## DEVELOPMENT SPECIFICATION FOR DESIGN

### INDEX

<table>
<thead>
<tr>
<th>Specification No.</th>
<th>Specification Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>0010</td>
<td>Quality requirements for design</td>
</tr>
<tr>
<td>0012</td>
<td>Waterfront development</td>
</tr>
<tr>
<td>0013</td>
<td>Bushfire protection</td>
</tr>
<tr>
<td>0021</td>
<td>Site regarding</td>
</tr>
<tr>
<td>0041</td>
<td>Geometric road layout</td>
</tr>
<tr>
<td>0042</td>
<td>Pavement design</td>
</tr>
<tr>
<td>0043</td>
<td>Subsurface drainage (design)</td>
</tr>
<tr>
<td>0044</td>
<td>Pathways and cycleways (design)</td>
</tr>
<tr>
<td>0061</td>
<td>Bridges and related structures</td>
</tr>
<tr>
<td>0074</td>
<td>Stormwater drainage (design)</td>
</tr>
<tr>
<td>0075</td>
<td>Control of erosion and sedimentation (design)</td>
</tr>
</tbody>
</table>

Dec 2014
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
- Demonstrate the QMS by providing records of the design process.
- Provide documentation relevant to asset management.

Design qualifications
Designer: Suitably qualified to undertake the works.
Authority requirements: Conform to Council requirements and be subject to approval by Council.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
Related worksections: Refer to Development Specification for Design index.

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:
Note: Only the most current standards are to be used.

Standards
AS/NZS 1170-Various Structural design actions
AS 1684-Various Residential timber-framed construction
AS 1742-Various Manual of uniform traffic control devices. (Includes AS 1742.2-2009 - Traffic control devices for general use)
AS 1743 \ Road signs—Specifications
AS 3600\ Concrete structures
AS 4100\ Steel structures
AS 5100-Various Bridge design
AS/NZS ISO-9000: Quality management systems - Fundamentals and vocabulary
AS/NZS ISO-9001 Quality management systems - Requirements
AS ISO-10013 Guidelines for quality management system documentation
AS/NZS ISO-19011 Guidelines for quality and/or environments management systems auditing

Other publications
Engineers Australia
Australian Rainfall and Runoff (AR&R)
RMS Australian Standard Supplements to – AS 1742 Manual of uniform traffic Control devices, Parts 1 - 15
RMS "Design Reference Documents" and AUSTROADS Guide to Road Design, Parts 1- 8 (to be used as reference documents for higher volume trafficked roads).

Council Development Specifications for Design and Construction
Council's Codes and Policies
Technical Publications used as Engineering Standards
Interim Policies and Guidelines

EP&A Act
Local Government Act

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:
- QMS: Quality Management System.
- RPEng: Registered Professional Engineer.
- CPEng: Chartered Professional Engineer.
- RMS: Roads and Maritime Services.

Definitions
General: For the purposes of this worksection the definitions given in AS/NZS ISO 9000 and the following apply:
- Chartered Professional Engineer: Engineer's Australia's Registration
- Registered Professional Engineer: Professionals Australia's
- Registered Surveyor (Accredited by Inst of Surveyors for civil designs)
- 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.

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.

**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:

- Regulatory and statutory requirements: As set out in the Conditions of Development Consent,
- Design criteria: As set out in the Conditions of Development Consent,
- Materials: As set out in the Conditions of Development Consent,

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: Only if required by the Conditions of Development Consent.

**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.

**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: As set out in the Conditions of Development Consent,

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 Sub consultants 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.
- 4 hard copies of all drawings and documentation to be provided to Council.
- Electronic copies of all drawings and documentation to be provided to Council. Drawings to be provided in both CAD and PDF format, documentation to be provided in PDF format.

**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-CFORMANCE**

**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 in conformance with the following checklists.

I certify that this design conforms to current Australian or International standards, industry guidelines, Council’s design specifications 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 the following:
- Part 5 of the Environmental Planning and Assessment Act

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.

I certify that this design is in strict compliance with the Conditions of Development Consent 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 the Design Plans (this includes designs for staged construction).

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.

<table>
<thead>
<tr>
<th>Checkpoint</th>
<th>By</th>
<th>Date</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Check detail survey by site inspection for existing drainage.</td>
<td>.......</td>
<td>..../....</td>
<td></td>
</tr>
<tr>
<td>1.2 Check detail survey by site inspection for existing property</td>
<td>.......</td>
<td>..../....</td>
<td></td>
</tr>
<tr>
<td>descriptions, boundaries and accesses.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3 Check detail survey of contours as representative of site terrain.</td>
<td>.......</td>
<td>..../....</td>
<td></td>
</tr>
<tr>
<td>1.4 Document trees and significant environmental features affected by the</td>
<td>.......</td>
<td>..../....</td>
<td></td>
</tr>
<tr>
<td>works.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 Document significant features to heritage within the Works</td>
<td>.......</td>
<td>..../....</td>
<td></td>
</tr>
<tr>
<td>boundaries.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6 Document existing public and private property likely to be affected by</td>
<td>.......</td>
<td>..../....</td>
<td></td>
</tr>
<tr>
<td>the design.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.7 Document survey and bench-marks.</td>
<td>.......</td>
<td>..../....</td>
<td></td>
</tr>
</tbody>
</table>

**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 RMS requirements.

__________________________
__________________________
__________________________
__________________________
__________________________

© AUS-SPEC (Dec 2014) 7 April 2015
3.3 DESIGN CHECKLIST 2 - HORIZONTAL ROAD ALIGNMENT

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

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

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 RMS..
### DESIGN CHECKLIST 3 - VERTICAL ROAD ALIGNMENT

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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Check that grades conform to maximum and minimum requirements.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
<tr>
<td>3.2</td>
<td>Check that vertical clearances to bridges and services conform to standards.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
<tr>
<td>3.3</td>
<td>Check that there is adequate vertical sight distance for drivers and pedestrians.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
<tr>
<td>3.4</td>
<td>Check that there is adequate cover to drainage structures or services.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
<tr>
<td>3.5</td>
<td>Check that there is adequate vertical alignment for disposal of surface drainage from properties and road.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
<tr>
<td>3.6</td>
<td>Check that grades conform to 1:100 year flood levels and take account of current Sea Level rise projections.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
<tr>
<td>3.7</td>
<td>Check that vertical alignment is compatible with property access.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
<tr>
<td>3.8</td>
<td>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.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
<tr>
<td>3.9</td>
<td>Check that there is acceptable sight distance for all accesses to roundabouts.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
<tr>
<td>3.10</td>
<td>Check that alignment coordination with horizontal alignment is in conformance with the Austroads design guides referenced in the AUS-SPEC specifications.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
<tr>
<td>3.11</td>
<td>Identify and resolve conflict with existing public utility services.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
<tr>
<td>3.12</td>
<td>Document vertical road alignment set out data on the longitudinal sections.</td>
<td>By: ..., Date: ..., NA:</td>
</tr>
</tbody>
</table>

**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.

- [ ]
- [ ]
- [ ]

© AUS-SPEC (Dec 2014) 9 April 2015
### 3.5 DESIGN CHECKLIST 4 - ROAD CROSS-SECTIONS

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

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>By</th>
<th>Date</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Document complete dimensions on typical cross-sections have.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Document kerb &amp; gutter, road safety barrier and surface drainage on typical cross-sections.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>Document batter slopes and batter treatment where appropriate.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td>Document property boundaries, service allocations and location of known existing underground services and pathway treatments.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.6</td>
<td>Document cross-sections to define all variations and width transitions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.7</td>
<td>Document cross-sections allowing for assessment of impact of road level on adjoining property.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.8</td>
<td>Verify the stability of embankment slopes, batters and retaining walls as satisfactory.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.9</td>
<td>Check that cross section reference level conforms with vertical road alignment.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Certified documents
Include the following certified documents:

- [Certified document 1](#)
- [Certified document 2](#)
- [Certified document 3](#)

List additional certified documents provided:

- [Additional document 1](#)
- [Additional document 2](#)
- [Additional document 3](#)

#### Non-conformance
Describe any special features of the project and document any variations from Council or RMS.

- [Non-conformance 1](#)
- [Non-conformance 2](#)
- [Non-conformance 3](#)
3.6 DESIGN CHECKLIST 5 - ROAD AND INTERALLOTMENT DRAINAGE

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

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

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 RMS requirements.
### 3.7 DESIGN CHECKLIST 6 - SIGNS AND MARKINGS

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

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>By</th>
<th>Date</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Conform to the documented Traffic Management Plan.</td>
<td>.........</td>
<td>.../.../...</td>
<td>□</td>
</tr>
<tr>
<td>6.2</td>
<td>Document sign types, sizes, locations and support structure details to conform with AS 1742 (All parts), AS 1743 and RMS Supplements as applicable to Local Roads.</td>
<td>.........</td>
<td>.../.../...</td>
<td>□</td>
</tr>
<tr>
<td>6.3</td>
<td>Document pavement linemarking, pavement marking type and set out to conform to AS 1742.2 and RMS Supplements as applicable to Local Roads.</td>
<td>.........</td>
<td>.../.../...</td>
<td>□</td>
</tr>
<tr>
<td>6.4</td>
<td>Document signs and linemarking to conform to Council's policies.</td>
<td>.........</td>
<td>.../.../...</td>
<td>□</td>
</tr>
</tbody>
</table>

**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 RMS requirements.

- ...
- ...
- ...
### 3.8 DESIGN CHECKLIST 7 - PAVEMENT DESIGN

**Checkpoints**

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

<table>
<thead>
<tr>
<th></th>
<th>By</th>
<th>Date</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>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.</td>
<td>...............</td>
<td>..../...../.....</td>
</tr>
<tr>
<td>7.2</td>
<td>Check that the pavement design conforms to 0042 Pavement design and/or 0044 Pathways and cycleways for adequacy.</td>
<td>...............</td>
<td>..../...../.....</td>
</tr>
<tr>
<td>7.3</td>
<td>Assess geotechnical data and keep records of design calculations.</td>
<td>...............</td>
<td>..../...../.....</td>
</tr>
<tr>
<td>7.4</td>
<td>Design conforms with AUSTROADS Pavement Design Guide Series as related to Local Roads.</td>
<td>...............</td>
<td>..../...../.....</td>
</tr>
</tbody>
</table>

**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 RMS requirements.

- [ ]
- [ ]
- [ ]
- [ ]
- [ ]
3.9 DESIGN CHECKLIST 8 - BRIDGE/MAJOR CULVERT DESIGN

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

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.

