

Central Coast Council



CIVIL WORKS SPECIFICATION

DESIGN GUIDELINE

2020

ROADS, TRANSPORT, DRAINAGE AND SUBDIVISIONS
DESIGN AND CONSTRUCTION

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Table of Revisions

Revision	Date	Remarks
Version 1.0	July 2018	Final review by Central Coast Council
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Acknowledgement, Disclaimer and Limitations of Liability

Elements of the former Wyong Shire Council's *Design Guideline, Construction Specification and Standard Drawings* and Gosford City Council's *Civil Works Specification* have been adapted in the preparation of Central Coast Council's *Civil Works Specification*.

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Section 1 - Application of Civil Works Specification - Design Guideline

The *Civil Works Specification* has been compiled to outline Council's requirements for the planning, survey, design, construction and maintenance of public infrastructure assets, subdivisions and various private site works within the Central Coast Local Government Area.

The *Civil Works Specification* is referenced in the Central Coast *Development Control Plan* and consists of the following volumes, which shall be read in conjunction with one another as required and not in isolation. These documents are available on Council's website:

1. Design Guideline
2. Construction Specification
3. Standard Drawings

This *Design Guideline* and referenced documents provide minimum requirements and references for the design of civil works within the Central Coast Local Government Area. Works may include, but are not limited to the following:

- Roads
- Intersections
- Pavements
- Pavement restorations
- Paths
- Cycleways
- Traffic facilities
- Earthworks
- Stormwater drainage
- Water supply
- Sewerage systems
- Water quality facilities
- Parks and reserves

Section 2 - Glossary of Terms

For the purpose of this *Design Guideline*, the following definitions shall apply:

Access Road - Minor road which carries a low volume of traffic, providing direct access to a limited number of allotments.

Accredited Certifier - Person who holds a certificate of accreditation under the *Building Professionals Act 2005* in relation to particular matters. An Accredited Certifier in general may issue Compliance Certificates for matters within their area of accreditation.

Note: An Accredited Certifier may not certify construction in respect of water and sewer works pursuant to Section 306 of the *Water Management Act 2000*. Works on public roads under the *Roads Act 1993* may preclude an Accredited Certifier from being appointed. In the case of the provision of water and sewer servicing, Council will issue a Section 307 Certificate of Compliance under the *Water Management Act 2000* when requirements have been met.

AEP - Annual Exceedance Probability.

Ancillary Road Asset - Road elements including kerb and gutter, drainage pits, drainage lines, subsoil drainage lines, pavement markings and street furniture.

Applicant - Person or corporation making application to Council for approval for a proposed development.

ARR - *Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia* (latest online edition).

Asset - Physical component of a road system or network. An asset is considered worthy of separate identification if it delivers services or benefits to the community of sufficient current or future value to warrant control and management on an individual basis. Typical assets include sections of pavements, bridges, culverts, traffic signals, signs, road furniture, road reserves, etc.

Australian Height Datum (AHD) - Datum surface approximating mean sea level as adopted by the National Mapping Council of Australia in May 1971.

Authorities - Authorities such as Department of Planning and Environment, Transport for NSW (formerly RMS), Telstra, Optus, Ausgrid, AGL Energy, Jemena, Sydney Water, etc.

Blue Book - *Managing Urban Stormwater: Soils and Construction*, 4th Edition, Landcom, 2004.

Carriageway - Portion of road or bridge used by vehicles (including shoulders and auxiliary lanes or between the face of kerbs).

CBR - California Bearing Ratio.

Certifying Authority - A Certifying Authority may be Council or an Accredited Certifier approved by Council.

Collector Road - Road linking access roads to major roads, possibly providing bus routes and giving road access to allotments.

Consulting Geotechnical Engineer - An experienced and qualified person or company holding an appropriate level of professional indemnity insurance, engaged by the Service Provider to provide advice, inspection reports and recommendations and testing as required by various parts of this Specification in relation to geotechnical matters.

Contractor - Person, private sector entity or consortium engaged by a Developer or Service Provider to execute a contract.

Council - Central Coast Council. Council may also be referred to as the Principal under a Construction Contract.

Council's Representative - Staff member nominated by Central Coast Council to act on Council's behalf in the discharge of its contractual responsibilities and/or the person responsible/delegated to make a decision for Council. This person may be referred to as the Superintendent under a Construction Contract.

CPI - Consumer price index.

Cycleway - Portion of a road or footpath devoted to the use of bicycles.

DA - Development application.

DBYD - Dial Before You Dig.

DCP - Development Control Plan.

Design - In relation to plant or a structure, it includes a design of part of the plant or structure and redesign or modification of the design.

Detention Basin (Retention/Retarding Basin) - Storage pond, basin or tank used to reduce and attenuate the peak discharge within a drainage system.

Driveway - Part of an access to/from a road or road related area, which is completely within the adjacent land.

