
AGBT05-2012	Guide to bridge technology - Structural drafting
AGBT06-2009	Guide to bridge technology - Bridge construction
AGBT07-2009	Guide to bridge technology - Maintenance and management of existing bridges
AGRD06A-2009	Guide to road design-Pedestrian and cyclist paths
AP-T196-2011	Guidelines for design construction, monitoring and rehabilitation of buried corrugated metal structures.

1.4 STANDARDS

General

Bridge design: To AS 5100.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- AGBT: Austroads guide to bridge technology

[\[complete/delete\]](#)

Definitions

General: For the purposes of this worksection the following definitions apply:

[\[complete/delete\]](#)

2 PRE-DESIGN PLANNING

2.1 PLANNING

Design procurement model

[Requirement: \[complete/delete\]](#)

Design delivery stages

[Requirement: \[complete/delete\]](#)

Checking and review concepts

[General: \[complete/delete\]](#)

[Independent review: \[complete/delete\]](#)

Funding

[Government grant funds: \[complete/delete\]](#)

[Construction budget: \[complete/delete\]](#)

2.2 CONSULTATION

Council and other Authorities

Requirements: Consult with Council and other relevant Authorities during the preparation of design.

Public consultation

General: Undertake public consultation on designs in conformance with Council policy.

Utilities services plans

Existing services: Obtain service plans from all relevant public utility Authorities and other organisations whose services exist within the area of the proposed structure.

[Proposed new services: \[complete/delete\]](#)

Heritage considerations

[General: \[complete/delete\]](#)

Requirement: Provide a plan for management of heritage assets.

Protection of existing infrastructure

Existing plans: Obtain drawings of existing structures adjoining the site.

Dilapidation reports: Carry out inspections of all existing structures adjoining the site. Prepare a report on the existing structural condition including a photographic record of any defects.

Groundwater control: Identify potential effects of dewatering during construction.

Concept design

Design investigations: Inspect the site and carry out necessary design investigations.

Checklists: Complete the following before commencement of detailed design:

- Action Checklist for preparation of bridge design concept: To AGBT04, Appendix B.
- Matters for resolution before design commences: To AS 5100.1, Appendix A.

3 DESIGN

3.1 DESIGN CRITERIA

Design life

Requirement: ~~[complete/delete]~~

Waterways and flood design

Design: To AS 5100.

Requirement: ~~[complete/delete]~~

Geotechnical investigation and survey

Responsibilities: ~~[complete/delete]~~

Traffic conditions

Requirements: ~~[complete/delete]~~

Geometry

Design: To AS 5100.

Requirements: ~~[complete/delete]~~

Road layout: Conform to *0041 Geometric road layout*.

Aesthetics

General: Consider visual appearance.

Design guidance: AGBT04, Appendix C.

Maintenance considerations

General: To AS 5100 and AGBT07.

Requirement: ~~[complete/delete]~~

Construction considerations

Requirement: ~~[complete/delete]~~

Provisions for traffic: Conform to *1101 Control of traffic*.

Design loads

General: To AS 5100.2.

Requirement: ~~[complete/delete]~~

Serviceability

General: To AS 5100.2.

Requirement: ~~[complete/delete]~~

Environmental constraints

Requirement: ~~[complete/delete]~~

Erosion and sedimentation control: To *0075 Control of erosion and sedimentation (Design)*.

Ecologically sustainable development

Requirement: ~~[complete/delete]~~

Inspection on completion

Requirement: To Section 4.8 of 1351 Stormwater drainage (Construction) for CCTV inspection on completion of all drainage structures

3.2 ROAD TRAFFIC AND PEDESTRIAN BRIDGES

General

Design: To AS 5100.

Design guidance: AGBT01, AGBT02, AGBT03, AGBT04 and AGBT06.

~~Standard designs: [complete/delete]~~

Design life maintenance

Requirement: Design for low maintenance.

Procedures for planned maintenance: To AGBT07.

Materials

General: Document low maintenance materials for construction, finishes and fitments.

Consider exposure conditions and appropriate durability requirements.

Protection of materials: Document protection methods for materials to satisfy durability requirements.

Drainage

General: Conform to *0074 Stormwater drainage (Design)*.

Freeboard

~~Minimum provision: [complete/delete]~~

Design: Provide freeboard to suit local conditions and expected amount and size of debris.

Public utilities

General: If public utilities are required, conceal from public view.

~~Attachments: [complete/delete]~~

3.3 PROVISIONS FOR PEDESTRIANS AND CYCLISTS ON ROAD BRIDGES

Walkways and cycleways

Standard: To AS 5100.1, AGRD06A.

~~Separate footpaths: [complete/delete]~~

Disabled access

Standard: To AS 1428.1 and AS/NZS 1428.4.1.

3.4 STRUCTURES, OTHER THAN BRIDGES, ASSOCIATED WITH ROADS

Buried corrugated metal structures

Standard: To AS 5100, AS/NZS 2041 and AP-T196.

Earth retaining structures

Standard: To AS 5100 and AS 4678.

Detention basins

Hydraulics: Conform to *0074 Stormwater drainage (design)*.

~~Authorities: [complete/delete]~~

Safety fencing: *To LMCC Engineering Drawing EGSD-602*

Safety fencing design: To AS 1926.

Culverts

Standard: To AS 5100.2 and AS 5100.3.

Noise barriers

Standard: To AS 5100.1 and AS 5100.2.

3.5 STRUCTURES USED FOR PUBLIC SAFETY.

Barriers and rails

Standard: To AS 5100.1, AS 5100.2 and AS/NZS 3845.

Omitting safety barriers: Conform to AS 5100.1, Cl 10.5.2. Specify flood depth indicators and signposting.

Final design drawings: Show details of all safety barriers and rails, including barrier performance level and support details.

Lighting and lighting support structures

Standard: To AS 5100.2, AS 1158 and AS 1798.

Design: Design street lighting for bridge approaches and crossings.

Final design drawing: Show details of lighting poles and support details.

Protection screens

~~General: [complete/delete]~~

Standard: To AS 5100.1 and AS 5100.2.

3.6 TEMPORARY WORKS**Design**

Standard: To AS 5100.

Construction program

Drawings: Show the construction program, indicating the sequence of events leading from the installation to the removal of any temporary structures.

4 DOCUMENTATION

4.1 GENERAL**Approvals**

~~Authorities: [complete/delete]~~

Design statement

Concept design: Provide a design statement including the design criteria, design options, recommended solution and recommended construction and maintenance procedures.

Design report

Detailed design: Provide a design report including the design criteria, detailed design calculations, structural design models and reference documents supporting the design, such as hydrological, geotechnical, construction sequence, maintenance schedule vibration study and fatigue study reports.

Specifications

Construction documentation: Prepare technical specifications suitable for inclusion in the AUS-SPEC contract documentation system. Consider including Construction and Maintenance worksection *Templates* from the National Classification System workgroups 02, 03, 11, 13, 14-18.

Design certification

Requirement: Provide a signed and dated design certificate.

Design certificate format: To *0160 Quality (Design)*.

4.2 DRAWINGS**Structural drafting**

Standards: To AS 1100.101, AS 5100.5, AS 5100.6 and AGBT05.

Drawing presentation

~~Drawing format: [complete/delete]~~

~~Drawing size: [complete/delete]~~

~~Drawing numbering, titles and subtitles: [complete/delete]~~

~~Title block format: [complete/delete]~~

Drawing content

~~Requirement: [complete/delete]~~

Verification and approval of construction drawings

~~Authorised personnel: [complete/delete]~~

Drawing distribution

Transmittal forms: Provide transmittal forms when distributing the drawings for review, information, tender or construction.

Change register: Provide space on the right hand side of each drawing to register changes to the drawings after the construction issue.

Issue numbering: Adopt a consistent and easy to follow numbering system for drawings at different design stages.

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

~~Drawing format: [complete/delete]~~

~~Final certification of completed works: [complete/delete]~~

0074 STORMWATER DRAINAGE (DESIGN)
--

1 GENERAL

1.1 RESPONSIBILITIES

Objective

General: Provide stormwater drainage systems design and documentation to meet the following requirements:

- Reduced frequency of flooding of private and public buildings in flood-prone areas.
- Control of surface flows to prescribed velocity/depth limits.
- Control of surface flows to minimise the effect on pedestrians and traffic in more frequent stormwater conditions.
- Within each catchment, retention of incident rainfall and runoff consistent with the planned use of the area.
- Conformance with the Australian Rainfall & Runoff (ARR) 'major/minor' system concept.
- A constant average recurrence interval (ARI) for existing and reconstructed works.
- Adoption of Water Sensitive Urban Design (WSUD) principles.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- 0010 *Quality requirements for design.*
- 0075 *Control of erosion and sedimentation (Design).*
- 1121 *Open drains, including kerb and channel (gutter).*
- 1351 *Stormwater (Construction).*

Related worksections:

- 1352 *Pipe drainage.*
- 1353 *Precast box culverts.*
- 1354 *Drainage structures.*

1.3 REFERENCED DOCUMENTS

Standards

General: The following documents are incorporated into this worksection by reference:

Australian standards

AS/NZS 1254: 2010	PVC pipes and fittings for storm and surface water applications.
AS 1289	Methods of testing soils for engineering purposes
AS 1289.4.2.1-1997	Soil chemical tests - Determination of the sulfate content of a natural soil and the sulfate content of the groundwater - Normal method
AS 1289.4.3.1-1997	Soil chemical tests - Determination of the pH value of a soil - Electrometric method
AS 1289.4.4.1-1997	Soil chemical tests - Determination of the electrical resistivity of a soil - Method for sands and granular materials
AS/NZS 2032: 2006	Installation of PVC pipe systems
AS 2200-2006	Design charts for water supply and sewerage
AS/NZS 2566	Buried flexible pipelines
AS/NZS 2566.1: 1998	Structural design
AS/NZS 2566.2:2002	Installation
AS/NZS 3500	Plumbing and drainage
AS/NZS 3500.3: 2003	Stormwater drainage
AS/NZS 3725: 2007	Design for installation of buried concrete pipes
AS/NZS 4058: 2007	Precast concrete pipes (pressure and non-pressure)
AS 4139-2003	Fibre reinforced concrete pipes and fittings

AS/NZS 5065: 2005 Polyethylene and polypropylene pipes for drainage and sewerage applications

Austrroads

AGRD05-2010

Guide to road design – Drainage design

AP-R232: 2003

Guidelines for treatment of stormwater runoff from the road infrastructure

Other publications

Council

Handbook for drainage design criteria

Engineers Australia

Australian Rainfall and Runoff (ARR) Volume 1 - A guide to flood estimation

- Book II - Design rainfall considerations
- Book III - Choice of flood estimation methods and design standards
- Book IV - Estimation of design peak discharges
- Book VII – Aspects of hydraulic calculations.
- Book VIII - Urban stormwater drainage.