By Date NA

8.2 Assess geotechnical data for adequacy and keep records.

By Date NA

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 and the AUSTRoads Bridge Design Codes including the Guide to Bridge Technology Part 4: Design Procurement and Concept Design

By Date NA

8.4 Document the type and class of all materials.

By Date NA

8.5 Keep records of all significant design calculations and make available for audit.

By Date NA

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 RMS requirements.
3.10 DESIGN CHECKLIST 9 - EROSION AND SEDIMENTATION CONTROL PLANS

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

<table>
<thead>
<tr>
<th></th>
<th>By</th>
<th>Date</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>Check that the concept erosion control plan conforms to 0075 Control of erosion and sedimentation (Design).</td>
<td>.../../....</td>
<td></td>
</tr>
<tr>
<td>9.2</td>
<td>Check that the erosion and sedimentation control conforms to development consent conditions and environmental legislations.</td>
<td>.../../....</td>
<td></td>
</tr>
<tr>
<td>9.3</td>
<td>Check that the soil and water management plan conforms to 1102 Control of erosion and sedimentation (Construction).</td>
<td>.../../....</td>
<td></td>
</tr>
</tbody>
</table>

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 RMS requirements.
ANNEXURE B

3.13 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.

<table>
<thead>
<tr>
<th>Sheet No</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Development consent number (if applicable), project title, locality drawing and index of sheets.</td>
</tr>
<tr>
<td>2.</td>
<td>General layout plan with contour details and extent of work.</td>
</tr>
<tr>
<td>3.</td>
<td>Typical road cross-sections showing road widths, pavement (design) configuration, batter slopes, kerb and gutter types.</td>
</tr>
<tr>
<td>4.</td>
<td>Plan and longitudinal section of each road showing set out data, road safety barrier locations, guide posts and services.</td>
</tr>
<tr>
<td>5.</td>
<td>Drainage plan and schedule of drainage elements (pipe lines and structures).</td>
</tr>
<tr>
<td>6.</td>
<td>Drainage profiles.</td>
</tr>
<tr>
<td>7.</td>
<td>Drainage structure details.</td>
</tr>
<tr>
<td>8.</td>
<td>Road cross-sections.</td>
</tr>
<tr>
<td>11.</td>
<td>Erosion and sedimentation control concept plans (short term and long term treatment).</td>
</tr>
<tr>
<td>12.</td>
<td>Structure details - bridges, retaining walls, etc.</td>
</tr>
</tbody>
</table>

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.
## 0012 WATERFRONT DEVELOPMENT

### 1 GENERAL

#### 1.1 RESPONSIBILITIES

**Objective**

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

Council's objectives: Design structures/waterways to support the following objectives:

- Retain and enhance the biological diversity of the local flora and fauna.
- Preserve or improve the local ecosystem.
- Maintain or improve the flood levels in the area.
- Improve public access to the intertidal area of the waterfront.
- Maintain or improve the quality of water air and land.
- Minimise the disruption of the natural shoreline.
- Minimise future maintenance.
- Integrate the waterfront developments into the natural landscape.
- Conserve the waterfront or offshore items of heritage significance.

Project details: As required by the Conditions of Development Consent.

Scope of design services: As required by the Conditions of Development Consent.

Designer's qualifications: A Suitably qualified Engineer to RP Eng or CP Eng standard to authorise design by signature.

Local government requirements: As required by the Conditions of Development Consent.

State planning legislation: As required by the Conditions of Development Consent.


#### 1.2 CROSS REFERENCES

**General**

Requirement: Conform to the following worksections:

- 0010 Quality requirements for design.
- 0061 Bridges and related structures.
- 0074 Stormwater drainage (Design).
- 0075 Control of erosion and sedimentation.

#### 1.3 REFERENCED DOCUMENTS

**Standards**

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

Note: Only the most current standards are to be used.

**Australian Standards**

- AS 1100: Technical drawing
- AS 1100.101: General principals
- AS 1428: Design for access and mobility
- AS 1428.1: General requirements for access - New building work
- AS 1428.4.1: Means to assist the orientation of people with vision impairment - Tactile ground surface indicators
- AS 1657: Fixed platforms, walkways, stairways and ladders - Design, construction and installation
- AS/NZ 3661: Slip resistance of pedestrian surfaces
- AS/NZS 3661.2: Guide to reduction of slip hazards
- AS 3962: Guidelines for design of marinas
- AS/NZS 4586: Slip resistance classification of new pedestrian surface materials
- AS 4678: Earth-retaining structures
- AS 4997: Guidelines for design of maritime structures
Austroads
AGR006A Guide to road design - Pedestrian and cyclist paths

Other documents
Australian and New Zealand Environment Conservation Council
ANZEC guidelines Australian and New Zealand guidelines for fresh and marine water quality
For work on the Forster Keys Drainage Reserve, refer to - Management Plan – 2013. (ref to revetment walls and jetty replacement).

Federal legislation

1.4 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
- ANZEC: Australian and New Zealand Environment Conservation Council.

Definitions
General: For the purposes of this worksection the following definitions apply:
- Revetment Wall - a permanent structure on earth embankment adjacent to waterways and the ocean to prevent it from subsidence or erosion e.g. sheet piling profile.
- Jetties - a landing stage or small pier at which boats can dock or be moored.
- Pontoons - a flat-bottomed boat or hollow cylinder used with others to support a floating landing stage.

2 PRE-DESIGN PLANNING

2.1 PLANNING

General
Requirement: As required by the Conditions of Development Consent.

Design delivery stages
Requirement: As required by the Conditions of Development Consent.

Design progress meetings
Attendance requirement: As required by the Conditions of Development Consent.

2.2 RESERVED

2.3 CONSULTATION

Council and other Authorities
Responsibility: Consult with 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.
Requirements: As required by the Conditions of Development Consent.

Public consultation
Requirement: Undertake public consultation on designs in conformance with Council policy.
Requirements: As required by the Conditions of Development Consent.

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 structures/waterways.

Heritage considerations
Requirement: Provide a plan for management of heritage assets.

Protection of existing infrastructure
Existing plans: Obtain drawings of existing adjoining structures.
Dilapidation reports: Carry out inspections of all existing structures adjoining the proposed construction works. Prepare a report on their existing structural condition including photographic records of any defects.

2.4 SITE INVESTIGATIONS

Survey
Requirement: Carry out a detailed survey including survey grid, survey datum, hydrographic survey and terrestrial surveys and prepare a survey report.
Standard: To AS 3962 and AS 4997.
Qualifications: Qualified and suitably experienced Surveyor.

Geotechnical report
Requirement: Carry out a detailed geotechnical investigation and prepare a geotechnical report.
Standard: To AS 3962 and AS 4997.
Qualifications: Professional geotechnical engineer.

Wind, hydrodynamic and sediment movement assessment
Requirement: Carry out detailed site investigations and prepare a report.
Standard: To AS 3962.
Qualifications: Professional hydraulic engineer.

3 ARTIFICIAL WATERWAYS

3.1 GENERAL

Cost benefit report
Requirement: Analyse the long term costs and the local economic benefits of installing an artificial waterway over retaining a naturally functioning ecosystem such as wetland or estuary. Prepare a report.

Environmental report
Requirement: Investigate the surrounding waterways, natural estuary process, water quality and contaminant flows originating from agricultural, industrial or urban run-off. Analyse the environmental impact of the proposed development and any other possible developments in the future, including future increases in road and navigation traffic. Prepare a detailed report.
Qualifications: Professional environmental engineer.

Marine biology report
Requirement: Investigate the flora and fauna in the surrounding waterways, sand dunes, estuary flats, coastal wetlands, salt marshes, mangrove forests, lagoons, oyster farms, etc. Analyse the impact of the proposed development on the existing flora and fauna. Prepare a detailed report.
Qualifications: Environmental marine biologist.

3.2 DESIGN CRITERIA

Critical design features
Maintenance: Design sustainable waterways which will minimise future maintenance.
Sea level rise: Design for sea level rise due to global warming. Minimum allowance for future sea level rise to AS 4997 Table 4.1.
Physical characteristics and appearance: Similar to the nearby natural estuaries or wetlands.
Features:
- Multiple entrances connected in a loop to natural bodies of water to enable circulation of fresh water.
- Interconnected channels to produce flow-through currents.
- Bends and meandering channels with low aspect ratio and rounded corners.
- No dead end channels or coves.
- Artificial islands and roughness elements to enhance local circulation.
- Alignment of the artificial waterway in the direction of prevailing summer winds to receive maximum turbulent mixing.
- Shallow depths to enable efficient tidal flushing.

Aquatic ecology
Existing wetland features: Preserve any existing ecosystems such as mangrove wetlands, sand dunes, estuary flats, salt marshes, lagoons, oyster farms, migrating bird habitats, fish habitats, etc.
Surrounding waterways: Preserve or improve the ecological condition of surrounding waterways.
Biological diversity: Maintain or improve the local biological diversity.

Water quality
Requirement: Conform to ANZECC guidelines.
Buffer strips: Maintain existing buffer zones of natural vegetation or design new buffer zones to act as a contaminant filter to industrial, agricultural and urban run-off.
Sewerage pump out stations: Allocate suitable locations next to jetties, wharfs and marinas.

Erosion and sedimentation
General: Conform to 0075 Control of erosion and sedimentation.
Alignment with prevailing winds: Analyse the advantages and disadvantages of increased wind action.
Temporary sedimentation control: Include measures and devices to eliminate sedimentation within the canal system during the construction phase, especially if excavation of acid sulphate soils or large scale earth moving operations are expected.
Control of fill: If using imported fill on site, specify measures for permanent erosion and sedimentation control.
Stormwater outlets: Choose locations which will minimise erosion or local scour. Make allowance in the design for sedimentation of material at stormwater outlets and scour protection.