Engineer - (Structural, Geotechnical, Civil, etc) - Where used in this document refers to a person of suitable experience (as a guide not less than 10 years industry experience), who holds an appropriate level of professional indemnity insurance and qualifications to undertake the relevant elements of the work and are eligible for corporate membership of the Institution of Engineers, Australia (or equivalent professional industry body).

EY - Exceedance per year.

Floodplain - As defined by the current NSW Government *Floodplain Development Manual*.

Area of land, which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.

Floodway Areas - As defined by the current NSW Government *Floodplain Development Manual*. Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood level.

Floodway - As defined by Austroads. A longitudinal depression in a carriageway specially constructed to allow the passage of floodwater across it without damage. The cross section of a stream in flood plus a nominated area for freeboard.

Footpath - Path or paved area reserved for the movement of pedestrians and manually propelled vehicles and motorised mobility devices.

Geocentric Datum of Australia (GDA) - Datum surface approximating the shape of the earth's surface as adopted by the Intergovernmental Committee for Surveying and Mapping in May 1990

Handover Documents - All documents provided by the Service Provider to Central Coast Council on Practical Completion as specified, including WAE drawings.

IPWEA Specification - *Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage 2010*.

Kerb and Gutter - Combined roadside element forming an open drain to capture and discharge runoff. The term kerb and channel was adopted by RMS to align with Austroads and other Australian States and Territories and may be used interchangeably with the term kerb and gutter.

Lane - Portion of the paved carriageway marked out by kerbs, painted lines or barriers, which carries a single line of vehicles in one direction. A lane is generally between 3.0 and 3.5m wide. A single carriageway road normally has at least one lane in each direction.

Late Fee - Any unauthorised work will incur a late fee in accordance to Council's Fees and Charges.

LEP - Local Environmental Plan.

LGA - Local Government Area. This refers specifically to the Central Coast Local Government Area which is defined by Frazer Park and Crangan Bay in the north, Hawkesbury River in the south and Kulnura in the west and the Pacific Ocean in the east.

Local Distributor Road - A road linking access roads to major roads, providing bus routes and giving restricted access to allotments.

Local Road - Minor road which carries a higher volume of traffic than an access road but still provides direct access to allotments.

Map Grid of Australia (MGA) - Rectangular co-ordinate system using a Universal Transverse Mercator (UTM) projection based on the Geocentric Datum of Australia (GDA).

NATA - National Association of Testing Authorities, Australia.

NCC - *National Construction Code*, which comprises of the *Building Code of Australia* (BCA) as Volumes 1 and 2 and the *Plumbing Code of Australia* (PCA) as Volume 3.

NSWRFS - NSW Rural Fire Service.

Obstruction - Any object which could impede or prevent the free and/or safe passage of pedestrians and/or vehicles.

Operating Speed - The 85th percentile speed of cars at a time when traffic volumes are low and which allows a free choice of speed within the road alignment as defined in the Austroads Glossary of Terms.

PAMP - Pedestrian Access and Mobility Plan.

Path - Footpath or shared path (refer to each respective definition).

Permanent Restoration - Restoration in accordance with Council's Specification is applied to the road or path after a temporary restoration has completed and left exposed to the public for a specified period of time.

Permanent Survey Mark (PSM) - Survey mark in the style or form for a permanent survey mark as described in the *NSW Surveying and Spatial Information Regulation 2017*.

Practical Completion - That stage in the execution of work under a Contract or capital works project when the works are complete except for minor omissions and minor defects that do not prevent the works from being reasonably capable of being used for their intended purpose, as determined by Council's Representative. This definition excludes Developer-constructed works as approved by a Development Consent.

Principal Certifier - For subdivision work, means the certifier appointed as the Principal Certifier under section 6.12(1) of the *Environmental Planning and Assessment Act 1979*. A Service Provider must appoint a Principal Certifier for each development project involving a subdivision. For the purposes of this *Design Guideline*, Principal Certifier could also mean the Principal Certifying Authority.

Principal Contractor - Under the *Environmental Planning and Assessment Act 1979* for building work is that person responsible for the overall co-ordination and control of the carrying out of the building work. A Principal Contractor may also be required under the *Work Health and Safety Regulation 2017*. The Service provider shall advise Council prior to commencement of any works who is the Principal Contractor in respect of both. In this Specification the Principal Contractor may also be referred to as "the Service Provider".

The Service Provider undertaking construction work for Central Coast Council shall be appointed as the Principal Contractor and accepts all the obligations associated with this role under the *Work Health and Safety Regulation 2017*.

Private Property - Property outside of the project, site boundary or road reserve. This is generally neighbouring property owned or leased by private owners and tenants.

Project Manager - The Service Provider shall appoint a person as the Project Manager for the Project. This person must be readily available and have sufficient authority and ability to discuss and resolve problems and act as the principal contact with Council's Representative. A Service Provider who chooses to adopt this role must be aware that Council does not become involved in co-ordinating activities or giving advice beyond Council responsibilities. The Service Provider's Project Manager may also be referred to as the Service Provider in this Guideline.