ARQ 2006 Australian runoff quality – A guide to Water Sensitive Urban Design

Concrete Pipe Association of Australasia

Hydraulic Design Manual for precast concrete pipes

Refer to www.concpipe.asn.au for the design of steel reinforced concrete pipelines

Australian National Conference On Large Dams, Leederville WA

ANCOLD, Guidelines on Acceptable Flood Capacity for Dams (2007)

Australian and New Zealand Environment and Conservation Council

ANZECC- 2000 National Water quality management strategy No.10 Guidelines for urban stormwater management

NSW RMS

Model analysis to determine hydraulic capacities of kerb inlets and gully pit gratings

LMCC

- *SQID Guidelines (Stormwater Quality Improvement Device)*
- *Drainage Design Guidelines*
- *Flood Management Guidelines*
- *Water Cycle Management Guidelines*
- *Erosion and Sediment Control Guidelines*

1.4 STANDARDS

General

Standard: Conform to the following:

- Rainfall and runoff: To ARR.
- Water sensitive urban design: To ARQ.
- To Council's Handbook for drainage design criteria (Handbook).

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the abbreviations given below apply:

- ARI: Average Recurrence Interval.
- ARR: Australian Rainfall and Runoff.
- ARQ: Australian Runoff Quality.
- BPP: Best Planning Practices.
- BMP: Best Management Practices.
- GPT: Gross Pollutant Trap.
- IFD: Intensity-Frequency-Duration.
- HGL: Hydraulic Grade Line.

- JP: Junction pits.
- OSD: On-site detention.
- SEP: Side entry pit.
- SMP: Stormwater Management Plan.
- SQID: Stormwater quality improvement devices.
- WSUD: Water Sensitive Urban Design.

Definitions

General: For the purposes of this worksection the definitions given below apply:

- Average Recurrence Interval (ARI): Average interval in years is the average or expected value of the period between exceedances of a given discharge.
- Catchment: A topographically defined area drained by a stream such that all outflow is directed to a single point.
- Catchment area: The catchment area of any point is defined by the limits from where surface runoff will make its way, either by natural or man made paths, to this point.
- Dual drainage: The major/minor approach to street drainage.
- Handbook: Council Handbook for drainage design criteria.
- Major system: The network of planned and unplanned drainage routes which provides safe, well-defined overland flow paths for rare and extreme storm runoff events. It includes roads, natural channels, streams, culverts, community retention/detention basins and other facilities.
- Minor system: The gutter and pipe network capable of carrying and controlling flows from frequent runoff events. It includes kerb and channels, inlet structures, open drains and underground pipes and on-site detention facilities.

Primary treatment SQID: Removal of the majority of gross pollutants and coarse-medium grained sediments by screening or sedimentation e.g. GPT's, trash racks, sediment trap.

- Redevelopment site: A site which had (or was originally zoned to have) a lower density development than is proposed.

Secondary treatment SQID: Removal of the majority of coarse, medium and fine grained sediments, as well as a significant proportion of the pollutants attached to sediments, by enhanced sedimentation and filtration e.g. Infiltration basins and wet ponds.

- Stormwater Management Plan: Plan to manage the stormwater quantity and quality within a catchment and protect receiving water features, such as the protection of existing waterways, lakes and wetlands.
- Sub-catchment: A topographically defined area drained by a tributary or branch drain of a primary stream or main drain draining a catchment.
- Tertiary treatment SQID: Removal of the majority of sediments, attached pollutants and dissolved pollutants by sedimentation, filtration and biological uptake e.g. Constructed wetlands.
- Time of concentration: The time required for storm runoff to flow from the most remote point on the catchment to the outlet of the catchment or to the inlet of a drainage structure within the catchment.
- Treatment train: Sequencing of SQID's to optimise treatment performance.
- Trunk drains: Large capacity channels or conduits which carry runoff from local street drainage systems to receiving waters. For example, natural or artificial channels, transitions and hydraulic structures, culverts and road crossings, naturally occurring ponds and lakes, artificial detention or retention storages.
- Water Sensitive Urban Design (WSUD): Design principles aimed at improving the sustainable management of the urban water cycle. It integrates the planning and design of urban water cycle, water supply, waste water, stormwater and groundwater management, urban design and environmental protection.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Best Planning Practices (BPP)

General: Carry out BPP including the following:

- Capability assessment: Assess the existing physical and natural attributes of the site including the following:
 - . Area and shape of the catchment area.
 - . Slopes and existing channels.
 - . Vegetation affecting run-off and/or loss factors.
 - . Existing works at risk of inundation.
 - . Existing drainage works location and capacity.
 - . Sensitive inhabited locations to be protected.
 - . Services and transport works to be protected.
 - . Any tidal considerations.
 - . Pollution control requirements.
- Planning and design for WSUD.

Best Management Practices (BMP)

General: Evaluate the structural and non-structural elements of a design that perform the prevention, collection, treatment, conveyance, storage and re-use functions of a water management scheme.

BMP: Include the following:

- BPP:
 - . Land and water use planning.
 - . Regulation assessment.
 - . Urban design.
- Source control:
 - . Land management.
 - . Enforcement.
 - . Education and awareness.
- System management measures:
 - . Stormwater management plan.
 - . Stormwater treatment.
 - . Flow management.

Water Sensitive Urban Design

General: Plan and design stormwater drainage using WSUD principles including the following:

- On-site detention (OSD).
- Capture and use of stormwater as an alternative source of water to conserve potable water.
- Use of vegetation for filtering purposes.
- Water-efficient landscaping.
- Protection of water-related environmental, recreational and cultural values.
- Localised water harvesting for re-use.
- Localised wastewater treatment systems.

2.2 CONSULTATION

General

Data collation and approval: The following organisations and/or personnel are involved in the data collation and approval process:

Hydrology inputs

Survey providers
 Program for completion
 Local constraints
 Legal inputs
 Transport interaction
 Communication risks
 Evacuation planning
 Utilities – protection

Calculations

Certified design calculations: Engage a qualified hydrologic and hydraulic design professional to perform all required calculations.

Major structures

Certified structural design: Engage a professional engineer for all bridges, major culvert structures and specialised structures in conformance with *0160 Quality (Design)*.

3 STORMWATER DRAINAGE SYSTEMS

3.1 GENERAL

Stormwater drainage

Design requirements: Consider the following elements in designing the stormwater drainage system:

- Determination of design flows.
- Hydraulic design of pipelines.
- Appropriate inlet and discharge structures.
- Structural elements of the drainage system.

Easements

Easements over private property: Do not surcharge major system flows across private property. Contain flows of ARI 100 years.

Collaboration: Plan services layout to avoid clashes with other services.

Control of erosion and sedimentation

Requirement: To *0075 Control of erosion and sedimentation*.

Inspection on completion

Requirement: To Section 4.8 of 1351 Stormwater drainage (Construction) for CCTV inspection no more than fourteen (14) days prior to the completion of the project.

Curved drainage lines

Requirement: Prior Council approval is required.

3.2 WATER CYCLE MANAGEMENT

Design for stormwater harvesting and re-use

General: Design for re-use of locally generated roof water, stormwater and wastewater. Adopt BPP and BMP systems to integrate the urban water cycle for collection, drainage and re-use.

Stormwater re-use scheme: Design the re-use scheme for ease of operation and maintenance. Consider the following when designing for collection, storage, treatment and distribution:

- End use requirements for water quality and quantity.
- Reliability of supply (varies with local climate and rainfall).
- Estimated demand for water with regard to peak flow. (Depends on the variable rainfall pattern).
- Assessment of water balance for sizing and storage.
- Storage requirements considering average annual volume and diversion flow rates.

- Treatment system based on:
 - . Diversion flow rates before storage.
 - . Distribution flow rates both before and after storage.

~~Statutory approvals: [complete/delete]~~

Roofwater: Provide an integrated design with rainwater tanks, coordinate with the appropriate engineering consultation and comply with the requirements of any authorities or local government.

Stormwater runoff: Design for the utilisation of stormwater runoff at the following scales:

- Allotment scale.
- Subdivisional/regional scale.

Wastewater and grey water: Design for wastewater and grey water re-use where it impacts the stormwater drainage design. Utilise professional engineering input where appropriate.

Stormwater collection

Requirement: Design the stormwater collection system to meet the following objectives:

- Extraction of sufficient water to meet the end use requirements without compromise to downstream aquatic eco systems.
- Potential to stop collection in the event that stormwater is contaminated by an incident within the catchment.
- Minimisation of the risk and/or impact of upstream flooding.

Stormwater storage

Requirement: Design the stormwater storage system to meet the following objectives:

- Storage of sufficient water to balance supply and demand.
- Above-ground storage: Minimisation of mosquito habitat (virus control), risks to public safety and risks to water quality and maximisation of dam safety.

Stormwater treatment

Treatment: Design appropriate stormwater treatment techniques to meet the following objectives:

- Minimisation of public health risks for the adopted public access arrangements.
- Minimisation of environmental risks.

~~Additional end use requirements: [complete/delete]~~

~~Additional stormwater quality criteria: [complete/delete]~~

Stormwater distribution

Requirement: Minimise the potential for:

- Contaminant inputs downstream of the final treatment facilities.
- Public exposure to untreated stormwater.
- Cross-contamination with mains water distribution networks or confusion with mains water supplies.

Irrigation: Design the irrigation system to the following requirements:

- Minimise run off, groundwater pollution and soil contamination.
- Minimise spray to areas outside the access control zone where access control is adopted to reduce public health risks.
- Application rate of stormwater: Uniform for the irrigation scheme and at a rate less than the nominal infiltration rate to avoid surface runoff.

3.3 STORMWATER MANAGEMENT

General

Requirement: Integrate management activities at the catchment, waterway and local development level in conformance with the *Guidelines for urban stormwater management* and the following:

- Restore of existing stormwater systems.