Stormwater design
General: Conform to 0074 Stormwater drainage (Design).
Stormwater harvesting system: As required by the Conditions of Development Consent.
Water quality: Demonstrate that the proposed method of stormwater management will not adversely affect water quality within the artificial waterway or lead to problems associated with siltation and erosion.
Stormwater discharge system: As required by the Conditions of Development Consent.
Stormwater outlets: Locate at points of maximal flushing.

Flood control
Requirement: Prepare a hydraulic/mathematical model to show that the proposed works will not cause increased flood levels in the area.

3.3 GEOMETRIC REQUIREMENTS

Waterway depths
Central, navigable area: Conform to AS 3962.
Non navigable areas: Keep non-navigable areas shallow. Create wetland habitats.

Waterway widths
Navigation width: As required by the Conditions of Development Consent.
Overall canal width: As required by the Conditions of Development Consent.
Vertical mixing: Maximize the width of the water surface in the canals to enhance vertical secondary mixing.
Structures: Allow for any proposed structures, such as jetty and ramp when establishing the overall canal width.

Waterway cross sections
Batters and stability coefficients: To the geotechnical report.
Edge treatment: Demonstrate that the proposed method of edge treatment will not adversely affect water quality within the artificial waterway or lead to problems associated with siltation and erosion.
Stability analysis: Carry out stability analysis of proposed waterway cross sections for relevant loads as described in AS 3962 and AS 4997.

Entrances
Standard: To AS 3962.
Locations: Avoid areas of naturally occurring sedimentation. Locate entrances in areas sheltered from excessive wave action and strong currents.

Orientation: Consider alignment of the entry with the tide currents and prevailing winds. Consider impact on tidal flushing, water circulation and sedimentation movements.

Multiple entrances: Provide at least one additional entrance, navigable or non-navigable.

Minimum width: As required by the Conditions of Development Consent.

Navigation: Consider the safety of craft likely to use the waterway.

4 STRUCTURES

4.1 DESIGN

General

Critical design feature: Provide water circulation and tidal flushing.

Sea level rise: Design for sea level rise due to global warming. Minimum allowance for future sea level rise to AS 4997 Table 4.1.

Aesthetics: Consider visual impact and design structures to complement the natural coastline.

Marinas

Standard: To AS 3962.

Council requirements: As required by the Conditions of Development Consent.

Residential developments: Avoid locating public marina facilities near residential areas to minimise the noise and privacy impacts.

Wharfs, jetties and boardwalks

(NOTE: For development in the Forster Keys Development Area to comply with the Forster Keys Drainage Reserve - Management Plan – 2013 requirements.) General: To AS 4997.

Disabled access: To AS 1428.

Slip resistance: To AS 3661.2 and AS/NZS 4586.

Ramp width: To AGRD06A-2009.

Council requirements: As required by the Conditions of Development Consent.

Boat ramps

(NOTE: For development in the Forster Keys Development Area to comply with the Forster Keys Drainage Reserve - Management Plan – 2013 requirements.) Standard: To AS 4997.

Extent of ramp: As required by the Conditions of Development Consent.

Scour protection: Design the footings to bear on rock or make allowance in the design for loss of material in conformance with the geotechnical report and wind/hydrodynamic/sediment report.

Floating structures and fenders


Construction materials selection: Consider marine growth.

Council requirements: As required by the Conditions of Development Consent.

Lifebuoys

Council requirements: As required by the Conditions of Development Consent.

Access and safety structures


Council requirements: As required by the Conditions of Development Consent.

Revetment structures

Location: If required, shall be located within the property boundary

(NOTE: For development in the Forster Keys Development Area to comply with the Forster Keys Drainage Reserve - Management Plan – 2013 requirements.)

Maximum height of the revetment: As required by the Conditions of Development Consent.

Erosion: Make allowance in the design for loss of material in front of the revetment, in conformance with wind, hydrodynamic and sediment control reports.
Runoff: Provide a kerb and gutter arrangement to the top of revetment.

Seawalls
(NOTE: For development in the Forster Keys Development Area to comply with the Forster Keys Drainage Reserve - Management Plan – 2013 requirements.) General: To AS 4997 and AS 4678. Drainage: Design appropriate drainage to relieve the water pressure behind the wall. Council requirements: As required by the Conditions of Development Consent. Erosion: Make allowance in the design for loss of material from the seaward face in conformance with the wind/hydrodynamic/sediment movement report. Alternatively, design foundations to bear on rock in conformance with geotechnical report.

Bridges and related structures
General: Conform to 0061 Bridges and related structures.
Vertical clearance: To the requirements of the relevant waterway and maritime Authorities.
Public access: Maintain continuity of public access along the public foreshore.

Services
Electrical connections: Consider the most adverse water levels when establishing the locations for the electrical services.

4.2 MATERIALS

General
Standards: To AS 4997 clause 6 and AS 3962 clause 5.2.
Council requirements: As required by the Conditions of Development Consent.

Durability
Design life: As required by the Conditions of Development Consent.
Maintenance: 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.

4.3 ENVIRONMENTAL CONSIDERATIONS

Construction
Demolition: Explore possibilities for re-using any demolished material from the site.
Imported fill: Analyse the impact on water quality, sedimentation and erosion.
Noise and light pollution: Analyse the impact onto local wild life patterns.

Construction materials
General: Demonstrate that the proposed construction materials will not have an adverse impact on the local ecosystem. Analyse the impact of construction materials on water quality, sedimentation and erosion. Prepare a report.
Council requirements: As required by the Conditions of Development Consent.

5 DOCUMENTATION

5.1 GENERAL

Approvals
Authorities: As required by the Conditions of Development Consent.

Design reports
Requirement: Provide a design report including the following:
- Design criteria.
- Site investigation reports supporting the design.
- Detailed design calculations (civil, structural and hydraulic).
- Hydraulic design models (drainage, flood control, tidal movements, sedimentation).
- Flood study report, including flood control measures.
- Water quality study.
Environmental management report for construction
Requirement: Provide environmental management plan as part of overall construction management plan. Include the following:
- Water quality management and monitoring program.
- Air quality management and monitoring program.
- Noise control program.
- Light pollution control program.
- Acid sulphate soils management plan.
- Erosion and sedimentation management plan.
- Plan for management and protection of marine flora and fauna.

Other reports
General: As required by the Conditions of Development Consent.

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 and 14-18.

Design certification
Requirement: Provide a signed and dated design certificate.

5.2 DRAWINGS
Engineering drafting
Standards: To AS 1100.101.

Drawing presentation
Drawing format: As required by the Conditions of Development Consent.
Drawing size: As required by the Conditions of Development Consent.
Drawing numbering, titles and subtitles: As required by the Conditions of Development Consent.
Title block format: As required by the Conditions of Development Consent.

Drawing content
Requirements: As required by the Conditions of Development Consent.

Verification and approval of construction drawings
Authorised personnel: As required by the Conditions of Development Consent.

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 the drawings at different design stages.

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. Provide a digital copy of the construction drawings in the required drawing format.
Drawing format: As required by the Conditions of Development Consent.
Final certification of completed works: As required by the Conditions of Development Consent.
0013 BUSHFIRE PROTECTION

1 GENERAL

1.1 RESPONSIBILITIES

Objective
General: Carry out designs of subdivision road layouts and protection zones to satisfy requirements of the State or Territory, Local Council and any guidelines published by the State's Rural Fire Service or equivalent.

1.2 OBJECTIVES

Bushfire hazards
General: To minimise bushfire hazards. The requirements are particularly pertinent to rural developments but should be an integral part of urbanised development as well. The concepts proposed need to be incorporated at an early stage of design development.

1.3 CROSS REFERENCES

General
Requirement: Conform to the following worksections:
- 0010 Quality requirements for design.
- 0281 Bushfire perimeter tracks.

1.4 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:
Note: Only the most current standards are to be used.
Australian Standards
AS/NZS 1596 The storage and handling of LP Gas
AS 2419 Fire hydrant installations
AS 2419 System design, installation and commissioning
AS 3959 Construction of buildings in bushfire prone areas.

Other publications
NSW Environment Planning and Assessment Act 1979—Section 94.
NSW Rural Fires Act.
Energy Australia - NS 179 Vegetation safety clearances-

State requirements

1.5 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
- APZ: Asset protection zone.
- IPA: Inner protection area.
- LEP: Local environment plan.
- OPA: Outer protection area.

Definitions
General: For the purposes of this worksection the definitions given below apply.
- Asset Protection Zone (APZ): An area surrounding a development managed to reduce the bush fire hazard to an acceptable level. It is also referred to as a fire protection zone. It aims to protect human life, property and highly valued public assets and values. It comprises inner and outer protection areas.
- Fire trails: Serve the following functions in inaccessible but strategic locations:
  - Safe access for fire fighters.
  - Fire control lines.
  - Access for APZ maintenance and equipment.
- Local Environmental Plan (LEP): Plans prepared by a Council that describe the planning status and or development standards required for the future development of an area.
- Perimeter roads: Form part of the asset protection zone and are required to provide a separation between the building and the boundary of the bush fire hazard by a wide, permanent and low maintenance fire break.
- Property access: Access from a public road system onto private land and access to the habitable building by fire fighters.
- Public roads: Include the perimeter road and the internal road system of any urban subdivision as well as public roads in rural-residential subdivisions.
- Setback: The distance required through planning provisions to separate a building from the bush fire hazard, street frontage or from adjacent buildings.
- Note that the 10/50 vegetation clearing requirements incorporated in the Rural Fires Act 1997 are defined in the Rural Fire Services, “10/50 Vegetation Clearing Code of practice for New South Wales”.
- Perimeter access tracks: Provide maintained access for fire fighting beyond private lots.

2 PRE-DESIGN PLANNING

2.1 PLANNING

Descriptions
Perimeter tracks: Where a subdivision abuts unimproved timber in a bushfire prone area (as classified by Council), locate perimeter tracks immediately between the created allotment and the bushland within a minimum cleared width of 6 m, and with a minimum formed width of 4 m. Drain such roads adequately to provide all weather access for fire fighting vehicles. Provide widening for parking and/or passing as required by Fire Authorities.

Property access: Provide alternative property access roads or egress for fire fighters and residents during a bush fire emergency if part of the road system is cut by fire. A distinction is drawn between rural private access and urban areas. Provide one property access road for developments that are located more than 200 m from a public through road.