Proponent - Person or service provider that puts forward a proposal to undertake work.

Restoration Order - Request to Council to undertake permanent restoration on behalf of a service provider.

Risk - The effect of uncertainty on objectives, as defined in AS/NZS ISO 31000:2009.

Roads Authority - National or state road authority, municipality, other body or individual responsible for the care, control and maintenance of road infrastructure.

Road Opening - Any form of excavation or digging of the road reserve including test bores for Geotechnical investigation purposes.

Road Opening Permit - Permit authorising the holder to undertake a road opening activity.

Road Pavement - Refer to definition for **Carriageway**.

Road Reserve - Legally defined area of land between the legal road boundaries within which facilities such as roads, paths and associated features may be constructed for public travel. Where roads have not been formed, it also refers to so called 'paper roads'.

Safety Barrier - Physical barrier separating roadside hazards or opposing traffic and the travelled way, designed to resist penetration by an out-of-control vehicle and as far as practicable, to stop or redirect colliding vehicles.

Service Provider - Any parties such as contractors, suppliers, consultants (accredited certifier), developers, authorities, or Council staff responsible for planning, designing and constructing works.

Shared Path - Paved area particularly designed (with appropriate dimensions, alignment and signing) for the movement of cyclists and pedestrians, but on which cyclists must give way to pedestrians.

Site - Land and structures within the extent of works area/site boundary, including storage areas. The site area may also include privately owned property that shall be dedicated to Central Coast Council as a public asset.

Specification - Detailed statement of materials, dimensions and quality for all work that shall be built, installed, or manufactured for Central Coast Council or for work which shall be dedicated to Central Coast Council as a public asset.

State Survey Mark (SSM) - A form of Permanent Survey Mark as described in the NSW *Surveying and Spatial Information Regulation 2017*.

Stakeholder - An individual or group of individuals such as employees, directors, developers, service providers, consultants and external organisations who have an interest in the project whether through their involvement with the project or because they will be impacted by its outcome.

Sub-contractors - Contractors engaged by the Principal Contractor. The identity of proposed sub-contractors and their proposed scopes of works shall be provided to the Certifying Authority prior to engagement. Council reserves the right to not accept any sub-contractor working on a site based on previous poor compliance with Council's requirements. Sub-contractors may also be suppliers of materials to be incorporated into the works. Sub-contractors who supply materials for the works may also be referred to in this Guideline as "Suppliers".

Surveyor - A registered Land Surveyor as defined in the NSW *Surveying and Spatial Information Act 2002* and/or an Engineering Surveyor qualified to carry out civil works surveying projects.

SWMS - Safe Work Method Statement.

Temporary Restoration - Restoration in accordance with Council's *Civil Works Specification* is applied to roads or paths following completion of a road opening activity or trenching. Temporary restorations must be safe and trafficable at all times until permanent restorations are carried out.

TMP - Traffic Management Plan.

Unauthorised Works - Works that are carried out without a permit or approval from Council.

Utility Authority - National or state roads authority, municipality, other body or individual responsible for the care, control and maintenance of utility infrastructure.

Utility Services - Public infrastructure services including water, sewerage, drainage, gas, electricity, telephone, telecommunication or other like service.

Vehicle Access Crossing - Part of an access to/from a road, which crosses a footway, verge or other road related area and connects a road to an adjoining driveway within adjacent land.

Verge - Area between the carriageway and the property line. It allows provision for services, footpaths shared paths, cycle paths, street trees and street furniture.

WAD - Works Authorisation Deed.

WAE - Work-as-Executed.

Works - All works required to complete the project as specified and approved.

WSAA - Water Services Association of Australia.

Section 3 - General Matters

3.1 General

The *Civil Works Specification* has been compiled to outline Council's general procedures and practices in respect of design and construction requirements for future public infrastructure assets and various private site works in the Central Coast Council Local Government Area (LGA).

This *Design Guideline* has been prepared to assist Service Providers, by informing them of Council's requirements with respect to the design and construction of assets, which will eventually be vested in and maintained by Council and to ensure that such works are provided to appropriate and sustainable standards, ensuring that the principles of ecologically sustainable development are appropriately considered in accordance with the *Local Government Act 1993*.

3.2 Reference Documents

Reference documents include but are not limited to:

- Austroads publications for which there is a specific Glossary of Terms publication and also incorporate some definitions in individual documents.
- Transport for NSW (TfNSW) or documents which incorporate definitions.
- Australian Standards documents for which there is a specific Glossary of Terms, such as AS 1348 *Road and traffic engineering* and incorporated definitions in individual documents.
- Engineers Australia publications.
- Water Services Association of Australia documents relating to supply of water and sewerage services and their respective Supplements.
- *Queensland Road Drainage Design Manual* (Department of Transport and Main Roads 2013) and the *Queensland Urban Drainage Manual*.
- Other Central Coast Council documents.