- Minimise the impacts of stormwater from new developments.
- Hydrological: Minimise the impacts of urbanisation on the hydrological characteristics of a catchment including wet weather and low flows. Mitigate pre-development inappropriate flows where practical.
- Water quality: Minimise the amount of pollution entering the stormwater system and remove residual pollution by implementing stormwater management practices.
- Vegetation: Maximise the value of indigenous riparian, floodplain and foreshore vegetation.
- Aquatic habitat: Maximise the value of physical habitats to aquatic fauna within the stormwater system.
- Processes for management: Submit processes for management for the following as applicable:
 - . Runoff.
 - . Water quality.
 - . Riparian vegetation.
 - . Watercourse and aquatic habitat.
 - . Urban bushland.
 - . Bridges and culverts across waterways.
 - . Water sensitive urban design.

Stormwater management plan

Requirement: Provide a stormwater management plan in conformance with the *Guidelines for urban stormwater management* and the following:

- Describe the catchment or sub-catchment area.
- Identify stakeholders and partnership mechanisms.
- Outline agreed values, issues and management objectives.
- Identify management strategies for land and water use and practices.
- Address implementation instruments and programs including education and training, planning, infrastructure provision, operation and maintenance, regulation and economic incentives.
- Address assessment and performance review including monitoring of values and conditions, monitoring of strategy implementation and review time frames.
- Link water quantity controls with water quality controls.
- Integrate permanent stormwater management features into overall development.
- Identify legal point(s) of discharge (prior to Development Approval).
- Address ecological protection issues that are influenced by the management of stormwater (e.g. waterway corridor vegetation and habitat management issues).
- Clearly identify pollutants of concern and their sources for both the construction and operational phases of development.
- Identify an optimum combination of structural and non-structural Stormwater Quality Best Management Practices to limit the pollutant export potential of the site for both the construction and operational phases of development.
- Address the management of specific water quality issues (where relevant).
- Specify a water quality monitoring program where necessary.
- Outline maintenance requirements.
- Ensure site-based measures complement regional water quantity and water quality management measures already planned through Council Stormwater Management Plans or Waterway Management Plans.

3.4 HYDROLOGY

Design rainfall data

Design Intensity-Frequency-Duration (IFD): Derive rainfall relationships for a particular catchment from the *Handbook*.

Alternatively: Derive rainfall relationships for a particular catchment from the following options:

- ARR volume 1 Book II section 1.
- AS/NZS 3500.3 Appendix E.
- Bureau of Meteorology IFD tool website www.bom.gov.au
- Geoscience Australia website www.ga.gov.au.

Record IFD: Document the adopted IFD data used in the hydrological calculations to the sample summary sheet in the *Handbook*.

Design ARI *for minor drainage system:*

- 10 years for commercial/industrial area
- 10 years for residential area
- 5 years for rural residential area
- 1 year for parks and recreation area
- 20 years for intersections with Arterial roads

Alternative: If there is no *Handbook* provided, derive the ARI from ARR Book III and AGRD 05.

Record ARI: Document the adopted ARI data in the hydrological calculations to the sample summary sheet in the *Handbook*.

Catchment area

Extent: To the *Handbook*.

Alternative: If the catchment area is not defined in the *Handbook*, determine the extent of the catchment area from current topographical mapping, aerial photographs or field survey.

Site inspection: Verify catchment boundaries by site inspection.

Catchment definition: To AGRD05 clause 4.5.3.

Record: Document the design to the **Catchment areas plan**.

Design variations: Consider potential changes to individual catchment areas due to the full development of the catchment, including changes in run-off coefficients and irrigation of areas effecting loss factors.

Catchment area land use: Establish catchment area land use on current available zoning information or proposed future zonings, where applicable.

Methods of analysis

Peak flows: Determine peak flows using Rational Method Calculations in conformance with ARR Book IV Section 1 and the requirements of this worksection.

Flow studies: Prepare flow studies including the following:

- A relevant range of ARI's for each sub-catchment.
- Calculation of total flows at junctions of existing drainage works.
- Assessment of allowable flows from catchment/sub-catchments for release to downstream areas or drainage systems.
- Assessment of release from dams/detention works affecting capacity of drainage works to avoid surcharge/inundation.

Run-off coefficients: To the *Handbook* for specific locations and zonings or ARR or AS 3500.3.

Record: Document details of adopted coefficients in the hydrological calculations summary sheet in the *Handbook*.

Percentage impervious: To the *Handbook* for specific locations and zonings or ARR.

Time of concentration

Time criteria: Conform to the following:

- Minimum time of concentration: 5 minutes.
- Maximum time of concentration in a urban area: 20 minutes unless sufficient evidence is provided to justify a greater time.

Flow time: If the flow path is through areas having different flow characteristics or includes property and roadway, calculate the flow time of each portion of the flow path separately.

Flow paths to pits: Show each collection pit on the catchment area plan for the fully developed catchment. Consider fencing, potential locations of buildings and changes to individual flow paths due to the full development of the catchment including proposed detention works.

Pipe and channel flow: Calculate pipe flow using the following formulae:

- Mannings formula: To AGRD05 clause 4.6.6 or AS/NZS 3500.3 Table 5.5.
- Colebrook-White formula (used in computer modelling where conduits are designed to act under pressure. HGL must not be above the surface level at any pit otherwise overflow will occur. Minimum freeboard: 150 mm): To AGRD05 clause 4.6.3 or AS/NZS 3500.3 Table 5.6.

Mannings roughness co-efficient ('n') for specific zonings: To the Handbook or ARR Book VII Section 1 Table 1.1 or AGRD05 Commentary 31 Table C31 1.

Modelling

~~Model type required for design: [complete/delete]~~

Alternative models and computer analysis

Other hydrological models: Use of other hydrological models or computer analysis is permitted provided the following requirements are met:

- Satisfy the requirements of ARR.
- Submit summaries of calculations.
- Submit details of all program input and output.
- Submit copies of the final data files.

3.5 HYDRAULICS

General

Design concept: To the ARR major/minor drainage concept as defined in AGRD05 and ARR Book VII.

Hydraulic grade line

Hydraulic grade line (HGL): Perform calculations to ARR.

Record: Document hydraulic calculations to the sample summary sheet given in the *Handbook* including the following:

- A summary of design calculations.
- Detailed drawings of the grade line.
- Listing of all programme input and output.

Downstream control: Adopt the appropriate downstream water surface level requirements from the following options:

- Known HGL level from downstream calculations including pit losses at the starting pit in the design event.
- If the downstream starting point is a pit and the HGL is unknown, adopt a level of 0.15 m below the invert of the pit inlet in the downstream pit.
- If the outlet is an open channel and the design storm is minor, the top of the outlet pipe is the downstream control.
- If the outlet is an open channel, the design storm is major and downstream flood levels are not known, the top of the outlet pipe is the downstream control.
- If the outlet is an open channel, the design storm is major and downstream flood levels are known, the downstream control is the ARI 100 years flood level.

Water surface limits: Limit the water surface in drainage pits as follows:

- Inlet pits: To 0.150 m below the gutter invert.
- Junction pits: To 0.150 m below the underside of the lid.

3.6 HYDRAULICS - MINOR SYSTEM CRITERIA

General

Gutter flow widths: Maximum 2.5 m for ARI 10 year event. Submit for approval for wider flow widths for roads with flat grades.

Conduit sizes: Minimum conduit sizes as follows:

- Pipes: 375 mm diameter.
- Box culverts: 600 mm wide × 300 mm high.

Pipe material: To be steel reinforced concrete pipe or fibre reinforced concrete pipe.

Pipe joints: To be collared and rubber ring jointed. The steel reinforced non-pressure concrete pipes with rubber ring joints to comply with AS/NZS4058:2007 whilst the fibre reinforced concrete pipes with dual rubber v-ring elastomeric joints to comply with AS4139-2003.

Pipe class: To be minimum Class 3 for longitudinal pipes and Class 4 for transverse pipes.

Velocity limits: Flow in stormwater pipelines as follows:

- Minimum: 0.6 m/sec.
- Maximum: 6 m/sec.

Pits

Pit location: To AGRD05 clause 2.2 and Commentary 14.

Spacing: In conformance with the following:

- Flow width:
 - . Minor systems: To AGRD05 Commentary 12 Table C12 1.
 - . Major systems: To AGRD05 Commentary 12 Table C12 2.
- Maximum recommended spacing of pits where flow widths are not critical: To the **Pit spacing table**.
- Inlet efficiency is not effected by adjacent inlet openings.
- Give preference to the location of drainage pits at the upstream side of allotments.

Types of pits: Provide other pits as follows:

- Access chambers: To enable access for maintenance.
- Gully pits: To provide drainage path into sections minimising overland flow.
- Junction pits: At changes in direction, grade, level or class of pipe.

Pit spacing table

	Pipe size (mm)	Spacing (m)
Generally	Less than 1200	100
	1200 or larger	150
In tidal influence	All	100

Inlet capacity: Kerb inlet lengths to side entry pits as follows:

- Preferred maximum: 3.0 m.
- Maximum 5.0 m where the grade is 10% or more.
- Maximum 4.0 m where the grade is less than 10%.

Pit capacities: To the following:

- The *Handbook*.
- Pit relationships in ARR Volume 1.
- (NSW) Roads and Traffic Authority *Model analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings*, with due allowance to inlet bypass due to grade, for grade inlet pits, and recognised orifice or weir formulae for sag inlet pits.

Allowable pit capacities: To the **Allowable pit capacities table**.

Allowable pit capacities table

Condition	Inlet type	Percentage of theoretical capacity allowed
Sag	Side entry	80%
Sag	Grated	50%
Sag	Combination	Side inlet capacity only Grate assumed completely blocked
Sag	'Letterbox'	50%
Continuous Grade	Side entry	80%
Continuous Grade	Grated	50%
Continuous Grade	Combination	80%

Hydraulic losses

Design: To standard practices in ARR.

Pit pressure change co-efficient 'K_e': [To the Handbook](#). Consider the following:

- Allowable reduction due to benching.
- Any approved bends, clashes with existing sewer mains.
- Ensure computer program default is consistent with the *Handbook*.

Record: Document the chart adopted and relevant co-efficients to the hydraulic summary sheet included in the *Handbook* and on the final design drawings.

Bends: Before detailed design, submit for approval any use of bends. Include the explanation.

Service entry requirements: For roof and subsoil pipes from private properties entering Council's system, conform to the following:

- All pipe inlets enter the main pipe system at junction pits.
- Flush, grouted junction pipes in the pit wall.
- Smaller inlets: Break into the drainage pipes for interconnection with the main line, finish flush and grout the sideline into the main line.