Minimum formed carriageway width: 4 m for rural areas and for urban areas with a distance greater than 70 m from the nearest hydrant point to the most remote external part of the proposed building.

Fire trail: In rural-residential subdivisions fire trails form part of the Inner Protection Area (IPA) surrounding isolated or groups of dwellings. In suburban subdivisions they function as a strategic control line around the hazard side of the IPA if they are connected to the public road. It is not a substitute for a perimeter road.

Reservations and easements: Contain the perimeter track within a 20 m reservation or easement which borders those allotments abutting the bushfire prone area. Such a reserve serves as a basis for fire protection measures to be undertaken and will not be considered as part of the public reserve dedication applicable to the subdivision.

Site conditions: Include vegetation classifications and ground slope effects in conformance with AS 3959 in layout of facilities.

Requirements
Access: Provide access to reservation or easements from the local road system at regular intervals in a system of 'loops'.

Fire hydrants: For those subdivisions receiving reticulated water, locate fire hydrants at appropriate intervals or near where potential fire hazard areas exist in accordance with AS 2419.1 or as determined by the Council. Provide posts to indicate location of reticulated water supply.

Consultation: Consult the Council for technical advice in relation to bushfire protection of subdivisions.

Representation: Indicate clearly asset protection zones access tracks and perimeter tracks on the subdivision plan. Also indicate erosion control features and revegetation requirements in the subdivision plan.
2.2 ASSET PROTECTION ZONES (APZ)

Description
Primary purpose: The primary purpose of Asset Protection Zones (APZ) is to ensure the progressive reduction of fuel and to reduce potential radiant heat levels, flame, ember and smoke attack between the bush fire hazard and any combustible structures within the development.

Location: Provide an APZ as part of the development of the subdivision pattern. For each individual allotment allow adequate space for the main building (usually a dwelling), an area of open space (front, back or side yard) and the APZ (which may include part of the yard area and/or neighbouring properties). Figure 2.1 illustrates a typical APZ.

Requirement: Provide an APZ for any development fronting a bush fire hazard area, whether a single dwelling, a group of isolated dwellings or an urban subdivision, to act as a buffer zone between the development and the fuel.

Vegetation: Provide vegetation control plans to minimise fuel loads.

![Diagram of Rural APZ](image)

![Diagram of Urban APZ](image)

**Figure 2.1 Components of an Asset protection zone**

Other design considerations
Secondary purposes: The APZ serves a number of other important purposes, dependent upon local fire fighting policy. Design the APZ to:
- Maximise the separation distance between high intensity fire and any structure, thereby reducing the radiation and direct flame contact.
- Provide an area free from combustible material where embers can fall with minimal opportunity to create further fire outbreaks.
- Provide a safe access to a structure for fire fighters by reducing the heat level from the main fire.
- Provide a safe retreat for fire fighters.
- Provide a clear control line from which to begin back burning or hazard reduction operations.

Fire fighting: Safety requirements sometimes dictate that fires are fought from the property itself rather than along the perimeter track. Ensure that access to a public road is available from such properties.

Components
Functional areas: Incorporate the following separate components in the APZ:
- Outer Protection Area (OPA).
- Inner Protection Area (IPA) incorporating:
A perimeter road or reserve (which incorporates an access track).
A setback (currently defined by minimum lot depths), which is usually part of the allotment.

2.3 OUTER PROTECTION AREA (OPA)

Planning
Location: The Outer Protection Area (OPA) is located adjacent to the hazard.
Cost: Provision of the OPA is part of the development so that the cost of dedication of land or a monetary contribution for fire protection is met by the developer, not by the general community.
Steep slopes: For slopes greater than 20 degrees, the environmental consequences of ground clearing (erosion) may not be acceptable. Avoid both the ridge and the slope in developments abutting such slopes.

Fuel loadings
Reduction: Fuel loadings can be reduced through thinning of vegetation, mechanical clearing, hazard reduction burning or location of suitable developments such as playing fields or car parks (provided they are wide enough).
Minimum fuel loadings: Keep fuel loadings within the OPA to a level where the fire intensity expected will not impact on adjacent developments. In the absence of any policy to the contrary, 8 tonnes/hectare of total fuel is commonly used.

2.4 INNER PROTECTION AREA (IPA)

Planning
Description: The Inner Protection Area (IPA) is located adjacent to, or is part of, the development and comprises a perimeter road, fire trail and a setback.

Perimeter roads and fire trails
Location: The perimeter road or access trail lies between the OPA and the boundary of the allotments.
Concept: The concept of a perimeter road requires that one side of the road has no fuel. Perimeter roads are not fire breaks in the same sense as they are used in fire fighting operations. Their main purpose relates to the reduction of radiation and provision of access. Without a fuel source on the other side, perimeter roads can however prove to be very effective fire breaks.
Form: The form that the perimeter road or track takes will depend on the Council policy in regard to both road construction and fire fighting. In many instances, a perimeter reserve will be preferred due to cost. Provide a reserve of minimum 20 m width, with a 6 m access track and passing bays about every 200 m.
Width: In designing for a perimeter road or track, the distance required may not seem very great. Given that the probability of fire jumping a fire break increases as the width decreases, provide fire breaks of greatest width in areas where the highest intensity fires are likely.

Costs and benefits of perimeter roads and tracks:
- Perimeter roads can be less economic than roads which service two frontages unless some innovative designs are incorporated into the subdivision. Figure 2.2 illustrates perimeter roads and perimeter tracks.
- Perimeter roads which do not require clearing or maintenance (compared to tracks), can be cheapest in the long term. Ultimately the decision between a road and a track depends on the Council's subdivision and Fire Authority requirements.
- Provide tracks to Soil Conservation Service (1983) guidelines and 0261 Bushfire perimeter tracks.
Figure 2.2 Perimeter road and track diagram

Setback
Minimum lot depth: Part of the allotment can be used as a section of the buffer by setting a minimum lot depth and rear setback. This can ensure that sufficient room (30–35 m) is available to allow for erection of a dwelling that does not encroach upon the rear of the allotment. Figure 2.3 shows the minimum setback required in an APZ.

Figure 2.3 Asset protection zone (Source: NSW Rural Fire Service Guidelines for Subdivisions applications)

2.5 MODIFICATIONS TO OPA AND IPA

Approval criteria
Requirement: If modifications to the width of either the OPA or the IPA are proposed obtain, the written approval from the Council. Base any proposed modification or examination of the particular cases rather than according to any formula.

Adjacent development: Modifications need to take account of adjacent or proposed development. Some difficulties arise where new development abuts existing development that is a fire hazard because of the nature of its usage (e.g. forests, parks etc.). The general principle is that fire protection
should be shared by both users which may require a certain level of negotiation outside the planning system.

Fuel: Even without an extensive area of fuel outside the OPA, intense fires can develop if the OPA has not been hazard-reduced and if the fire begins as a line ignition from spotting embers. Slope: Under adverse conditions fires moving up a slope may not be slowed by the presence of rocky outcrops and ledges, even though the continuity of the fuel bed may be broken.

2.6 INTERNAL ACCESS FROM SUBDIVISION ROADS

Planning
Subdivision design: Control the provision of adequate internal access by subdivision design incorporating the following features:
- Width, vertical clearances and any dips and crests which allow the two-way movement of firefighting appliances.
- Construction standards of roads and any bridges which allow for the carrying of fully loaded fire appliances (28 tonnes or 9 tonnes/axle). Minimise timber load bearing members in access roads/tracks in bushfire prone areas.
- Curves which have a minimum inner radius of 6 m and are minimal in number.
- Maximum grades for sealed roads less than 15% (1:7) and an average grade less than 10% (1:10).
- Clearly signposted roads.
- Dead end roads which do not exceed 200 m in length.
- Dead ends which incorporate a minimum 12 m outer radius turning circle.
- Minimum vertical clearance to a height of 4 m above the road at all times.
- For roads greater than 6.5 m in width locate hydrants outside of parking reserves to ensure accessibility to reticulated water for fire suppression.
- A road network which connects regularly to any access tracks.
- Roads which do not traverse a wetland or other land potentially subject to periodic inundation (other than a flood or storm surge).
- Parking bays which are a minimum of 2.6 m wide from kerb edge to the road pavement.
- For public roads up to 6.5 to 8 m wide and one way only public access roads no less than 3.5 m wide provide parking in parking bays.

2.7 STAGING WORKS

Development control
Sequence: When considering the rate of development, provide for initial development to occur on the hazard perimeter of the development. A line of dwellings will tend to minimise the threat to the entire subdivision by limiting the hazard interface. Scattered developments allow a continuous network of fuel to threaten individual buildings until development is substantially underway. New developments should be 'tacked' onto old developments to minimise the hazard perimeter. It is important to incorporate much of the bushfire protection into the design of the development, rather than into individual allotments.

2.8 LOCATION OF SERVICES

Reticulated water supplies
Design: Use a ring main system to urban subdivisions. For reticulated water supply above ground and external to the building, use only metal components. For fire hydrant spacing, sizing and pressures comply with AS 2419.1: Do not locate hydrants within any road carriageway.

Non- reticulated water supply areas
Provision: Install and maintain a water supply reserve dedicated to firefighting purposes for rural-residential or developments in bushfire prone areas. Do not use swimming pools, creeks and dams as a substitute for a dedicated static supply as these sources are not reliable during drought conditions.

Requirement: Provide the minimum dedicated water supply required for fire fighting purposes in accordance to the Minimum dedicated water supply table below.

Minimum dedicated water supply table

<table>
<thead>
<tr>
<th>Development type</th>
<th>Water requirement</th>
</tr>
</thead>
</table>

© AUS-SPEC (Oct 12) 6 April 2015
<table>
<thead>
<tr>
<th>Category</th>
<th>Minimum Water Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential lots (&lt; 1000 m²)</td>
<td>5000 litres/lot</td>
</tr>
<tr>
<td>Rural-residential lots (1000 – 10000 m²)</td>
<td>10,000 litres/lot</td>
</tr>
<tr>
<td>Large rural/Lifestyle lots (&gt; 10000 m²)</td>
<td>20,000 litres/lot</td>
</tr>
<tr>
<td>Dual occupancy</td>
<td>2500 litres/lot</td>
</tr>
<tr>
<td>Townhouse/Unit style (e.g. Flats)</td>
<td>5000 litres/unit to 20,000 litres maximum</td>
</tr>
</tbody>
</table>

Connections: Make available a suitable connection for firefighting purposes, located between the IPA and away from the structure. Provide 65 mm Storz outlet with gate or ball valves or as required by the Fire Authorities.