In any instance, where because of terminology, the interpretation of this *Design Guideline* is in dispute, definitions shall be clarified by Council's Representative.

3.3 Conflicting Standards and Guidelines

The provisions of Council's *Civil Works Specification* apply to all works within the Central Coast LGA, but do not override any conflicting provisions of other Parts of Council's *Development Control Plan* or any consent issued applying to a particular development.

This *Design Guideline* is intended to highlight the specific requirements of Central Coast Council, with respect to the requirements of other Councils, Australia/New Zealand Standards and other industry standards, i.e. differences, additions and omissions. Where there is a conflict or ambiguity between a requirement of Council's *Civil Works Specification* and that of a referenced document, then the requirements of this *Design Guideline* shall take precedence over those in the referenced documents in so far as resolution of the point of conflict is concerned.

Where this *Design Guideline* refers to an Australian Standard, Australian/New Zealand Standard, Austroads or TfNSW publication or other document that has been superseded by a new or updated version, which was issued after commencement of the works, then Council's Representative shall be consulted as soon as possible to determine which requirements shall apply.

In all cases, the Service Provider shall adequately inform Council's Representative of any potential and actual conflicts as soon as they become aware to allow Council the maximum time available to resolve the conflict. The Service Provider shall provide all necessary information to adequately inform Council's Representative of any associated and consequential impacts on design or construction prior to the contract commencing.

Council's Policies and Procedures take precedence for all Central Coast Council employees.

3.4 Departure from the Specification

Consideration may be given for products or work methods which do not strictly comply with Central Coast Council's *Civil Works Specification*. Details of the proposed departure from the Specification need to be submitted to Council's Representative for approval.

3.5 Council's Standard Drawings

Standard Drawings referred to in this *Design Guideline* can be found in Council's *Civil Works Specification - Standard Drawings* and are available to download from [Central Coast Council's website](#).

3.6 Lapsing of Approvals and Certificates

Council's Specification requirements shall be those current at the time of issuing of the Subdivision Works Construction Certificate and/or Civil Works Approval.

A Construction Certificate and/or Civil Works Approval for subdivision works and/or development related works shall lapse with the Development Consent, or in the instance of a Development Consent that has commenced, the approval shall be limited to a maximum of 5 years from the date of the approval. A Development Consent for a subdivision involving subdivision works or other Development involving civil works will normally lapse after a set time following the issue of the Development Consent. In this event, should a new Development Consent be obtained, a submission of updated engineering plans will be required for a new Construction Certificate and/or Civil Works Approval related to the new consent.

A Civil Works Approval for civil engineering works associated with a Building Development shall lapse with the Development Consent, or in the instance of a Development Consent that has commenced, the approval shall be limited to a maximum of 5 years from the date of the plan approval.

3.7 Project Personnel

The Service Provider shall nominate to Council the persons who will hold key roles for the works. These key roles may include the Project Manager, any Accredited Certifier, the Engineering Designers, Registered Surveyors, the Geotechnical Consultant and others as directed by Council.

3.8 Limitations on Accredited Certifiers

Accredited Certifiers when appointed by a Service Provider operate under Part 6 of the *Environmental Planning and Assessment Act 1979*. Accredited Certifiers may not certify design plans/drawings in respect of works which the Council needs to approve under alternative legislation, even though those works are required by a condition of a Development Consent under the *Environmental Planning and Assessment Act 1979*.

These works include:

- Water and sewer works or works which affect water and sewer works pursuant to Section 306 of the *Water Management Act 2000*.
- Works on public roads requiring an approval under the *Roads Act 1993*.
- Drainage works requiring an approval under the *Local Government Act 1993*.
- Works where the Local Environmental Plan (LEP) may preclude an Accredited Certifier from being appointed.

Further approvals may be required on Classified Roads where TfNSW is the approval authority.

Compliance Certificates for Development Consent conditions involving such approvals can only be issued by Council once Council is satisfied the condition has been complied with.

Persons accredited or acting under the *Environmental Planning and Assessment Act 1979* as private Accredited Certifiers are specifically excluded from varying the requirements of Council's *Civil Works Specification* in any way.

3.9 Works Subject to Approvals by Other Authorities

Where conditions have been imposed under an integrated approval or where the Service Provider is required by legislation to obtain approval from others the following applies:

- The design and construction of works shall be carried out to meet those Authorities' specifications in addition to those of Council.
- The Service Provider is responsible for obtaining any permits and licences, achieving required inspection and works standards and gaining final approval of relevant Approval Authorities.
- Copies of approvals, permits and licences to be obtained from Approval Authorities by the Service Provider shall be provided to Council prior to commencement of site activities.
- Copies of final approvals of works and documentation verifying compliance with the requirements of Approval Bodies shall be provided to Council by the Service Provider before completion can be agreed to and accepted by Council.