Pipe junctions: Submit for approval where a junction without an inlet structure is required. Include the pressure change co-efficients K_u for the upstream pipe and K_l for the lateral pipe [determined from the Handbook](#).

Contraction/expansion: Do not transition from larger upstream to smaller downstream pipes. Submit for approval where required, including the detail for pit benching for smooth flow transition. [Determine losses in expansion and contraction from the Handbook](#).

Pipe friction: Design drainage pipe systems as an overall system including upstream and downstream systems, not as individual pipe lengths.

Drainage pipeline systems: Design as gravity systems flowing full at design discharge. Pressurise with the use of appropriate pits and joints.

Pipe friction losses and pipe sizes: In relation to discharge, calculate using the Colebrook-White formula and roughness co-efficients to AS 2200.

3.7 HYDRAULICS - MAJOR SYSTEM CRITERIA

General

Surcharging: Do not permit any surcharging of drainage systems where the water depth is above the top of kerb, except for the following:

- Storm frequencies greater than ARI 20 year event and only across the road centreline where the road pavement is below the natural surface of the adjoining private property.
- Submit details for approval for flow across footpaths, providing there is no flooding of private property.

Velocity/depth criteria: Consider safety of children and vehicles in the design of velocity \times depth product flow across the footpath and within the road reserve. Conform to the following:

~~—Maximum depth of water: 0.2 m.~~

- Maximum velocity \times depth product: $0.4 \text{ m}^2/\text{s}$.
- Maximum velocity \times depth product (where the safety of only vehicles can be affected): $0.6 \text{ m}^2/\text{s}$.
- Child safety: Address the requirements for safety in relation to children by providing safe egress points from any channel.

Freeboard: Design for minimum freeboard for floor levels and levee bank levels from flood levels in roadways, stormwater surcharge paths and open channels as follows:

- Roadways:
 - . 0.5 m between the 100 year flood level and floor levels on structures and entrances to underground car parks. A higher freeboard may be required in certain circumstances.
 - . 0.1 m freeboard between the ponding level of water in the road and the high point in the footpath if the road is in fill or overtopping of kerbs and flow through properties may occur. Driveway construction in these instances needs to consider this requirement.
- Stormwater surcharge paths: 0.5 m between the 100 year flood level and floor levels on structures and entrances to underground car parks.
- Open channels: 0.5 m between the 100 year flood level and floor levels on structures and entrances to underground car parks.

Fixing of roadway reserve capacity flows: Calculate roadway reserve capacity flow for each carriage way used in the catchment and apply storage correction for each type to AGRD05 clause 4.5.3.

Roadway capacities: To ~~the Handbook and~~ Council's standard road designs. For other road designs, calculate flow capacities of roads using ARR with the flow adjustment factors to the *Handbook*.

Open channels

Design open channels: To ARR and the following:

- Contain major system flow less any flow in the minor system allowing for blockage of the minor system.
- Open channels are permitted as follows:
 - . Where they form part of the trunk drainage system.
 - . Designed for smooth transitions with adequate access provisions for maintenance and cleaning.
 - . To convey flows from a works site to the receiving water body, only if Council has approved the use of an open channel.

Channel roughness: Determine friction losses in open channels using Mannings 'n' values to the **Specific channel type 'n' values table**.

Safety of persons: If the product of average velocity and average flow depth for the design flow rate is greater than $0.4 \text{ m}^2/\text{s}$, design in conformance with ARR and Council's standard documentation to specifically provide for the safety of persons who may enter the channel.

Side slopes on grassed lined open channels:

- Prefer 6H:1V.
- Maximum 4H:1V.

Channel inverts: Minimum cross slopes of 20H:1V.

Low flow provisions in open channels (man-made or altered channels): Contain flows within a system or concrete lined channel section at the invert of the main channel.

Subsurface drainage: Design subsurface drainage in grass lined channels to prevent waterlogging of the channel bed.

Width of the drain invert: Equal to the width of the concrete lined channel section or at least to accommodate the full width of a tractor.

Hydraulic jumps: Design transition in channel slopes to avoid or accommodate any hydraulic jumps without generating erosion.

Specific channel type 'n' values table

Channel type	'n'
Concrete pipes or box sections	0.011
Concrete (trowel finish)	0.014
Concrete (formed without finishing)	0.016
Sprayed concrete (gunite)	0.018
Bitumen seal	0.018
Bricks or pavers	0.015
Pitchers or dressed stone on mortar	0.016
Rubble masonry or random stone in mortar	0.028
Rock lining or rip-rap	0.028
Corrugated metal	0.027
Earth (clear)	0.022
Earth (with weeds and gravel)	0.028
Rock cut	0.038
Short grass	0.033
Long grass	0.043

3.8 MAJOR STRUCTURES

Design criteria

Design ARI: Design all major structures in urban areas, including bridges and culverts for 100 year ARI storm event without afflux.

Afflux and upstream inundation: Permitted, provided the increased upstream flooding is minimal and does not inundate private property.

Minimum clearance for passage of debris without blockage: 0.3 m between the 100 year ARI flood level and the underside of the superstructure.

Minimum floor levels of dwellings: Freeboard 0.5 m above the 100 year ARI flood level in the basin.

Routing: Model flood routing to ARR.

Pipe and culvert bedding: Design to minimise permeability and provide cut off walls and anti-seepage collars where appropriate.

Harvesting: Design stormwater harvesting options in locating diversion or detention systems.

Culverts

Design culverts (either pipe or box section): To the *Handbook* and consider the following:

- Inlet and exit losses.
- Inlet and outlet control.
- Scour protection.

Basins

Critical storm duration: For each ARI, consider a range of storm events to determine the critical storm duration, the peak flood level and discharge from the retarding basin.

Provide a graph showing the range of peak flood levels in the basin and peak discharges from the basin for the storms examined.

Storm patterns: Adopt storm patterns given in ARR and check the sensitivity to storm pattern by reversing the storm patterns.

Public safety issues: Design for the following:

- Side slopes: Flatter than 6H:1V to allow easy egress.
- Handrails required: Where steeper than 4H:1V to assist in egress.
- Water depths: Maximum 1.2 m in the 20 year ARI storm event. Submit for approval greater depths including the design of safety refuge mounds.
- Document depth indicators for maximum depth in the basin.
- Protection for the low flow intake pipe to reduce hazards for any person trapped in the basin and prevent blockages.
- Document signage of the spillway to indicate the hazard.
- No ponding of water on private property or roads.
- No planting of trees in basin walls.
- No basin spillway located directly upstream of urban areas.

Stilling basin dissipaters: Provide appropriate dissipaters at high velocity outlets to prevent erosion.

High level outlet: Capacity capable of containing a minimum of 100 year ARI flood event.

Hazard category: Determine the hazard category to ANCOLD *Guidelines on acceptable flood capacity for dams*.

Check: Additional spillway capacity requirement due to the hazard category of the structure.

Spillway design: To **Open channels**.

Salinity prevention: Design basins to prevent surface drainage water leaking to the subsurface, recharging groundwater in areas known to be affected by high water tables and/or salinity of ground water. Conform to the requirements of the land and water resources authority for salinity levels where discharging to natural watercourses.

Basin location: Locate basins for stormwater detention, stormwater treatment or sedimentation purposes to avoid areas that are known permanent or seasonal groundwater discharge areas to reduce recharge into the groundwater.

Pipe systems: Design the pipe system to contain the minor flow through the retarding basin wall.

Outlet pipes: Provide rubber ring jointed with lifting holes securely sealed.

Approval by the dam safety committee: Consult prior to assessment where the basin falls into the significant dam category and comply with any requirements.

Design drawings: Submit to the Dam Safety Nominated Officer where any of the guidelines are not met or as required by Council.

Fencing: To Council's policy on SQIDs.

On-site stormwater detention

Stormwater detention: Required on work sites or redevelopment sites where under capacity drainage systems exist.

3.9 INTERALLOTMENT DRAINAGE

General

Requirement: Provide interallotment drainage for every allotment that does not drain directly to the frontage street or a natural watercourse. [See the Handbook.](#)

Easement: Contain interallotment drainage within an easement minimum 2.0 m wide and in favour of the upstream allotments. *This minimum width may be reduced under special circumstances with the approval of Council.*

Concentrated drainage: Design the interallotment drain to accept concentrated drainage from buildings and paved areas on each allotment for flow rates having a design ARI the same as the 'minor' street drainage system.

Impervious surface: Areas of impervious surface are assumed to contribute runoff to the interallotment drain to the **Runoff contribution to interallotment drains table**.

Runoff contribution to interallotment drains table

Development type	% of lot area
<i>Low Density Residential R2</i>	50
<i>Medium Density Residential R3</i>	70
Industrial	90
Commercial	90

Pipes

Design requirement: Design pipes to flow full at the design discharge without surcharging inspection pits.

Minimum longitudinal gradient: *0.5%*

Construction requirement: Design for pipes ~~with rubber ring joints~~ in conformance with the following:

- Fibre reinforced concrete pipes: To AS 4139.
- Precast concrete pipes: To AS/NZS 4058.
- PVC pipes *Sewer grade SN4*: To AS/NZS 1254.
- ~~— Polypropylene pipes: To AS/NZS 5065.~~
- ~~— Buried flexible pipes: To AS/NZS 2566.1 and AS/NZS 2566.2.~~
- *Other pipes as approved by Council*

Pits

General: Design and detail pits as follows:

- Locate interallotment drainage pits at all changes of direction.
- Detail concrete pits, with:
 - . 100 mm thick walls and floor.
 - . Minimum 600 × 600 internal plan dimensions.
 - . 100 mm concrete lid finished flush with the surface of works.
- Depressed grated inlets are acceptable.
- For high water tables design, to resist flotation.

Sewer mains relationship

Interallotment drainage and sewer mains laid adjacent to each other: Provide space of 1.5 m between pipe centrelines (where the pipe inverts are approximately equal).

Disparity in level between inverts: Submit the spacing for approval.

Sewer mains in close proximity to interallotment drainage lines: Show on the interallotment drainage plan.

Connections to interallotment drainage

Maximum number of connections: No more than ten (10) lots to any one interallotment drainage system.

Minimum pipe size: 150mm for 1 – 2 dwellings, 225mm for 3 – 6 dwellings and 300mm for 7 – 10 dwellings.

3.10 GROSS POLLUTANT TRAPS (GPT) AND SEDIMENT TRAPS

General

Treatment objectives: To Council's Water Cycle Management Guidelines.