Tanks: Provide the following facilities:
- For underground tanks, provide an access 200 mm hole to allow tankers to refill directly from the tank. Provide a hardened ground surface within 4 m of the access hole. Protect the tanks from loads.
- Above ground tanks and supports are of concrete or metal. Protect stands for raised tanks. Provide adequate shielding for the protection of fire fighters for the tanks located on the hazard side of the building. Provide only metal, above ground water services external to the building.

Electricity services

Design: Locate electricity services so that they limit the possibility of ignition of surrounding bushland or the fabric of the building. Undertake regular inspection of lines to ensure they are not fouled by branches. Wherever practicable provide electrical transmission lines underground. Where overhead transmission lines are proposed, install lines with short pole spacing of 30 m, unless crossing gullies, gorges or riparian areas. Limit the distance of a tree from the power line to the local electricity provider’s requirements.

Gas services

Design: Locate gas services so that they do not lead to ignition of surrounding bushland or the fabric of the building. Install and maintain the reticulated or bottled gas in accordance to AS 1596. Use metal piping. Keep all fixed cylinders clear of all flammable materials to a distance of 10 m and shielded from the hazard side. If gas cylinders are kept close to the building, direct the release valves at least 2 m away from the building so as not to act as a catalyst to combustion. Do not use polymer sheathed flexible gas supply lines to gas meters adjacent to buildings.
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: As required by the Conditions of Development Consent.
Authority requirements: As required by the Conditions of Development Consent.

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
Note: Only the most current standards are to be used.
AS 3798: Guidelines on earthworks for commercial and residential developments
AS 4970: Protection of trees on development sites
Austroads
AGPT08- Guide to Pavement Technology - Pavement construction
AGRD07- 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: As required by the Conditions of Development Consent.

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 and projected sea level rise where applicable.

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: Consult with Council’s Tree Management Officer.
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
General: Council’s Tree Management Officer shall be consulted for all tree related issues.
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.
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.
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.
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: As required by the Conditions of Development Consent.
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: As required by the Conditions of Development Consent

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. The payment of a Bond may be required to be paid by the Developer/Contractor.

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. Provide a digital copy of the construction drawings
in the required drawing format.
Drawing format: As required by the Conditions of Development Consent.
Final certification of completed works: As required by the Conditions of Development Consent.

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.
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
Note: Only the most current standards are to be used.
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

NOTE: All references to AUSTROADS Design Guides are to be read in conjunction with the relevant RMS supplements.

Road safety engineering risk assessment. Part 1: Relationships between crash risk and the standards of geometric design elements 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 Austraods 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. Refer to the relevant Roads and Maritime Services (www.rms.nsw.gov.au) Road Hierarchy definitions 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.
Classification
Terminology: The terminology used to describe each class of road varies from state to state. This work section uses the functional categories common to the majority of states.
Functional classification of rural roads: To AGRD02 Table 2.2.
Functional classification of urban 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. Great Lakes Council has additional levels of roads being an Industrial Road, Commercial Laneway and Shareway.

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.

Shareway
A shareway is a minor linkage which carries the lowest volume of traffic, providing access to no more than 3 allotments or forming a link between two access places (with a maximum of 6 lots).

Access street
Identification: Access street is the next 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.

Local street
Identification: Local street is the next 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.
Collector street
Identification: Collector street is the next 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.

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

**Additional Classifications**

Within the Great Lakes Local Government Area, the following road classifications also apply. The use of and approval of such road classifications shall be outlined in the Conditions of Development Consent.

*Industrial Road*
- Description: Its main function is to provide access to industrial areas and subdivisions. Industrial roads shall have a minimum 11m roadway formation (13m desirable) to cater for large vehicle access and turning movements. Where possible, the provision of parking provisions for B Double vehicles should be considered during design development.

*Commercial Laneway*
- Description: Its main function is to provide access to the rear of commercial properties. Commercial laneways are typically 6m in width, with a 4m formed pavement and barrier kerbs.

*Shareway*
Description: Its main function is to provide access to provide access to residential allotments (maximum of 3 allotments permitted). A shareway is a minor road that carries low traffic volumes and does not provide through access or forming a link between two access places (with a maximum of 6 lots)
- Vehicle, pedestrian and recreational use is shared with design to encourage priority to pedestrians.

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.

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.

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: As required by the Conditions of Development Consent.
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

Location
Road network location: As required by the Conditions of Development Consent.

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 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
Roads and Maritime Services 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:
- Shareway: 15km/h.
- Access street / Commercial laneway: 25 km/h.
- Local street: 50 km/h.
- Collector street: 60 km/h.
- Local sub-arterial road / Industrial 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: urban / rural (As required by the Conditions of Development Consent)
Function of the road: through route / local access (As required by the Conditions of Development Consent)
Type of road: new / existing (As required by the Conditions of Development Consent)
Traffic volume: As required by the Conditions of Development Consent.
Public transport: As required by the Conditions of Development Consent.
Environmental constraints: Topography, existing public utilities, existing road reserve width, vegetation, geology, etc.

Availability of construction materials: As required by the Conditions of Development Consent.

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.

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

<table>
<thead>
<tr>
<th>Type of pavement</th>
<th>Crossfall (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth, loam</td>
<td>5</td>
</tr>
<tr>
<td>Gravel, water bound Macadam</td>
<td>4</td>
</tr>
<tr>
<td>Bituminous sprayed seal</td>
<td>3</td>
</tr>
<tr>
<td>Asphalt</td>
<td>2.5 – 3</td>
</tr>
<tr>
<td>Concrete</td>
<td>2 – 3</td>
</tr>
</tbody>
</table>

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: 0.5m.
  - 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 gutter 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.

Restrictions: 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, in accordance with AS2890.1.
- 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 gutters.
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.
- Note: alternative grades will be considered if these conditions cannot be met.
- The minimum depth below the pavement base layer shall be 200mm.
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 gutter: Provide kerb and gutter 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 gutter 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**

<table>
<thead>
<tr>
<th>Lane width (m)</th>
<th>Speed limit (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Desirable</td>
<td>1.5</td>
</tr>
<tr>
<td>Acceptable</td>
<td>1.2 - 2.5</td>
</tr>
</tbody>
</table>

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.
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 Roads and Maritime Services. 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.

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 centrelne 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: To AGRD03 Table 7.10.
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 gutter:
  - Minimum desirable grade: 1%
  - Absolute minimum grade: 0.3%.
- Roads in cut:
. Unlined drains: 0.5%.
. Lined drains: 0.3%.
- Roads without kerb and gutter 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 %.

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.

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 70º.
- 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 a minimum 8.5 radius. 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 4.4. 4.5.2.
  - 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 unsignalled intersections. Prefer not to use and many state and territories do not approve.

- Channelised turn treatment (Type CH):
  - Rural channelised (CH) intersection turn treatment: Layout to AGRD04A Figure 4.7 and design details to AGRD04A Figure 8.3 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 (e.g. 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

<table>
<thead>
<tr>
<th>Road</th>
<th>Carriageway Width (min)</th>
<th>Stops (Spacing)</th>
<th>Bays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector</td>
<td>9m</td>
<td>400m*</td>
<td>Single</td>
</tr>
<tr>
<td>Local sub-arterial</td>
<td>11m</td>
<td>400m</td>
<td>Shelters*</td>
</tr>
<tr>
<td>Arterial</td>
<td>13m</td>
<td>400m</td>
<td>Shelters and bays**</td>
</tr>
</tbody>
</table>

*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 Council Designer or Council’s Consultant 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...Council has the authority to refuse plans that do not meet the required standards...Plans copied from other works will not be accepted.

**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. Where readability is compromised, scales greater than 1:500 may be required.
- Part plans at 1:200 scale, showing merging details of new roads, cycleways and pathways with existing roads.
- Longitudinal sections: 1:500 Horizontal and 1:100 Vertical. Where possible Longitudinal section scale should match plan scale.
- 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. Provide a digital copy of the construction drawings in the required drawing format.

Drawing format: As required by the Conditions of Development Consent.

Final certification of completed works: As required by the Conditions of Development Consent.
## Urban

<table>
<thead>
<tr>
<th>Road Class</th>
<th>Description</th>
<th>Indicative Lots Serviced</th>
<th>Indicative Traffic (VPD)</th>
<th>Carriageway Width (between kerbs)</th>
<th>Kerb &amp; Gutter</th>
<th>Wearing Surface Type</th>
<th>Pavement Design</th>
<th>Drainage Design</th>
<th>Cycleway</th>
<th>Traffic Facilities (RAI, Pedestrian Refuges)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>Shareways</td>
<td>Max of 6 lots</td>
<td>&lt;50</td>
<td>3.5m</td>
<td>yes</td>
<td>Asphalt or Concrete</td>
<td>40 years</td>
<td>5 yr minor, 100 yr major</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>1B</td>
<td>Culdeesacs/Access St</td>
<td>Approx 7-30 Lots</td>
<td>&lt;400</td>
<td>5.5 m</td>
<td>yes</td>
<td>Asphalt</td>
<td>40 years</td>
<td>5 yr minor, 100 yr major</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>2</td>
<td>Minor/Local</td>
<td>Approx 100 or less</td>
<td>400 - 2000</td>
<td>6.5 - 8.0 m</td>
<td>yes</td>
<td>Asphalt</td>
<td>40 years</td>
<td>5 yr minor, 100 yr major</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>3</td>
<td>Collector</td>
<td>100 - 500</td>
<td>2000 - 8000</td>
<td>8.5 - 11.0 m</td>
<td>yes</td>
<td>Asphalt</td>
<td>40 years</td>
<td>5 yr minor, 100 yr major</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>4</td>
<td>Distributor/Sub-arterial</td>
<td>NA</td>
<td>8000 - 15000</td>
<td>11.0 - 13.0 m</td>
<td>yes</td>
<td>Asphalt</td>
<td>40 years</td>
<td>5 yr minor, 100 yr major</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Note: Consideration of bitumen seal will be given to wearing surface treatment in urban non-coastal areas.