3.10 Classified Roads and Applicable Standards

Transport for NSW (TfNSW) control works on Classified Roads under the *Roads Act 1993*. Classified Roads include those with a legal class of highway, main road, secondary road, tourist road or transitway. Council controls works on Classified Regional Roads. Refer to *Schedule of Classified Roads and Unclassified Regional Roads* on the [*Transport for NSW website*](#).

To manage the extensive network of roads for which Council is responsible under the *Roads Act 1993*, TfNSW in partnership with local government established an administrative framework of State, Regional, and Local Road categories. State Roads are managed and financed by TfNSW and Regional and Local roads are managed and financed by Councils.

Designers shall obtain from TfNSW the current design and project requirements applicable to classified roads.

Designers shall contact TfNSW at the beginning of the design process to clarify administration processes for design and works agreements (Works Authorisation Deeds).

TfNSW have adopted the Austroads Guides and Australian Standards as their primary technical references related to road design. However, it must be noted that TfNSW has issued Supplements to clarify, add to, or modify these documents.

3.11 Constructability, Health and Safety in Design

Designers shall comply with the [*SafeWork NSW requirements for Health and Safety in Design - CHAIR - Safety in Design Tool*](#).

CHAIR (Construction Hazard Assessment Implication Review) is a tool to assist designers, constructors, clients and other key stakeholders to come together to reduce construction, ongoing operation, maintenance, repair and demolition safety risks associated with design.

The Australian Council of Building Design Professions (BDP) and the Royal Australian Institute of Architects (RAIA) support the use of CHAIR. The BDP believes that along with the quality and amenity of the built environment, its safety is also determined at the design stage. "CHAIR is a tool that will enable better safety awareness and solutions for improving safety and construction through identifying potential hazards by a co-ordinated approach by all stakeholders.

3.12 Road Safety Audits

Road Safety Audits and/or Road Safety Checks shall be conducted in accordance with the TfNSW *Guidelines for Road Safety Audit Practices 2011* by auditors who are registered on the Register of Road Safety Auditors administered by Transport for NSW. This is a minimum of one Level 3 (Lead) Auditor and one Level 2 (Senior) Auditor as the minimum team for a Road Safety Audit. A minimum one Level 3 (Lead) Auditor will be required for a Road Safety Check.

Generally, the requirement for an Audit or a Check will be identified by a consent condition and will be based on the type, value, scale and complexity of the proposal. However, if the project relates to a proposal that is not subject to a consent condition such as a Master Plan, a Rezoning, or where the consent is silent regarding the requirement, the intervention levels in Table 3.1 below shall apply.

Road Safety Audits and/or Road Safety Checks may also be required for minor works or developments where increased risk has occurred, for example, where a bus stop is relocated that will influence bus users to cross roads at a different location, or where a construction access may increase traffic volume and traffic type at a school zone. Refer to Note 11 of Table 3.1 below.

Table 3.1 Road Safety Audit and Road Safety Check Intervention Levels

These intervention levels are minimum intervention levels and do not preclude Council or TfNSW from carrying out inspections at any time. The Service Provider may elect to arrange a concept Road Safety Audit to provide greater confidence prior to the commencement of a detailed design.

Development or Work Type	Total Project Cost ^{2,9}	Road Safety Audit ³ (RSA) or Road Safety Check ⁴ (RSC)			
		Concept Design	Detailed Design	Roadworks ^{5,6}	Pre-Open or Finish
Subdivision with new roads	≤\$500,000		RSA		RSC
Subdivision with new roads	>\$500,000		RSA		RSA
Intersection	≤\$300,000		RSA		RSC
Intersection	>\$300,000	RSA	RSA	RSC	RSA
Intersection	>\$4 million	RSA	RSA	RSA	RSA
Roadworks	≤\$750,000		RSA		RSC
Major Roadworks	>\$750,000		RSA	RSC	RSA
Traffic Control Facility ¹	≤\$50,000		RSC		
Traffic Control Facility ¹	>\$50,000 ⁷		RSA		
Shared paths	≤\$100,000		RSC		RSC
Shared paths	>\$100,000		RSA ¹⁰		RSA ¹⁰
Development Access			RSC		RSC
Developments ⁸			RSA		RSA

Development or Work Type	Total Project Cost ^{2,9}	Road Safety Audit ³ (RSA) or Road Safety Check ⁴ (RSC)			
		Concept Design	Detailed Design	Roadworks ^{5,6}	Pre-Open or Finish
Rezoning/Master Plan, etc		RSA			
Minor Works ¹¹		Refer to Note 11 below			

Notes:

- As defined by the *Transport Administration Act 1988*.
- Excluding Council fees and contributions and consulting fees.
- As defined by Austroads.
- As defined by the TfNSW *Guidelines for Road Safety Audit Practices*.
- Only required where traffic controls applied and mix of traffic (pedestrians/cyclists/vehicles).
- These are in addition to any Work Health and Safety routine checks.
- Where value exceeds \$500,000, apply same requirement as intersection.
- Inclusive of tourist, shopping/commercial or industrial, master planning, educational/sporting and recreational facilities, places of worship, hospitals, service stations or other developments depending on traffic generation and/or development layout.
- Project values shall be indexed in accordance with CPI amounts.
- Either a Detailed Design or a Pre-Opening Audit is required, not both.
- Minor works that involve increasing vehicle/vehicle conflict, pedestrian/vehicle conflict, new accesses (temporary or permanent), changes to public transport, loading or delivery areas, etc that increase crash risk will require either a Road Safety Audit(s) or a Road Safety Check.