Locating a GPT/sediment trap: Determine the best location(s) for GPT(s)/sediment trap(s) and its catchment size in conformance with ARQ clause 8.4 and the following:

- Complementary with the strategic catchment treatment objectives.

- Topography.
- Available space.
- Proximity to pollutant source areas.
- Outlet approach: Use a single device to treat a whole catchment (up to 200 ha or more).
- Distributed approach: Target smaller individual catchments with many traps.
- Site constraints: Including topography, soils and geology, groundwater, space, access, odour problems, visual impacts, safety concerns and vermin.

GPT/sediment trap performance and type

Design: Determine the performance for GPT and sediment traps in conformance with ARQ clause 8.5 including the following:

- Treatment objectives: Define the objectives for the project e.g. Gross pollutants: Remove litter and vegetation larger than 5 mm. Sediment: Remove particles larger than 0.125 mm. e.g. Remove 90% of all material greater than 0.125 mm.
- Operating design flows: Select the design flow in conformance with ARQ chapter 7 e.g. 3 month ARI.
- Flood capacity: Analyse hydraulics of the drainage system including the headloss of the GPT and diversion weir under flood conditions. Check the design of the bypass system for impacts on the local drainage system and consequences on flooding.
- Trapped pollutant storage: Assess the pollutants that are likely to be collected and determine the holding capacity with respect to the maintenance operations and frequency.
- Maintenance requirements: Design the GPT for maintainability and operability including the following considerations:
 - . Ease of maintenance and operation.
 - . Access to the treatment site.
 - . Frequency of maintenance.
 - . Disposal.

Assessment of GPT performance: Include in the maintenance program requirements for validating the GPT performance by field monitoring, physical laboratory models or computer simulation.

Selection of the GPT: Design the GPT with consideration of the following and the checklist available in ARQ Appendix 8A:

- Life cycle costing.
- Footprint and depth of the unit.
- Hydraulic impedance and requirements.
- Disposal costs.
- Occupational health and safety.

Hydrocarbon management: Where required, design and size water/oil separators or interception devices in conformance with ARQ clause 9.7.

3.11 CONSTRUCTED WETLANDS AND PONDS

General

Assess the treatment process: Determine the pollutant requirements in conformance with ARQ clause 12.3 and the following:

- Sedimentation.
- Filtration.
- Adsorption.
- Biological uptake.
- Pollutant transformation.
- Pollutant storage.

System design: Design the system in conformance with ARQ clause 12.4 and 12.5 including the following:

- Hydrological effectiveness: Quantify the effects of the interaction between the following:
 - . Volume of the detention system.
 - . Hydraulic capacity of the outlet structure of the system.
 - . Variability of runoff inflow to the system.
- Hydraulic efficiency: Control the flow patterns for uniform distribution throughout the system to provide optimal treatment on the inflow.
- Notional detention time: Select the design detention period.
- Facilitate and optimise water quality treatment processes.
- Locate ponds and wetland systems.
- Select treatment device or treatment train.
- Select wetland vegetation, fish or fauna.

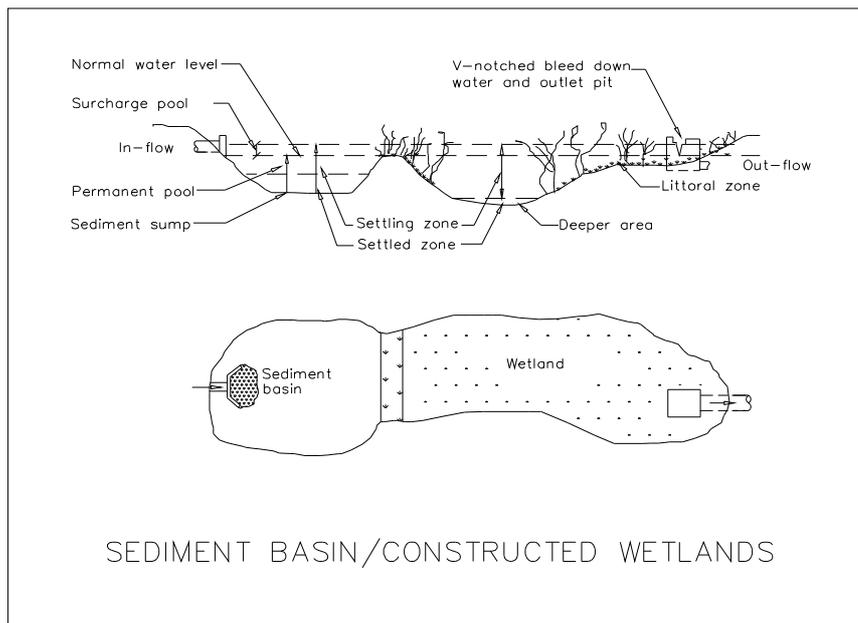


Figure - Sediment trap/constructed wetland

3.12 DETAILED DESIGN

Conduits

Pipe bedding and cover: Conform to the following:

- Reinforced and fibre reinforced concrete pipes: To AS/NZS 3725 or to the *Concrete Pipe Association of Australasia* (CPAA) publication *A rational approach to hydraulic design of pipe conduits* available from www.concpipe.asn.au.
- PVC pipes: To AS/NZS 2032.
- Polyethylene and polypropylene pipes: To AS/NZS 5065.
- Buried flexible pipes: To AS/NZS 2566.1. Submit for approval for use.

Location: Locate drainage lines in:

- Road reserves behind the kerb line and parallel to the kerb.
- Easements over private property centrally within the easement.

Bulkheads: Design bulkheads on drainage lines where the pipe gradient exceeds **12%**, include details to address the size and position in the trench and the spacing along the line.

Position of bulkhead: At every second pipe joint for up to 18% gradient. At every pipe joint for gradients exceeding 18%.

Buried flexible pipes: Particular situations may require the use of buried flexible pipes instead of the pipes specified in the Handbook or Specification 1352. Select the flexible pipe type appropriate for the particular application and prepare the relevant technical

specification clauses for supply and construction with reference to AS/NZS 2566.1, Buried flexible pipelines Part 1: Structural design. Submit proposed additional clauses as a variation to the development consent, for approval by Council. If approved, supply and construction specification clauses to be inserted in the Special Requirements section of Specification 1352 for Pipe Drainage.

Pits

Bench: Design pits with benching to improve hydraulic efficiency and reduce water ponding.

Safety and safe access: Detail step irons and provide bicycle-safe grates.

Ventilation: Provide ventilation for pits and other confined structures requiring access for maintenance, inspection or repairs.

~~Standards: [complete/delete]~~

Stormwater discharge

Salinity prevention: Locate stormwater discharge to avoid recharging groundwater and creating or worsening salinity degradation of adjacent land.

Kerb and channel (gutter) termination: Extend kerb and channel (gutter) to drainage pit or natural point of outlet. Provide protection to prevent scour and dissipate the flow where outlet velocity is greater than 2.5 m/s or where the kerb and gutter discharge would cause scour.

Scour protection and velocity dissipation structures design: To Austroads AGRD05-2010.

Easements

~~Deed of Agreement: [complete/delete]~~

Adjoining owners: Identify points of discharge of gutters or stormwater drainage lines or any concentration of stormwater on to adjoining properties. *Developer to enter into a Deed of Agreement with the adjoining owner(s) granting permission to the discharge of stormwater drainage and the creation of any necessary easements with the cost of the easement being met by the Developer.*

Easement width:

- Minimum: 3.0 m.
- Overall: To contain the full width of overland flow or open channel flow in the major system design event.

Other authorities' requirements: Where drainage discharge is under the control of another statutory authority, e.g. public works, conform to the design requirements of that statutory authority.

Recreation reserves: For piped stormwater drainage discharging to recreation reserves, conform to the following:

- Discharge through an outlet structure to a natural water course.
- Direct to the nearest trunk stormwater line.

Council easements: Drainage lines within easements that are or are to be the responsibility of Council, the pipelines are to be concrete reinforced with either steel or fibre, as approved by Council.

Trench subsoil drainage

Subsoil drainage in pipe trenches: If pipe trenches are backfilled with sand or other pervious material, provide the following:

- 3 m length of 100 mm diameter agricultural pipes, butt jointed with joints wrapped with geotextile, or slotted PVC pipe of subsoil drain in the bottom of the trench immediately upstream from each pit or headwall.
- Seal the upstream end of the subsoil drain with cement mortar, and the downstream end to discharge through the wall of the pit or headwall.

Durability

~~Service life expectancy: [complete/delete]~~

Requirement: Design for the service life of the drainage system including the following:

- Thickness and type of base material of drainage structures including pipes and culverts.
- Life expectancy of the coating.
- pH and resistivity of water and backfill material.
- Presence of impurities such as chloride, sulfate and aggressive CO₂ in the groundwater or soil.

Geotechnical NATA test: Determine the pH and resistivity of water and soil in conformance with AS 1289.4.3.1 and AS 1289.4.4.1.

Test for concentration of impurities: Carry out groundwater or soil extract testing for chloride, sulfate and aggressive CO₂. Testing to conform with AS 1289.4.2.1.

3.13 BUFFER STRIPS, VEGETATED SWALES AND BIORETENTION SYSTEMS

Buffer strips

Urban catchments: Design for grassed areas to direct runoff from adjoining impervious areas to the stormwater discharge location.

Design: Consider the following:

- Maximum slope: 5%.
- Maximum velocities: 0.4 m/s.
- Usage of flow spreaders.
- Vegetation density.
- Distribution/spread of stormwater over the buffer strip.
- Prevention of the formation of rills through properly designed entry conditions and vegetation.
- Design vegetation: Conform to ARQ clause 10.3.

Vegetated swales

Location: At any point of the flow including the following:

- Applied to the top of a catchment: Serve minor drainage requirements.
- Applied further downstream: Generally will require a parallel underground pipe network.

Geometry: Trapezoidal or parabolic shapes.

Side slopes: No steeper than 1V:3H.

Longitudinal slope: 1 – 4%. If greater or less than 1 – 4%, conform to the following:

- Slopes greater than 4%: Design for check dams.
- Slopes less than 1%: Design for under drains.

Maximum swale width: 2.5 m.

Maximum flow velocity: Conform to the following:

- For 1 year ARI: 0.5 m/s.
- For 100 year ARI: 1.0 m/s.

Mannings 'n' value:

- For flow conditions where depth of flow is below the height of the vegetation: 0.15 to 0.3.
- For 100 year event: approximately 0.03.
- Design vegetation: Conform to ARQ clause 10.4.2.