## Rural

<table>
<thead>
<tr>
<th>Road Class</th>
<th>Description</th>
<th>Indicative Lots Serviced</th>
<th>Indicative Traffic (VPD)</th>
<th>Pavement/Seal Width</th>
<th>Kerb &amp; Gutter</th>
<th>Wearing Surface Type</th>
<th>Pavement Design</th>
<th>Culvert Design</th>
<th>Cycleway</th>
<th>Traffic Facilities (RAI, Pedestrian Refuges)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Culdeesacs/Access St</td>
<td>5 Lots</td>
<td>&lt;50</td>
<td>5.5m (subject to Rural Fire Service conditions)</td>
<td>N/A</td>
<td>Gravel</td>
<td>Min 200mm - Min CBR 5</td>
<td>5 yr</td>
<td>N/A</td>
<td>no</td>
</tr>
<tr>
<td>2</td>
<td>Minor/Local</td>
<td>Up to 30 Lots</td>
<td>20 - 200</td>
<td>7.0m</td>
<td>N/A</td>
<td>Gravel</td>
<td>Min 300mm - Min CBR 5</td>
<td>30 yr</td>
<td>N/A</td>
<td>no</td>
</tr>
<tr>
<td>3</td>
<td>Collector</td>
<td>200 - 500</td>
<td>9.0m</td>
<td>N/A</td>
<td>N/A</td>
<td>Bitumen Seal</td>
<td>40 years</td>
<td>20 yr</td>
<td>N/A</td>
<td>no</td>
</tr>
<tr>
<td>4</td>
<td>Distributor/Sub-arterial</td>
<td>500</td>
<td>11.0m</td>
<td>N/A</td>
<td>N/A</td>
<td>Bitumen Seal</td>
<td>40 years</td>
<td>100 yr</td>
<td>N/A</td>
<td>yes</td>
</tr>
</tbody>
</table>

**NOTE**: Where a new rural road connects to an existing bitumen road, the new road is to be sealed on its entire length.

NOTE: GLC Road Classification table listed below.
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:
Note: Only the most current standards are to be used.

Austroads
AGPT01: Guide to Pavement Technology – Part 1 Introduction to Pavement Technology.
AGPT02: Guide to Pavement Technology – Part 2 Pavement structural design.
AGPT04C: Guide to Pavement Technology – Part 4C Materials for Concrete Road Pavements.
AGPT05: Guide to Pavement Technology – Part 5 Pavement Evaluation and Treatment Design.
AGPT06: Guide to Pavement Technology – Part 6 Unsealed Pavements.
AGPT08: Guide to Pavement Technology – Part 08 Pavement Construction.
AGRD02: Guide to Road Design Part 2: Design considerations.
AGRD08: Guide to Road Design - Part 8 Process and Documentation
AP-T68: Update of the Austroads sprayed seal design method.

Other publications
Cement Concrete Aggregates Australia (CCAA)
Concrete Masonry Association of Australia (CMAA)
T45: Concrete Segmental Pavements—Design guide for residential access ways and roads. 
Clay Brick and Paver Institute (CBPI)

Roads and Maritimes Services (RMS) Supplement to AUSTROADS, Guide to Pavement Technology
Part 2: Pavement Structural Design VERSION 2.1

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 www.australia.gov.au.

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: 20 years or minimum pavement design, whichever is the greater.
- Flexible, containing one or more bound layers: 40 years or minimum pavement design, whichever is the greater.
- Rigid (concrete): 40 years or minimum pavement design, whichever is the greater.
- Segmental block: 20 years or minimum pavement design, whichever is the greater.

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 20 year design life table subject to variation depending on the circumstances for the particular project.

### Design ESA’s 20 year design life table

<table>
<thead>
<tr>
<th>Street type</th>
<th>Design ESA’s—20 year design life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Residential</td>
<td></td>
</tr>
<tr>
<td>- Access Street</td>
<td>$6 \times 10^4$</td>
</tr>
<tr>
<td>- Local Street</td>
<td>$3 \times 10^5$</td>
</tr>
<tr>
<td>- Collector Street</td>
<td>$1 \times 10^6$</td>
</tr>
<tr>
<td>Local Sub-Arterial</td>
<td>$2 \times 10^6$</td>
</tr>
<tr>
<td>Rural Residential</td>
<td>$3 \times 10^6$</td>
</tr>
<tr>
<td>Commercial and Industrial</td>
<td>$5 \times 10^6$</td>
</tr>
</tbody>
</table>

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.

©AUS-SPEC (Oct 12) 4 April 2015
- 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).
- Asphalactic concrete.
- Cement concrete.
- Concrete segmental pavers.

**Materials**

Pavement materials: To AGPT02 Table 6.1 for pavement material categories and characteristics.
Unbound granular materials including modified granular materials: To 1141 Flexible pavements.
Bound (cemented) granular materials: To 1141 Flexible pavements.
Asphalactic concrete: To 1144 Asphalactic 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 pavers: To 1145 Segmental paving.

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 gutter: 300 mm where surfacing is less than 30 mm.
- Unkerbed roads: 200 mm.
- Carparks: 150 mm.
- Unsealed roads: 150 mm

Final thickness of subbase and base layers:
- Flexible pavement: Kerbed road - Subbase 100 150mm, base 100 150mm
  Unkerbed road - Subbase 100mm, base 100mm
- Rigid pavement: Kerbed Road - Subbase 100 150 mm, base 150 mm
  Unkerbed Road - Subbase 100mm, base 150mm
Subbase extent
Subbase layer: Minimum of 300 mm behind the rear face of any kerb and/or gutter.

Base extent
Base and surfacing: To the face of any kerb or kerb and/or gutter.
Kerb conditions: If the top surface of the subbase layer is below the level of the underside of the kerb gutter, extend the base layer a minimum of 300 mm behind the rear face of the kerb and/or 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).

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 12.9 (or software designed for this purpose).
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.

4 SURFACING DESIGN

4.1 SURFACE TYPE

Streets
Wearing surface specifications: Bituminous wearing surface as follows except where the pavement is designed for concrete or segmental block surfacing:
- Urban/rural residential streets: Access street and local street, alternatives:
  - primer seal plus two coat flush seal, or
  - primer seal, plus asphalt.
- Urban/rural residential streets: Collector and local sub-arterial,
  - primer seal, plus asphalt.
- Commercial and industrial streets:
  - primer seal, plus asphalt.
Braking and turning zones
Alternatives: Provide 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. Such variations shall be approved by Council.

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 10mm primer seals below all asphalt surfacings. Conform to the following:
- Use 7-10 mm size aggregate > 200 vfl/d.

Two-coat flush seals: Double-double seals, comprising a minimum of two coats binder and two coats of aggregate as follows:
Urban residential street:
- 1st coat—14 mm.
- 2nd coat—7 mm.

Main roads and other rural roads
- 1st coat—20 14mm.
- 2nd coat—40 7mm.

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

Asphaltic concrete
Light to medium traffic: In urban residential access and local streets, rural or light trafficked commercial streets (design traffic up to approximately $3 \times 10^6$ ESAs), design the asphalt mix as either a 'high-bitumen content' mix or a mix to AGPT02 Section 6.5 and 1144 Asphaltic concrete (Roadways).

Medium to heavy traffic: In urban residential collector and sub-arterial roads, medium to heavily trafficked rural and commercial streets and in all industrial roads, design the asphalt mix as a dense graded mix to 1144 Asphaltic concrete (Roadways).

Minimum thickness: Design asphaltic concrete surfacings to provide a nominal compacted layer thickness:
- On light to medium trafficked residential rural and commercial streets: > 30mm
- On medium to heavily trafficked residential, rural or commercial roads: 50 mm.
- On cul de sac turning heads: 50 mm.
- On bus areas: 50 mm.

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

Segmental pavers
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.

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: As required by the Conditions of Development Consent.

Design reports
Requirements: As required by the Conditions of Development Consent.

© AUS-SPEC (Oct 12) 7 April 2015
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. Provide a digital copy of the construction drawings in the required drawing format.

Drawing format: As required by the Conditions of Development Consent.

Final certification of completed works: As required by the Conditions of Development Consent.
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.

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:
Australian standards
Note: Only the most current standards are to be used.
AS/NZS 1477: PVC pipes and fittings for pressure applications.
AS 2439: Perforated plastics drainage and effluent pipe and fittings.
AS 2439.1: Perforated drainage pipe and associated fittings.
Austroads
AGRD05: Guide to Road Design – Part 5: Drainage design

Other publications
ARRB Australian Road Research Board.
ARR368: 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 kerbline. 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.
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](image)

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. Crushed glass, subject to being fully compliant with these Specifications, may also be used, subject to Council approval.

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: As required by the Conditions of Development Consent.

Design reports
Requirements: As required by the Conditions of Development Consent.

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: As required by the Conditions of Development Consent.

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. Provide a digital copy of the construction drawings in the required drawing format.

Drawing format: As required by the conditions of Development Consent.

Final certification of completed works: As required by the Conditions of Development Consent.
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: As required by the Conditions of Development Consent.
State legalisation: As required by the Conditions of Development Consent.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- 0010 Quality requirements for design.
- Related worksections:

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:
Note: Only the most current standards are to be used.

Australian standards
AS/NZS 1158 Lighting for roads and public spaces
AS/NZS 1158.3.1 Pedestrian area (Category P) lighting - Performance and design requirements
AS 1158.5 Tunnels and underpasses
AS 1428 Design for access and mobility
AS 1428.1 General requirements for access - New building work
AS 1428.2 Enhanced and additional requirements - Buildings and facilities
AS/NZS 1428.4.1 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 Bicycle facilities
AS 1742.10 Pedestrian control and protection
AS 1798 Lighting poles and bracket arms-Preferred dimensions.
AS 2156 Walking Tracks
AS 2156.1 Classification and signage
AS 2156.2 Infrastructure design
AS 2890 Parking facilities
AS 2890.3 Bicycle parking facilities
Austroads
AP-G88 Cycling aspects of Austroads guides
AGRD06A Guide to Road Design – Pedestrian and cyclist paths
AGPT02 Guide to pavement technology – Pavement structural design

Other publications
Concrete Institute of Australia
CIA Z15 Cracking in concrete slabs on ground and pavements
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:
- 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 ration 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 RESERVED

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: As required by the Conditions of Development Consent.