Any corrective action or treatment identified for change resulting from the audit or check will require resolution in consultation with Council's Representative prior to approval.

Subject to availability a Level 3 (Lead) Auditor from Council may elect to be involved in any audits/checks carried out.

3.13 Bushfire Prone Areas (BPAs)

In carrying out the design and construction of the works, designers shall ensure that bushfire protection measures required by conditions of consent, other approvals or other Authorities' requirements are incorporated into design plans and specifications. Designers must also ensure that all works do not create previously unidentified bushfire protection issues. This may include the impact of fully established landscaping on fire protection measures.

Designers shall reference relevant current documents published by the NSW Rural Fire service, current Australian Standards and the *Building Code of Australia* when designing for provisions related to bushfire protection.

3.14 Design in Flood Affected Area

Reference shall be made to Council's Flood Risk Management Plans when carrying out design in areas that are or may be flood affected.

Filling of Flood Plains and Floodways is not permitted.

Flood Planning Levels (FPL), Flood Levels or Floor Levels with appropriate allowances for climate change (including sea level rise) is available on Council's website and can also be provided by Council following a Flood Level enquiry made through Council's Customer Services Section, Mann Street, Gosford (1300 463 954) or Hely Street, Wyong (1300 463 954).

Where no reliable information is held by Council and where Council's records indicate that the land has flood controls or if the land is likely to be flood affected, the determination of the flood extent must be supported by a flood study, supplied by the Service Provider and prepared by a qualified engineer experienced in flood modelling. This study shall be provided to Council for consideration.

All work carried out as part of this study shall comply with the following documents:

- The Institution of Engineers, Australia, *Australian Rainfall and Runoff, A Guide to Flood Estimation* latest edition.
- DTM/DEM LiDAR survey data, digital aerial photography and spatial modelling products: The supply of these products is to satisfy the specifications produced by the NSW Land and Property Management Authority (*LPMA Standard LiDAR Product Specifications (Including RCD105 Imagery)* Version 2.0, July 2010 copy available from ([Office of Environment and Heritage](#)) on request).

All flood model results shall be provided to Council in a format suitable for use with ESRI as specified within Council's *Spatial Data Standards* available on request from Council's Representative.

All model output data files shall be in a format compatible with WaterRide™ as detailed below:

- TUFLOW: *.2dm, *.h.dat (or *.d.dat) and *.v.dat or
 *.2dm, *.xmdf
- MIKE21: *.dfs2 or *.dfsu
- MIKE11: *.res11
- SOBEK: Time series ASCII grids: level and velocity. Static: terrain or
 SOBEK project folder
- DELFT3D: *.dat
- ASCII Grid: Time series ASCII grids: level and velocity (total or u/v direction).
 Static: terrain
- ANUGA: *.sww
- SELFE 2D: hgrid.gr3 and *_dahv.62
- InfoWorks: v6+ : CSV network export and CSV/Binary Results export
 v5 or earlier: CSV network export and CSV results export

CSV network export and 2D Tri GIS and Binary results export

3.15 Consideration of Coastal Hazard Areas

Reference shall be made to Council's Coastal Zone Management Plans when carrying out design in areas that are currently or may be in the future, affected by coastal hazards.

Coastal hazard information (including erosion, recession, slope instability and coastal inundation) with appropriate allowances for climate change (including sea level rise) can be provided by Council following a Coastal Hazard enquiry made through Council's Customer Services Section, Mann Street, Gosford (1300 463 954) or Hely Street, Wyong (1300 463 954).

Section 4 - Applications for Works Approval

4.1 General

A **Construction Certificate** must be obtained prior to commencement of any site establishment and construction works to which a Development Consent relates. The Construction Certificate normally relates to works only within the properties to which the Development Consent relates.

A **Civil Works Approval** must be obtained prior to commencement of any site establishment and construction works in relation to works where the approval of those works is required under the *Roads Act 1993* or the *Local Government Act 1993* or the *Water Management Act 2000*.

In addition to the preparation of engineering plans and specifications, the issuing of a Construction Certificate or Civil Works Approval may involve compliance with a range of matters which may include:

- Development Consent conditions.
- Integrated Development Approval requirements.
- Utility suppliers' information and requirements.
- Affected landowner requirements.