Bioretention systems

Requirement: Design the bioretention system of 2 or 3 subsurface layers including:

- Base or drainage layer.
- Transition layer.
- Filtration layer.

Design vegetation: To complement the landscape of the area. Conform to ARQ clause 10.5.1.

3.14 INFILTRATION SYSTEMS

General

Requirement: Design infiltration and aquifer recharge systems: Submit calculations demonstrating the effectiveness of the infiltration device for successions of storms and hydrological effectiveness to ARQ clause 11.4.

System design: Conform to ARQ clause 11.3.4 for the following:

- Unsuitable soils: Test soils for permeability and assess for suitability.
- Clearance distances to building footings and boundaries: Conform to ARQ clause 11.3.1 with regard to the soil classification.
- Rock and shale: Test for permeability and assess for suitability.
- Shallow soil cover over rock: Test for permeability and assess geology for weathered or fractured rock.
- Steep terrain: Check soil depth on a downslope and assess suitability.
- Watertable interaction with infiltration systems: Check watertable stability and salinity for suitability and the presence of any aquifers that may interact.
- Watertable effected by upstream infiltration devices: Assess geology for any likely upstream infiltration devices that may limit retention.
- Aquifer recharge/retrieval annual balance: Assess for continual equilibrium of local potentiometric levels.
- Water quality inflows to infiltration devices: Provide treatment is required for all water running directly into soakaways in conformance with ARQ clause 11.2.3.

Flood control: Design on-site storage for flood control to ARQ clause 11.6.

Constructed wetlands and ponds: Design hydrological effectiveness and location of wetlands or ponds to ARQ chapter 12.

4 DOCUMENTATION

4.1 GENERAL

Approvals

Authorities: Document the approval conditions established by the appropriate authority which form the basis of the design.

Design reports

~~Requirements: [complete/delete]~~

Calculations

Design: Provide a design report incorporating the criteria, computer studies, calculations and references supporting the design.

Specifications

Construction documentation: Prepare technical specifications suitable for inclusion in the AUS-SPEC contract documentation system. Consider including Construction and Maintenance worksection *Templates* from the National Classification System workgroups 02, 03, 11, 13, 14-18.

Design certification

Requirement: Provide a signed and dated design certificate.

4.2 DRAWINGS

General

Requirements: Provide drawings and/or computer output defining the works and assumed operating and maintenance procedures.

Catchment areas plan

Catchment area drawings: Provide drawings showing the following:

- For any variation: Submit for approval.
- Scale 1:1000 or 1:5000.

- Contour interval: 1 – 2 m (closer if the area is very flat).
- Grade direction for kerb and gutter.
- General layout of the drainage system with pit locations.
- Catchment limits.
- Any other information necessary for the design of the drainage system.

Drainage system layout

Drainage system layout drawings: Provide drawings showing the following:

- For any variation: Submit for approval.
- Scale 1:500.
- Drainage pipeline location.
- Drainage pit location.
- Number and road centreline chainage.
- Size of opening.
- Drainage easements.
- Reserves and natural water courses.
- Location of buffer strips, vegetated swales and bioretention systems.
- Location and details of infiltration systems.
- Any other information necessary for the design and construction of the drainage system.
- If appropriate, combine with the road layout plan.

Longitudinal section

Drainage system longitudinal sections: Provide drawings showing the following:

- For any variation: Submit for approval.
- Horizontal scale: 1:500.
- Vertical scale: 1:50.
- Pipe size, class and type.
- Pipe support type to AS/NZS 3725 or AS/NZS 2032.
- Pipeline and road chainages.
- Pipeline grade.
- Hydraulic grade line.
- Any other information necessary for the design and construction of the drainage system.

Open channels

Open channel cross sections: Provide drawings showing the following:

- For any variation: Submit for approval.
- Scale: 1:100.
- The direction of the view of cross sections, normally downstream.
- Reduced levels to Australian Height Datum (AHD).
- Provide a data input file for the design flow rates.

Other

Detailed drawings: Provide details including standard and non-standard pits and structures, pit benching, open channel designs and transitions to scales appropriate to the type and complexity of the detail being shown.

Easements for subdivision: Submit witnessed letters by the landowners in agreement of any increased flood levels on their property or other adverse effects to their property.

Prior to issue of the subdivision certificate, create any required easements.

Submit hydrology and hydraulic summary sheets: To the *Handbook*.

Computer data files and output: Submit final hydrological and hydraulic computer data files.

Landscape plans and planting plans: For inclusion of buffer strips, vegetated swales and bioretention systems.

Deed of Agreement: Evidence to be provided.

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

[Final certification of completed works: \[complete/delete\]](#)

5 ANNEXURE

5.1 ANNEXURE A – COUNCILS HANDBOOK FOR DRAINAGE DESIGN CRITERIA

Record of design requirements

General: The following table outlines the design criteria referenced in this worksection and available in Councils *Handbook for drainage design criteria (Handbook)*.

Council's Handbook for drainage design criteria table

Design requirements	Worksection clauses
Design IFD rainfalls for specific locations and individual zonings	HYDROLOGY / Design rainfall data
Average recurrence interval (ARI)	HYDROLOGY / Analysis
Percentages impervious for specific locations and individual zonings	HYDROLOGY / Analysis
Run-off co-efficients for specific locations and individual zonings	HYDROLOGY / Analysis
Sample summary sheet for hydrological calculations	HYDROLOGY / Alternative models and computer analysis
Sample summary sheet for hydraulic calculations	HYDRAULICS / Hydraulic grade line
Pit capacities	HYDRAULICS / Pits
Pressure change co-efficient 'K _e ' charts	HYDRAULICS / Hydraulic losses
Allowable reductions in 'K _e ' due to benching	HYDRAULICS / Hydraulic losses
Pit pressure change co-efficients at bends	HYDRAULICS / Hydraulic losses
Chart for pressure change co-efficient K _p	HYDRAULICS / Hydraulic losses
Junction pressure change co-efficients K _i and K _u chart	HYDRAULICS / Hydraulic losses
Sudden expansion and contraction losses	HYDRAULICS / Hydraulic losses
Road capacity charts and flow adjustment factors to Tech Note 4 Book 14 of ARR 1987	HYDRAULICS / Major system criteria
Culvert Design Charts—inlet and exit losses, inlet and outlet control and scour protection	MAJOR STRUCTURES / Culverts
Inter allotment drainage requirements	INTER ALLOTMENT DRAINAGE / General

0075 CONTROL OF EROSION AND SEDIMENTATION (DESIGN)

1 GENERAL

1.1 RESPONSIBILITIES

Objective

General: Provide control of erosion and stormwater management systems design and documentation incorporating all reasonable and practicable measures to prevent or at least minimise environmental harm.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- 0010 Quality requirements for design.
- 0074 Stormwater drainage (Design).
- 0167 Integrated management.
- 0257 Landscape – Roadways and street trees.
- 1102 Control of erosion and sedimentation (Construction).
- 1111 Clearing and grubbing.

1.3 REFERENCED DOCUMENTS

Other publications

General: The following documents are incorporated into this worksection by reference:
Department of Sustainability, Environment, Water, Population and Communities

DEWHA 2002 Introduction to urban stormwater management in Australia.

Engineers Australia

ARQ 2006 Australian runoff quality: a guide to water sensitive urban design.

International Erosion Control Association

IECA 2008 Best practice erosion and sediment control for building and construction sites
Books 1 to 4

LMCC DCP

Erosion and Sediment Control Guideline

1.4 STANDARDS

General

Standard: To IECA Best practice erosion and sediment control for building and construction sites Books 1 to 4.

1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the abbreviations given in IECA Book 3 Appendix N and those below apply:

- ARI – Average Recurrence Interval.
- DECCW: Department of Environment, Climate Change and Water.
- DEWHA: Department of Sustainability, Environment, Water, Population and Communities.
- EMP: Environmental Management Plan.
- ESCP: Erosion and Sediment Control Plan.
- GPT: Gross Pollutant Trap.
- IECA: International Erosion Control Association.
- SWMP: Stormwater Management Plan.

- WSUD: Water Sensitive Urban Design.

Definitions

General: For the purposes of this worksection the definitions given in IECA Book 3 Appendix N and below apply:

Catchment: A topographically defined area drained by a stream such that all outflow is directed to a single point.

Clean water: Water that is one of the following:

- Water that enters the property from an external source and has not been further contaminated by sediment within the property.
- Water that has originated from the site and does not require treatment to reach water quality standard.
- Water that would not be further improved if it was to pass through the sediment trap for the sub-catchment.

Dirty water: Water not classified as clean water.

Drainage control measures: Temporary management of stormwater during construction and building phase to prevent or reduce soil erosion caused by concentrated flow, including the management of rill and gully erosion and to appropriately manage the movement of clean and dirty water through the site.

Erosion and sediment control: The adoption of drainage, erosion and sediment control measures.

Erosion control measures: Measures to prevent or reduce soil erosion caused by raindrop impact, sheet flow (i.e. the control of splash and sheet erosion) and runoff from construction sites.

Microclimate: Small microclimates can be generated by a dense stand of tree's, a deep gully, or a meander in a creek channel and can significantly influence the success of a design.

Sediment control measures: Measures to trap and retain sediment that is either moving along the land surface (bed load) or contained within flowing water (suspended sediment).

Subcatchment: A topographically defined area drained by a tributary or branch drain of a primary stream or main drain draining catchment.

2 PRE-DESIGN PLANNING

2.1 CONSULTATION

Council and other Authorities

Data collation: For input into the documentation listed, consult *as appropriate* with the *relevant* authorities *for*:

- Stormwater management systems
- Erosion and stormwater management plan
- Local constraints assessment
- Environmental impact statement
- Tree preservation policy
- Wetlands for rehabilitated areas
- Protection of utilities
- Environmental Management Plan
- Catchment water quality

Procure approvals as required:

~~—Development approval certification: [complete/delete]~~

2.2 CONTROL OF EROSION PLANNING

Planning phase

Requirement: Document the following planning phase activities:

- Data collection including soil testing and site constraints: Align extent with the potential environment risk and the complexity of the soil disturbance.
- Site hazard assessment.
- Conceptual ESCP.

Data collection

Requirement: Assess available soil data to carry out the following actions:

- Assess the erosion risk and/or environment of the site.
- Identify potential soil problems such as unstable, dispersive or acid sulphate soils.
- Assist in the selection, design and operation of various drainage, erosion and sediment control measures.
- Assist in the design of site revegetation.
- Identify necessary soil treatments to facilitate site revegetation.
- Identify non-erodible areas which may be preferred diversion routes.