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: As required by the Conditions of Development Consent.
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: As required by the Conditions of Development Consent.

3.2  DESIGN CRITERIA

General
Pavement design life: As required by the Conditions of Development Consent.

Maintenance considerations: As required by the Conditions of Development Consent.

Cycleway and pathway types
Cycleway type:
- On road: Shared parking / bicycle lane, wide kerbside lanes, shared traffic lanes, exclusive bicycle lane, sealed shoulder.
- Off road: Shared bicycle / pedestrian pathway, segregated pathway, exclusive cycleway, educational cycleway, BMX facilities.

Pathway type:
- Common types include: Exclusive pedestrian pathways, shared bicycle / pedestrian pathways.

Footpath requirement: As required by the Conditions of Development Consent.

Geometric design
Design criteria: To the Design criteria table.

Design criteria table

<table>
<thead>
<tr>
<th>Feature</th>
<th>Cycleway</th>
<th>Pathway</th>
<th>Shared use pathway</th>
<th>Separated paths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path width Desirable minimum (To AGRD06A clause 7.5)</td>
<td>Local access path: 2.5 m</td>
<td>Minimum width: 1.2 m</td>
<td>Local access: 2.5 m</td>
<td>Cycleway: 1.5 m</td>
</tr>
<tr>
<td></td>
<td>Major path: 3.0 m</td>
<td>Absolute minimum: 1 m</td>
<td>Commuter path: 3.0 m</td>
<td>Pathway: 1.5 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High pedestrian</td>
<td>Recreational</td>
<td>Pathway: 2.0 m</td>
</tr>
</tbody>
</table>

© AUS-SPEC (Oct 12) 3 April 2015
<table>
<thead>
<tr>
<th>Feature</th>
<th>Cycleway</th>
<th>Pathway</th>
<th>Shared use pathway</th>
<th>Separated paths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>One-way</td>
</tr>
<tr>
<td>Path width</td>
<td>Local access path: 2.5 – 3 m</td>
<td>For disability access: 1.5 – 1.8 m</td>
<td>Local access: 2.5 - 3 m</td>
<td>Cycleway: 1.2 – 2 m</td>
</tr>
<tr>
<td>Minimum – Maximum</td>
<td>Major path: 2.5 – 4 m</td>
<td></td>
<td>Commuter path: 2.5 - 4 m</td>
<td>Pathway: ≥1.2 m</td>
</tr>
<tr>
<td>(To AGRD06A clause 7.5)</td>
<td>Footway dining: 5 m</td>
<td></td>
<td>Recreational path: 3.0 - 4 m</td>
<td>Cycleway: 2.0 – 3 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical clearance</td>
<td>2.5 m</td>
<td>2.0 m</td>
<td>2.5 m</td>
<td>2.5 m</td>
</tr>
<tr>
<td>(To AS 1742.2-2009 and AS 1428.2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crossfall</td>
<td>1:40</td>
<td>General: Flat – 2.5% (0 – 1:40)</td>
<td>Maximum: 2.5% (1:40)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seal ed surfaces: 2%-4% (1:50 – 1:25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unsealed surfaces: 5% (1:20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gradient</td>
<td>Desirable maximum: 3%</td>
<td>NA</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>(To AGRD06A, Figure 7.1)</td>
<td>Maximum: 5%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum radius for horizontal curves for</td>
<td>Without superelevation: To AGRD06A Tables 7.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cycleways and shared pathways</td>
<td>With superelevation: To AGRD06A Table 7.2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>To AGRD06A Figure 7.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum sight stopping distance for</td>
<td>Flat gradients: 35 km/h</td>
<td>Walking speed: 1 m/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cycleways and shared pathways</td>
<td>Moderate gradients: 50 km/h</td>
<td>Walking speed at crossings: 1.2 m/s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

© AUS-SPEC (Oct 12) 4 April 2015
Drainage
Water sensitive design: Council encourages the use of WSUD principles in the development of workable drainage solutions. Where possible, such principles should be incorporated into the design proposals.
Landscaping: To be incorporated as part of the WSUD proposals where required.

Safety
General: As required by the Conditions of Development Consent.
Ramp and footpath landings: Conform to the Landings table.

<table>
<thead>
<tr>
<th>Landings table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of path</td>
</tr>
<tr>
<td>Ramp</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Footpath</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Maximum bicycle operating speed: As required by the Conditions of Development Consent.

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: As required by the Conditions of Development Consent.
Joints to existing pavement: As required by the Conditions of Development Consent.

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: If proposed, are subject to approval by Council.

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.

4 DOCUMENTATION

4.1 GENERAL

Approvals
Authorities: As required by the Conditions of Development Consent.

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: As required by the Conditions of Development Consent.

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 1:100 vertical. Where readability is compromised, scales greater than 1:500 may be required.
- 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. Provide a digital copy of the construction drawings in the required drawing format.

Drawing format: As required by the Conditions of Development Consent.
Work-as-executed drawing format: As required by the Conditions of Development Consent.

4.4 CERTIFICATION

General
Final certification of completed works: As required by the Conditions of Development Consent.
1 GENERAL

1.1 RESPONSIBILITIES

Objective
General: Provide design and documentation for the structures covered by this worksection.
Details of structures: Examples of structure types include:
- Road traffic bridges.
- Pedestrian bridges.
- Structures other than bridges, but associated with roads (e.g. retaining walls).
- Small earth dams, detention basins.
- Structures used for public safety (traffic barriers, pedestrian barriers, street lighting).
- Temporary works.
Scope of design services: As required by the Conditions of Development Consent.
Designer’s qualifications: Suitably qualified to undertake the works.
Evidence of designer’s qualifications and experience: Submit to Council Authorities.
State planning legislation: As required by the Conditions of Development Consent.

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.

1.3 REFERENCED DOCUMENTS

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

Australian Standards
Note: Only the most current standards are to be used.

AS 1100 Technical drawing
AS 1100.101 General principals
AS 1158-various Lighting for roads and public spaces
AS 1428 Design for access and mobility
AS 1428.1 General requirements for access-New building work
AS/NZS 1428.4.1 Means to assist the orientation of people with vision impairment-Tactile ground surface indicators
AS 1798 Lighting poles and bracket arms-Preferred dimensions
AS 1926 various Swimming pool safety
AS/NZS 2041 various Buried corrugated metal structures
AS/NZS 3845 Road safety barrier systems
AS 4678 Earth-retaining structures
AS 5100 Bridge design
AS 5100.1 Scope and general principals
AS 5100.2 Design loads
AS 5100.3 Foundations and soil supporting structures
AS 5100.4 Bearings and deck joints
AS 5100.5 Concrete
AS 5100.6  Steel and composite construction
AS 5100.7  Rating of existing bridges
Austroads
AGBT01  Guide to bridge technology - Introduction and bridge performance
AGBT02  Guide to bridge technology - Materials
AGBT03  Guide to bridge technology - Typical superstructures, substructures and components
AGBT04  Guide to bridge technology - Design procurement and concept design
AGBT05  Guide to bridge technology - Structural drafting
AGBT06  Guide to bridge technology - Bridge construction
AGBT07  Guide to bridge technology - Maintenance and management of existing bridges
AGRD06A  Guide to road design-Pedestrian and cyclist paths
AP-T196  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

2  PRE-DESIGN PLANNING

2.1 RESERVED

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: As required by the Conditions of Development Consent.

Heritage considerations
General: As required by the Conditions of Development Consent.
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: As required by the Conditions of Development Consent.

Waterways and flood design
Design: To AS 5100.

Geotechnical investigation and survey
Responsibilities: All costs associated with required geotechnical investigations and survey is the responsibility of the Developer.

Traffic conditions
Requirements: As required by the Conditions of Development Consent.

Geometry
Design: To AS 5100.

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.

Construction considerations
Requirement: As required by the Conditions of Development Consent.
Provisions for traffic: Conform to 1101 Control of traffic.

Design loads
General: To AS 5100.2.

Serviceability
General: To AS 5100.2.

Environmental constraints
Requirement: As required by the Conditions of Development Consent.
Erosion and sedimentation control: To 0075 Control of erosion and sedimentation (Design).

Ecologically sustainable development
Requirement: As required by the Conditions of Development Consent.

3.2 ROAD TRAFFIC AND PEDESTRIAN BRIDGES

General
Design: To AS 5100.
Design guidance: AGBT01, AGBT02, AGBT03, AGBT04 and AGBT06.
Standard designs: As required by the Conditions of Development Consent.

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: As required by the Conditions of Development Consent.
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.
3.3 PROVISIONS FOR PEDESTRIANS AND CYCLISTS ON ROAD BRIDGES

Walkways and cycleways
Standard: To AS 5100.1, AGRD06A.
Separate footpaths: As required by the Conditions of Development Consent.

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: As required by the Conditions of Development Consent.
Safety fencing: As required by the Conditions of Development Consent.
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: As required by the Conditions of Development Consent.
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: As required by the Conditions of Development Consent.

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 0150 Quality (Design).

4.2 DRAWINGS

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

Drawing presentation
Drawing format: As required by the Conditions of Development Consent.
Drawing size: As required by the Conditions of Development Consent.
Drawing numbering, titles and subtitles: As required by the Conditions of Development Consent.
Title block format: As required by the Conditions of Development Consent.

Drawing content
Requirement: As required by the Conditions of Development Consent.

Verification and approval of construction drawings
Authorised personnel: As required by the Conditions of Development Consent.

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: As required by the Conditions of Development Consent.

Final certification of completed works: As required by the Conditions of Development Consent.
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 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
Note: Only the most current standards are to be used.