Applications to Council for Construction Certificates involving civil works and for Civil Works Approvals shall be made using the appropriate application forms which may be obtained from Council's Web Site (<http://www.centralcoast.nsw.gov.au/>). Application forms shall be accompanied by all documentation relevant to the application.

A Compliance Certificate for Complying Civil Works is only issued by Council where Council has been engaged to carry out compliance inspections as the Certifying Authority.

4.2 Consultation with Council

It is recommended that the Service Provider and their Design Consultant meet with Council prior to commencement of the design process to gain an understanding of critical aspects of the Development Consent and the approval processes relevant to the design.

4.3 Development Consent

The Development Consent may require:

- Obtaining approvals from other authorities.
- Obtaining further approvals from Council regarding aspects of the development.

It is the responsibility of the Project Manager to make enquiries and meet any additional requirements to enable the detailing of drawings and preparation of specifications as required for such matters as:

- Integration of environmental and professional report information.
- Integrating requirements of other Council approvals.
- Location, protection or relocation of utility mains and Installations.
- Provision of utilities and street lighting.

- Approval body compliance.
- Affected private landowner agreement.

Council may require copies of appropriate documentation for any consent, licence, permit, permission or any form of authorisation prior to the issuing of a Construction Certificate or Civil Works Approval.

4.4 Preparation of Engineering Design Submission to Council

Plans and documentation which accompany an application for **Civil Development and Subdivision Works** shall be prepared in accordance with Council's *Civil Works Specification* and the Development Consent.

Design plans and documentation are also to serve as the reference plans for detailing other site activities or controls required by conditions of the Development Consent, for example, wildlife and heritage protection. Where supplementary plans, documentation or studies are required to appropriately detail other site activities or controls, notes shall be included on the appropriate design base plans referencing the supplementary requirements.

It is necessary that engineering plans for civil works incorporate all necessary details for all approved development activities. It may not be sufficient to reference environmental or other reports without incorporating relevant report recommendations into the design.

Please also refer to Appendix A - Preparation and Presentation of Design.

4.5 Submission of Preliminary Engineering Plans to Council

A preliminary set of plans and supporting information may be submitted for examination with a view to resolving technical issues. Subsequent submissions shall comprise of a full application for a Construction Certificate and/or Civil Works Approval, a Compliance Certificate or other required approval.

Fees will be applicable for preliminary reviews and resolving technical or other design related issues in accordance with Council's adopted fees and charges.

4.6 Other Approval Applications Required by Council

A range of applications to Council may be required where Council is responsible for approvals outside the *Environmental Planning and Assessment Act 1979* or where Council-controlled land is affected.

These approvals may include:

- Local Approvals under the *Local Government Act 1993*.
- Water and Sewer connections or adjustments.
- Section 306 Certificate of Compliance Notice of requirements (*Water Management Act 2000*).
- Application for Approval of Engineering Plans and Specifications for Water and Sewer works under Section 306(2) (b) the *Water Management Act 2000*.

- Applications for Approval under Sections including 74, 75, 115, 122, 138 and 139 of the *Roads Act 1993* to do work or control traffic on a Public Road.
- Works on Council-controlled land.
- Approvals under Section 51 of the Road Transport (Safety and Traffic Management) Act 1999.

The requirement to make these applications will usually be contained in the Development Consent conditions. However, the requirement for these applications may not be evident until assessment of Civil Works designs or the commencement of construction.

4.7 Other Issues relating to Development Consent

Applicants are responsible for giving adequate lead time for consideration of an application by Council and any other Authority where applicable.

Construction works cannot commence until a Construction Certificate and/or a Civil Works Approval is issued and any other required approval has been obtained.

Further approval will be required to commence works within a public road reserve following the issue of a Civil Works Approval. Refer to Council's *Civil Works Specification - Construction Specification*.

It must be noted that legislation stipulates that a Construction Certificate has no effect and may not be issued retrospectively for works already carried out.

4.8 Application to Modify Works Approval

An application may be made for modification of a Construction Certificate as permitted by Regulation 148 of the *Environmental Planning and Assessment Regulation 2000*.

This application may be made by the applicant for the original Construction Certificate or a person having the benefit of the Construction Certificate.

An application may also be made for modification of a Civil Works Approval.

4.9 Works Undertaken by Council

Generally, road and drainage upgrade works undertaken by Council or its Contractors in road and drainage reserves do not require Development Consent under Part 4 of the *Environmental Planning and Assessment Act 1979*.

An environmental assessment shall be prepared by the Service Provider or Council's Representative for proposed upgrade works under Part 5 of the *Environmental Planning and Assessment Act 1979*, in accordance with Council's Environmental Management System, taking into consideration the provisions of the *State Environmental Planning Policy (Infrastructure) 2007* and other applicable internal environmental, waste and stockpile management guidelines. The environmental assessment shall be approved by a delegated officer, prior to commencement of construction works.

Section 5 - Site Earthworks Design

5.1 General

Provisions of Council's *Civil Works Specification - Construction Specification* and other Council references apply to subdivision development site works involving earthworks or earthen structures as well as other development related works on land under Council's control.