Site hazard assessment

Requirement: Identify high risk areas including the following:

- Areas with high potential for soil loss.
- Areas with high potential to cause environmental harm.
- Areas located within or within close proximity to critical habitats such as wetlands, creeks and waterways.

Identify: High risk construction activities including the following:

- Activities which disturb natural wetlands or flowing streams.
- Activities which disturb threatened species, habitats or environmental values.
- Activities which disturb protected vegetation.
- Activities with the potential to cause significantly more soil loss and/or environmental harm when compared to alternative construction practices.

Conceptual erosion and sedimentation control plan (ESCP)

Requirement: Prepare a Concept ESCP if any of the following applies to the site:

- Average slope of proposed land disturbance > 10%.
- Required for planning negotiations.
- High risk areas identified.
- High risk construction identified.
- Emerson class 1 or 2 soils.
- Expected soil disturbance > 6 months.
- Expected soil disturbance > 1 ha.
- Earthworks or construction within a natural water course.
- Complete the erosion hazard assessment form in IECA Book 2 Appendix F for evaluating any requirement for a concept ESCP.

Submission: Submit the Concept ESCP for approval prior to detailed design work.

Identify the following:

- Specific requirements for soil data.
- Site constraints.
- Feasibility of construction while protecting the environment.
- Any requirements for sediment basins on site.
- Adequate space for construction and operation of major sediment traps and essential flow diversion systems.
- Problem soil areas including dispersive soils, acid sulphate soils, areas of potential mass movement.

- Protected environmental features.

Soil and Water Management Plan

Requirement: Where the disturbance exceeds 2.5ha as required by the LMCC Erosion and Sediment Control Guidelines

3 DESIGN

3.1 DESIGN CRITERIA

Site planning

Site planning checklist: Assess the site in conformance with the Site planning checklist in IECA Book 1 clause 3.6.

Sub-catchments: List the data available for each sub-catchment affected by the construction and include the following:

- Contour plans.
- Soil types.
- Vegetation.
- Salinity.
- Natural water courses, swamps, springs and artesian features.

Pollutant characteristics: Assess the storm flow quality for pollutant characteristics to ARQ clause 3.4. Include an assessment of possible sedimentation transportation from vehicles leaving the site.

Sequential control measure: Prepare criteria for the integration of sequential control measures with construction schedules for the site works.

Protection measures: Document and provide for the following requirements:

- Evaluate the existing buffer zones protecting the site.
- Identify sensitive natural and indigenous features for protection.
- Fencing and isolation measures to protect features including habitats.
- Temporary drainage works to allow diversion through works in progress.
- Determine flow capacities or temporary detention works by reference to the Stormwater Management Plan in conformance with *0074 Stormwater drainage (Design)*.
- Time-zoned documentation of sub-catchment works to minimize risk of uncontrolled erosion for the recurrence interval matching the construction period exposure.

Development planning

Requirement: Minimise the risk of erosion within downstream waterways. Take all reasonable and practicable measures to minimise changes to the volume, frequency, duration and velocity of stormwater runoff effecting the natural water cycle.

Erosion and sediment control techniques and practices: To IECA and the following:

[State legislation: \[complete/delete\]](#)

Development planning requirement: Submit the following information:

- A catchment map defining sub-catchment boundaries.
- The preferred location and area requirements of major sediment traps such as sediment basins and whether they can be permanently incorporated into the stormwater management system. e.g. Detention basin or wetland.

Modelling

Site evaluation tools: If required, use the appropriate mapping tools to determine the risks and hazards that may occur in erosion control as follows:

- Urban capability mapping.
- Erosion risk mapping.
- Erosion hazard assessment.

Site constraints

Soil limitations: Provide a soil survey identifying the existence of any problematic soils and the recommended soil treatment and management technique. Consider IECA Book 2 Appendix C.

Topographic limitations: Minimise land reshaping and identify potential limitations due to topography on the development design and layout including the following:

- Coastal and intertidal areas: Identify and provide protection as required. Mitigate the potential for acid sulphate soil, dunal systems, wind erosion, wave refraction/reflection, marine plants and coastal buffer zones.
- Drainage problem areas: Identify and avoid the potential for salinity problems, soil moisture and advise groundwater levels, and decrease of flood storage volume.
- Existing erosion problems: Identify the potential to aggravate existing erosion problems. Do not locate structures within 3H:1V from the toe of a watercourse bank.
- Flood prone land: Provide dynamic flood modelling to identify potential impacts of filling flood prone land. Place sediment basins and other major sediment traps above the 1 in 5 year ARI flood level.
- Land prone to mass movement erosion: Identify the potential for landslip or landslide. Consider the impacts of clearing within the past 5 years and in the future, removal of material from the toe of a steep slope, changes to the natural flow of groundwater on steep slopes, placing of load bearing fill or structures on unstable slopes, perched water tables, seepage zones, plastic clays or with visual features such as slip scars.
- Local microclimates or storm surges: Identify the potential for microclimates or storm surges and allow for the associated constraints in the design assessment.
- Rock outcrops: Identify areas of rock outcrops and shallow soil depths.
- Steep slopes: Provide effective drainage and erosion control. Ensure space is available for sediment control measure and identify slope instabilities. Limit vegetated final slopes to a vertical fall of 10 m between cross drainage systems. Avoid slab on ground construction near steep slopes.
- Waterways and wetlands: Stabilise existing bank erosion. Identify and protect essential riparian zones. Where required expand the waterway corridor for natural or induced channel erosion/expansion or stream migration. Do not locate structures within 15 m of the crest of a watercourse bank nor within the zone of 3H:1V gradient from the toe of a watercourse bank. Protect wetlands from sediment inflow.

Water limitations: Determine the expected seasonal water quality, quantity and supply cost. Allow for sediment basins where appropriate.

Vegetation limitations: Retain or rehabilitate critical areas, and select trees for preservation before locating roads, buildings and open works. Locate roadways, construction storage areas and parking bays away from the drip zone of preserved trees. Avoid excavation, traversing, filling, trenching within the drip zones of preserved trees. Identify preserved trees within the ESCP. Retain existing ground cover on slopes steeper than 10%. Retain deep rooted vegetation on slopes steeper than 20%. See IECA Book 2 Appendix C for further discussion.

Ecological limitations: Consult with the appropriate authorities for any limitations to type of erosion and control measures within the particular site. e.g. Fisheries authority for instream options.

Geotechnical investigations

Assessment report: Provide a soil assessment report in conformance with IECA Book 1 clause 3.5 and Book 2 Appendix C including the following:

- Integration of the development into the site.
- Integration of erosion and sediment control issues into site and construction planning.
- Development of effective and flexible ESCP based on anticipated soil, weather and construction conditions.
- Minimisation of the extent and duration of soil disturbance.

- Control of water movement through the site.
- Minimisation of soil erosion.
- Prompt stabilisation disturbed areas.
- Maximisation of sediment retention on the site.
- Maintenance of all ESC measures in proper working order at all times.
- Monitoring of the site and adjusting ESC practices to maintain the required performance standard.

3.2 DRAINAGE CONTROL

Design standards

Permanent drainage design: To 0074 *Stormwater drainage (Design)*.

~~Design life: [complete/delete]~~

Temporary drainage works: Design all temporary drainage works in conformance with IECA Book 1 Table 4.3.1.

~~ARI: [complete/delete]~~

Technique selection

Flow diversion around soil disturbances: Provide for up-slope stormwater runoff where the up-slope catchment area exceeds 1500 m².

Design: Document drainage control techniques in conformance with IECA Book 1 clause 4.3, including the following:

- Spacing of lateral drains down long continuous slopes.
- Low gradient drainage.
- Drainage down slopes.
- Outlet structures for temporary drainage systems.
- Velocity control structures.
- Selection of channel and chute linings.
- Drainage controls on unsealed roads.
- Temporary watercourse crossings.
- 'No access' fenced areas for vegetation protection.

Techniques: Use symbols for documenting the various drainage techniques in conformance with IECA Book 1 clause 4.3. Alternatively adopt a technique schedule.

For various channel linings: Conform to IECA Book 2 Appendix A Tables A22 to A27.

Flow velocity: Where required, reduce the flow velocity by either:

- Reducing the depth of flow (increase the width of the channel).
- Reducing the bed slope.
- Reducing the peak discharge (reduce the effective catchment area or diverting water away from the channel).
- Increasing the channel roughness.
- At all times when reducing the flow velocity the flow capacity must be maintained.

Hydraulic capacity: Design drainage channels with sufficient gradient and surface conditions to limit the maximum flow velocity to a value not exceeding the maximum allowable flow velocity for the given surface material.

Considerations for technique selection

Sandbags: Use for shallow drains of depth < 500 mm.

Rock check dams: Use for deep drains of depth > 500 mm.

Track drainage: To IECA Book 3 Appendix K4.

Stripped topsoil: Where possible re-use stripped topsoil to form flow diversion banks up-slope of the soil disturbance.

Watercourse crossings: Filter runoff through surrounding grass or bush land before it enters streams.

Temporary culvert crossings: Limit the head loss across the structure to < 300 mm at the point when over topping first begins to occur.

Divide into areas: Divide any long slope of disturbed or unstable soil into smaller areas to prevent or minimise rill erosion.

Fish passage at temporary culvert crossings: Provide for minimum flow area of 80% of normal channel cross sectional area below the crest of the crossing. Conform to Fisheries Management Act.

Dispersive soils: Show details for stabilising dispersive soils.

Scour protection: Provide scour protection to all stormwater outlets, chutes, spillways and slope drains to dissipate flow energy and minimise soil erosion risk.

3.3 EROSION CONTROL

Design standards

~~Locally adopted risk assessment procedure: [complete/delete]~~

Erosion control risk assessment: Determine the erosion control risk in conformance with IECA Book 1 clause 4.4 in terms of the following factors:

- Monthly rainfall erosivity: IECA Book 1 Table 4.4.1.
- Monthly rainfall depth: IECA Book 1 Table 4.4.2.
- Estimated soil loss rate: IECA Book 1 Table 4.4.3.
- Monthly rainfall by town: Conform to IECA Book 1 Table 4.4.4.
- Queensland average monthly rainfall depth by town: Conform to IECA Book 1 Table 4.4.5 and Table 4.4.6.

~~[complete/delete]~~

Technique selection

Best practice land clearing and rehabilitation requirements: Document any best practice requirements in conformance with IECA Book 1 Table 4.4.7.