AS/NZS 1254 PVC pipes and fittings for storm and surface water applications.
AS 1289 Methods of testing soils for engineering purposes
AS 1289.4.2.1 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 Soil chemical tests - Determination of the pH value of a soil - Electrometric method
AS 1289.4.4.1 Soil chemical tests - Determination of the electrical resistivity of a soil - Method for sands and granular materials
AS/NZS 2032 Installation of PVC pipe systems
AS 2200 Design charts for water supply and sewerage
AS/NZS 2566 Buried flexible pipelines
AS/NZS 2566.1 Structural design
AS/NZS 2566.2 Installation
AS/NZS 3500 Plumbing and drainage
AS/NZS 3500.3 Stormwater drainage
AS/NZS 3725 Design for installation of buried concrete pipes
AS/NZS 4058 Precast concrete pipes (pressure and non-pressure)
AS/NZS 5065 Polyethylene and polypropylene pipes for drainage and sewerage applications
Austroads
AGRD05 Guide to road design – Drainage design
AP-R232 Guidelines for treatment of stormwater runoff from the road infrastructure

Other publications
Council
Drainage design intensities

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
Australian and New Zealand Environment and Conservation Council
ANZECC- 2000 National Water quality management strategy No.10 Guidelines for urban stormwater management
NSW RTA
Model analysis to determine hydraulic capacities of kerb inlets and gully pit gratings

1.4 STANDARDS

General
Standard: Conform to the following:
- Rainfall and runoff: To ARR.

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.
- GPT: Gross Pollutant Trap.
- IFD: Intensity-Frequency-Duration.
- HGL: Hydraulic Grade Line.
- OSD: On-site detention.
- SEP: Side entry pit.
- SQID: Stormwater quality improvement devices.
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 main/minor approach to street drainage.
- 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 gutters, 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 drainages 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.
- Water-efficient landscaping.
- Protection of water-related environmental, recreational and cultural values.
- Localised water harvesting for re-use.
- Localised wastewater treatment systems.
- Protection and enhancement of natural water systems (creeks, rivers, wetlands, estuaries, lakes, lagoons, groundwater systems).
- Minimise harmful impacts of development upon surface and groundwater flow regimes.
- Protection and enhancement of water quality by improving or maintaining the quality of stormwater run off.
- Integration of stormwater management systems into the landscape in a manner that provides multiple benefits for water quality protection, stormwater retention and detention, ecological enhancement, public open space and visual amenity.

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: To be confirmed for specific development.
- Survey providers: To be confirmed for specific development.
- Program for completion: To be confirmed for specific development.
- Local constraints: To be confirmed for specific development.
- Legal inputs: To be confirmed for specific development.
- Transport interaction: To be confirmed for specific development.
- Communication risks: To be confirmed for specific development.
- Evacuation planning: To be confirmed for specific development.
- Utilities – protection: To be confirmed for specific development.
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 B160 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.

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: As required by the Conditions of Development Consent.

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: As required by the Conditions of Development Consent.
- Additional stormwater quality criteria: As required by the Conditions of Development Consent.

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. 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

Record IFD: Document the adopted IFD data used in the hydrological calculations.

Design ARI: To derive the ARI from ARR Book III and AGRD 05.
Record ARI: Document the adopted ARI data in the hydrological calculations.

Catchment area
Extent: To the ARR.
Alternative: 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 affecting 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 ARR or AS 3500.3.
Record: Document details of adopted coefficients in the hydrological calculations.
Percentage impervious: To the 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:
- Manning's 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 ARR Book VII Section 1 Table 1.1 or AGRD05 Commentary 31 Table C31 1.

**Modelling**
Model type required for design: As required by the Conditions of Development Consent.

**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 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 5 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 x 300 mm high.
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

<table>
<thead>
<tr>
<th>Pipe size (mm)</th>
<th>Spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generally</td>
<td></td>
</tr>
<tr>
<td>Less than 1200</td>
<td>100</td>
</tr>
<tr>
<td>1200 or larger</td>
<td>150</td>
</tr>
<tr>
<td>In tidal influence</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

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:
- 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

<table>
<thead>
<tr>
<th>Condition</th>
<th>Inlet type</th>
<th>Percentage of theoretical capacity allowed</th>
</tr>
</thead>
</table>

© AUS-SPEC (Oct 12) 9 April 2015
<table>
<thead>
<tr>
<th>Condition</th>
<th>Inlet type</th>
<th>Percentage of theoretical capacity allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sag</td>
<td>Side entry</td>
<td>80%</td>
</tr>
<tr>
<td>Sag</td>
<td>Grated</td>
<td>50%</td>
</tr>
<tr>
<td>Sag</td>
<td>Combination</td>
<td>Side Inlet capacity only Grate assumed completely blocked</td>
</tr>
<tr>
<td>Sag</td>
<td>'Letterbox'</td>
<td>50%</td>
</tr>
<tr>
<td>Continuous Grade</td>
<td>Side entry</td>
<td>80%</td>
</tr>
<tr>
<td>Continuous Grade</td>
<td>Grated</td>
<td>50%</td>
</tr>
<tr>
<td>Continuous Grade</td>
<td>Combination</td>
<td>90%</td>
</tr>
</tbody>
</table>

**Hydraulic losses**

Pit pressure change co-efficient \(K_p\): To the ARR. Consider the following:
- Allowable reduction due to benching.
- Any approved bends, clashes with existing sewer mains.
- Ensure computer program default is consistent with.

Record: Document the chart adopted and relevant co-efficients to a summary sheet 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 ARR.

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 ARR.

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**

Surfacing: Do not permit any surfacing 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 m\(^2\)/s.
- Maximum velocity \(\times\) depth product (where the safety of only vehicles can be affected): 0.6 m\(^2\)/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:
  . 0.3 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: 0.3 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 AGRD05and Council's standard road designs. For other road designs, calculate flow capacities of roads using ARR with the flow adjustment factors.

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 m²/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

<table>
<thead>
<tr>
<th>Channel type</th>
<th>'n'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete pipes or box sections</td>
<td>0.011 – 0.012</td>
</tr>
<tr>
<td>Concrete (trowel finish)</td>
<td>0.012 – 0.015</td>
</tr>
<tr>
<td>Concrete (formed without finishing)</td>
<td>0.013 – 0.018</td>
</tr>
<tr>
<td>Sprayed concrete (gunite)</td>
<td>0.016 – 0.020</td>
</tr>
<tr>
<td>Bitumen seal</td>
<td>0.018</td>
</tr>
<tr>
<td>Bricks or pavers</td>
<td>0.014 – 0.016</td>
</tr>
</tbody>
</table>
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 AS3500 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 anyone 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.
Approval by the dam safety committee: As required by the Conditions of Development Consent.
Stillin 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 jointed with lifting holes securely sealed.
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 ARR.
Easement: Contain interallotment drainage within an easement minimum 1.0 m wide and in favour of the upstream allotments.
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

<table>
<thead>
<tr>
<th>Development type</th>
<th>% of lot area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential (2a)</td>
<td>40</td>
</tr>
<tr>
<td>Residential (2b)</td>
<td>70</td>
</tr>
<tr>
<td>Industrial</td>
<td>80</td>
</tr>
<tr>
<td>Commercial</td>
<td>90</td>
</tr>
</tbody>
</table>

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:
- Precast concrete pipes: To AS/NZS 4058.
- PVC pipes: To AS/NZS 1254.
- Polypropylene pipes: To AS/NZS 5065.
- Buried flexible pipes: To AS/NZS 2566.1 and AS/NZS 2566.2.

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 x 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.

### 3.10 GROSS POLLUTANT TRAPS (GPT) AND SEDIMENT TRAPS

**General**

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.

![Diagram of Sediment Basin/Constructed Wetlands]

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 5%, include details to address the size and position in the trench and the spacing along the line.

**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: As required by the Conditions of Development Consent.

**Stormwater discharge**
Salinity prevention: Locate stormwater discharge to avoid recharging groundwater and creating or worsening salinity degradation of adjacent land.
Kerb and gutter termination: Extend kerb and 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.

**Easements**
Deed of Agreement: As required by the Conditions of Development Consent.
Adjoining owners: Identify points of discharge of gutters or stormwater drainage lines or any concentration of stormwater on to adjoining properties. Council to arrange for permission of the discharge of stormwater drainage and the creation of any necessary easements.
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.

**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: As required by the Conditions of Development Consent.
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.
Maximise 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.
- Clearance distances to building footings and boundaries: Conform to ARQ clause 11.3.1 with regard to the soil classification.

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 affected 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: As required by the Conditions of Development Consent.

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.

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.

### 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. Provide a digital copy of the construction drawings in the required drawing format.

Drawing format: As required by the Conditions of Development Consent.

Final certification of completed works: As required by the Conditions of Development Consent.
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).
- 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:
Note: Only the most current standards are to be used.
Department of Sustainability, Environment, Water, Population and Communities
DEWHA Introduction to urban stormwater management in Australia.
Engineers Australia
ARQ Australian runoff quality: a guide to water sensitive urban design.
International Erosion Control Association
IECA Best practice erosion and sediment control for building and construction sites Books 1 to 4.

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.
- ESCP: Erosion and Sediment Control Plan.
- GPT: Gross Pollutant Trap.
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 subcatchment.
Water pollution: "Pollute" is defined as: “to place in or on, or introduce into ‘waters’ any refuse, litter, debris or matter which changes the condition of 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 with the appropriate authorities:
- Stormwater management systems: To be confirmed for specific development.
- Erosion and stormwater management plan: To be confirmed for specific development.
- Local constraints assessment: To be confirmed for specific development.
- Environmental impact statement: To be confirmed for specific development.
- Tree preservation policy: To be confirmed for specific development.
- Wetlands for rehabilitated areas: To be confirmed for specific development.
- Protection of utilities: To be confirmed for specific development.
- Environmental Management Plan: To be confirmed for specific development.
- Catchment water quality: To be confirmed for specific development.
Procure approvals as required:
- Development approval certification: To be confirmed for specific development.

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.

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:

Dams Safety Act 1978
Soil Conservation Act 1938
Water Act 1912

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: As required by the Conditions of Development Consent.
Temporary drainage works: Design all temporary drainage works in conformance with IECA Book 1 Table 4.3.1.
ARI: As required by the Conditions of Development Consent.

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: As required by the Conditions of Development Consent.
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.
- ARR volume 2 for the local area.
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: As required by the Conditions of Development Consent.

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
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 ISEA Book 2 Appendix E.
- Any other relevant information Council may require to properly assess the ESCP.
- Requirement: As required by the Conditions of Development Consent.

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. Provide a digital copy of the construction drawings in the required drawing format.

Drawing format: As required by the Conditions of Development Consent

Final certification of completed works: As required by the Conditions of Development Consent.