Techniques: Use the symbols for documenting the various control techniques in conformance with IECA Book 1 clause 4.4. Alternatively provide a technique schedule.

Design: Document erosion control techniques in conformance with IECA Book 1 clause 4.4., including the following:

- Soil stabilisation and protection.
- Mulching.
- Erosion control blankets.
- Control of soil erosion on slopes.
- Dust control techniques.
- Stabilisation of major drainage channels and watercourses.

Protect from raindrop impact erosion: Lightly mulch grass seeded areas immediately after seeding.

Prevent soil crusting: Mulch to insulate the soil against rapid temperature changes to IECA Book 2 Appendix C.

Disturbed areas water course: Extend revegetation into the water to link aquatic and riparian habitats. Stabilise by rock protection during plant establishment, to IECA Book 3 Appendix I clause 7.10.

3.4 SEDIMENT CONTROL

Design standards

Sediment control standard: To IECA Book 1 Table 4.5.1 for soil loss rate limit.

Classification of sediment traps: Type 1, 2, or 3 to IECA Book 1 Technical note 3.1 and Table 4.5.5.

Classification of sediment control techniques: To IECA Book 1 Table 4.5.3 and Table 4.5.4.

Design storm for sediment traps: 0.5 times the 1 in 1 year ARI peak discharge.

Technique selection

Design: Document sediment control techniques in conformance with IECA Book 1 clause 4.5, including the following:

- Sediment control measure in areas of sheet flow.
- Sediment controls at kerb inlets.
- Sediment control at field (drop) inlets.
- Sediment control measures in areas of minor concentrated flows.
- Sediment control structures in areas of concentrating flow.
- Sediment traps at pipe and culvert inlets.
- Sediment traps at temporary stormwater outlets.
- Dewatering sediment control measures.
- Sediment controls at entry/exit points.
- Also see DEWHA Chapter 8 on sediment and erosion control.

Sediment runoff: Collect and retain wholly within the work site. Trap prior to entry onto a road surface.

Sediment runoff originated from the road surface: Prevent sediment entering a sealed (e.g. hard lined) drainage system or permanent drainage system (e.g. piped or open channel drain).

Sediment controls within or adjacent roadside stormwater outlets: Provide for gully bags in preference to sag and on-grade kerb inlet sediment traps.

Kerb inlet sediment traps: Adopt the requirement for Type 1, 2, 3 sediment traps up-slope of all stormwater inlets as required by the **Design standard**.

Temporary stormwater outlet sediment traps: Locate downstream of the influence of outlet “jetting” (10-13 x pipe diameters downstream of the outlet).

Instream sediment traps: To IECA Book 3 Appendix I.

Location: Locate sediment traps in conformance with the following:

- Trap sediment as close to the source as possible wholly within property boundaries.
- Sediment trap: Divert clean water around sediment traps in a manner that maximises the sediment trapping efficiency. Where required, use the checklist for selecting a GPT in ARQ clause 8.9.
- Sediment: Protect adjacent properties and downstream environments from the adverse effects of sediment and sediment laden water discharged from the site.
- Environmental protection: Do not rely solely on sediment control measures.
- Straw bales as sediment traps: Do not use unless the site conditions prevent the use of other more appropriate sediment control systems.

3.5 STOCKPILE MANAGEMENT

General

Location: Indicate the location of stockpiles in conformance with the following:

- Clear of existing or proposed drainage works.
- Clear of areas likely to be disturbed during construction.
- Clear of the drip zone of trees.
- On reasonably flat areas.

Topsoil stockpiles: Isolate topsoil from subsoil material in separate stockpiles.

Erosion control measures

Requirement: Divert up-slope stormwater around stockpiles in conformance with the following:

- During periods when rainfall is possible.

- Up-slope catchment area > 1500 m².
- Average monthly rainfall > 45 mm.

Protection: Protect sand and soil stockpiles from wind and rainfall to IECA Book 1 Table 4.6.1.

Sediment control measures

Down-slope of stockpiles: To IECA Table 4.6.2.

3.6 EROSION AND SEDIMENT CONTROL PLANS

Development of ESCP

Requirement: Provide an ESCP for the site in conformance with IECA Book 1 clause 5.3 and incorporating the following:

- Assessment: Consider local issues, concerns, site constraints and development approval conditions. Review the proposed development layout.
- Soil maps: Prepare soil maps for the site where appropriate to identify problems soils including dispersive and acid sulphate soils, define areas of sandy soils and clayey soils.
- Cut and fill plan: Prepare a cut and fill plan if not already completed.
- Locate traffic entry/exit points and specify control measures to *1101 Control of traffic*.
- Identify potential areas of non-disturbance.
- Locate and stabilise temporary construction roads and watercourse crossing.
- Divide the site into hydraulically manageable drainage areas and prepare construction drainage plans.
- Determine the required sediment control standard.
- Locate major sediment traps (including truck cleaning facilities where required).
- Review proposed staging of works.
- Control clean water runoff.
- Control flow velocities in drains.
- Control dirty water runoff.
- Control erosion on disturbed boundary.
- Establish sediment traps within the development.
- Define the final limits of disturbance.
- Prepare the site revegetation/rehabilitation plan.
- Prepare the installation sequence.
- Specify emergency ESC measure.
- Prepare the monitoring and maintenance program.
- Prepare inspection and test plans.
- Prepare the supporting documentation.
- Include technical notes.
- Assign a unique identification number to each ESC measure within the ESCP.

Erosion and sediment control plan checklist: Complete and submit the Erosion and sediment control plan checklist from IECA Book 1 clause 5.10.

Construction drainage plans

Disturbances > 1500 m²: Prepare construction drainage plans for each stage of the earth works, they can be submitted as part of the ESCP or separate showing the following:

- Flow entry and exit points.
- Areas of sheet flow and lines of concentrate flow (including all drainage channels).
- Sub-catchment boundaries.
- All permanent and temporary roads.

Technical notes

Conditions: Prepare technical notes that include directions to the Contractor in conformance with examples in IECA Book 1 clause 5.8 and incorporating the following:

- Land clearing.
- Site management.
- Maintenance of ESC measure, drainage, erosion and sediment.
- Watercourse management.
- Site rehabilitation.
- Vegetation management.
- Soil management including earthworks, topsoil and problematic soils.
- Dust control.
- Site inspection and monitoring.

Additional certification

Sites with a soil disturbance > 2500 m²: Provide certification by a professional engineer that the ESCP conforms to the following:

- Satisfies the intent and design/performance standards established by all relevant local state and federal policies relating to erosion and sediment control.
- Has been reviewed and approved for construction, soil science, hydrology/hydraulics and site revegetation/rehabilitation.

Certification by a hydrology and hydraulics professional engineer: Required for sites > 1 ha or where the ESCP incorporates a sediment basin.

Certification by a geotechnical specialist: Provide if ESCP incorporates a sediment basin with a constructed earth embankment with a height > 1 m.

4 DOCUMENTATION

4.1 GENERAL

Approvals

Conditions: Document the approval conditions advised by the appropriate authority which contribute to the basis for the design of erosion control measures.

Calculations

Requirement: Provide a design report incorporating the criteria, computer studies, calculations and references supporting the design and maintenance requirements.

Program

Recurrence interval storms: Provide drawings and/or computer output defining the works and the sequential program to minimise exposure to erosion from ARI storms.

Specifications

Construction documentation: Prepare technical specifications suitable for inclusion in the AUS-SPEC contract documentation system. Consider including Construction and Maintenance worksection *Templates* from the National Classification System workgroups 02, 03, 11, 13, 14-18.

Design certification

Requirement: Provide a signed and dated design certificate.

4.2 DRAWINGS

General

~~Requirements: [complete/delete]~~

Drawing content

Drawings: Prepare to the minimum drafting requirements in *0160 Quality (Design)* and include the following as a minimum:

- Existing and final contours.
- Location of all earthworks including roads, areas of cut and fill and re-grading.
- Location of access haulage tracks and borrow pits.
- Location and design criteria of erosion and sediment control structures.

- Location and description of existing vegetation.
- Proposed vegetated buffer strips and 'no access' areas.
- Location of critical areas (vegetated buffer strips, drainage lines and structures, water bodies, unstable slopes, flood plains and seasonally wet areas).
- Type and location of diversion works that direct uncontaminated run-off around areas of future disturbance.
- Protection of channels and outfall zones.
- Revegetation program.
- Procedures for maintenance of erosion and sediment control.
- Details for staging of works.

Sample design

Guidance: Obtain example design details of water quality structures, sediment and erosion control devices from Council.

Erosion and sediment control plans

Requirement: To the check list in the LMCC Erosion and Sediment Control Guidelines.

Conceptual ESCP scale: < 1:1000.

Erosion and sediment control plans: Include the following:

- North point and plan scale.
- Site and easement boundaries and adjoining roadways.
- Construction access points.
- Site office, car park and location of material stockpiles.
- Limits of disturbance.
- Retained vegetation including protected trees.
- General soil information and location of problematic soils.
- Location of critical environmental values (where appropriate).
- Existing site contours (unless the provision of these contours adversely impacts the clarity of the ESCP).
- Final site contours including locations of cut and fill.
- Construction drainage plans for each stage of earthworks, including land contours for that state of construction, sub-catchment boundaries and location of watercourses.
- General layout and staging of proposed works.
- Location of all drainage, erosion and sediment control measures.
- Full design and construction details (e.g. cross sections, minimum channel grades, channel linings) for all drainage and sediment control devices, including diversion channels and sediment basins.
- Site revegetation requirements (if not contained on a separate plan required to be submitted to Council).
- Site monitoring and maintenance program, including the location of proposed water quality monitoring stations.
- Technical notes relating to the following:
 - . Site preparation and land clearing.
 - . Extent, timing and application of erosion control measures.
 - . Temporary ESC measures installed at end of working day.
 - . Temporary ESC measures in case of impending storms, or emergency situations.
 - . Installation sequence for ESC measures.
 - . Site revegetation and rehabilitation requirements.
 - . Application rates (or at least the minimum application rates) for mulching and revegetation measures.
 - . Legend of standard symbols used within plans.
- Calculation sheets for the sizing of ESC measures.

- A completed Erosion and sediment control plan checklist to IECA Book 2 Appendix E.
- Any other relevant information Council may require to properly assess the ESCP.

~~—Requirement: [complete/delete]~~

4.3 WORK-AS-EXECUTED

General

Work-as-executed drawings: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.

~~Final certification of completed works: [complete/delete]~~