Requirements from any management plans related to the development approval or required by the development approval conditions shall be incorporated in the design of earthworks.

The Developer is to ensure that necessary environmental licences pertaining to site earthworks are obtained and their requirements are incorporated in the engineering design and any supplementary Specification.

The Designer shall consider as a minimum those factors that may affect the earthworks listed in Section 2 of AS 3798 *Guidelines on earthworks for commercial and residential developments*, for all types of development.

A Geotechnical Consultant shall be engaged by the Developer to carry out site investigation and provide site specific recommendations regarding earthworks design and construction.

5.2 Expansive and Reactive Soils

The retention and use of expansive and reactive soils shall be in accordance with the recommendations of a Geotechnical Engineer's report obtained in respect of the impact of any reactive soils on the following:

- Design of road pavements.
- Design of public infrastructure.
- Behaviour in conjunction with the operation of Water Sensitive Urban Design systems.
- Suitability for building foundations.
- Design of thrust restraint.

5.3 Urban Salinity

The Designer shall seek specialist advice regarding designing for urban salinity where it has been identified as an issue during the development assessment process or where the site investigation by the Geotechnical Consultant identifies urban salinity as an issue.

The Designer shall provide measures and specifications to:

- Prevent any impacts of salinity on proposed infrastructure.
- Mitigate the impacts of salinity on proposed private land.
- Prevent any immediate or progressive increase in severity or coverage of areas affected by salinity.

5.4 Minimisation of Soil Surplus

The Designer shall endeavour to minimise the amount of surplus material that will be required to be removed from the site. Factors that must be considered in relation to surplus material include the cost to remove and dispose of material to an approved waste facility, classification of the material and reuse of the material at an alternative approved site if allowed by the materials waste classification.

5.5 Site Regrading

Site regrading may only be carried out as identified in the Development Consent.

The Designer shall consider the following points as part of the design:

- Any requirements arising from the Development Consent conditions in particular a Stormwater Management Plan and a Vegetation Management or Tree Protection Plan.
- Cut and filled areas are generally to be shaped and graded at a minimum of 1% to avoid surface ponds and facilitate drainage.
- The fall of the regraded surface shall direct surface flow to generally retain existing runoff conditions beyond the regrade area other than where being collected and conveyed by a designed drainage system such as a roadway. Surface runoff from regrade areas is not to be directed into existing interallotment drainage systems. Provision shall be made along the toe of the fill batters or base of retaining walls within or adjacent to regrade areas to permit the free passage of stormwater and subsurface water away from adjoining properties.
- Regrading or retaining works at property boundaries are not to cause surface ponding or the reduction in stormwater disbursement from adjoining properties or impact on the amenity of such properties. Catch drains, sub-surface drains and/or interallotment drainage shall be provided to adequately drain such areas. The drainage system shall be designed and have a capacity to ensure that there is no risk to persons, inundation of habitable property or potential for drainage nuisance due to flooding.
- Where slopes exceed four horizontal to one vertical (4:1), geotechnical advice shall be obtained in respect of groundwater flows and slope stability issues in areas affected by regrading.
- The design of works within areas affected by regrading must consider the proposed finished surface levels in addition to the existing surface levels. (Refer to Appendix A - Preparation and Presentation of Design).

5.6 Retaining Walls and Batters

The location of retaining walls or batters will depend on the following:

- Type and design of the wall or batter including surface and subsurface drainage and backfill material.
- Foundation requirements.
- Construction method with provision for support throughout construction activities.
- Locations of existing and proposed services including interallotment drainage and sewers.
- Locations of existing and proposed drainage secondary flow paths.

- Measures and works designs required for the protection and support of services throughout construction activities and in a permanent manner.
- Any structures on the properties adjacent to a proposed excavation.
- Vegetation to be retained.
- Permit to Enter or impacts on adjoining land or structures.
- Impact on existing drainage overland flow paths.
- Achieving the required sight distance where retaining wall is located adjacent to a road.
- Location of existing or proposed water or sewer mains.

Where practicable, avoid placing public utility services in fill zones, particularly existing or proposed water and sewer mains. Best practise is to install these mains in virgin cut material rather than within a constructed fill embankment due to the increased risk of water ingress and subsequent slip failure.

All retaining walls and batters must be consistent in height and extent as approved in the Development Consent. Road batters shall be blended into adjacent proposed lots where possible.

Retaining walls, including the footings, footing support and batters, other than road batters, shall be wholly located within the lot required to provide support (Note: The common law duty of care for negligence regarding support for land is contained in Section 177 of the *Conveyancing Act 1919*).

The Service Provider shall arrange for the retaining wall to be designed and certified by a Qualified Civil or Structural Engineer who is registered on the National Engineers Register (NER) using recommendations made by a Geotechnical Engineer. The design shall, as a minimum design standard, be carried out in accordance with AS 4678 *Earth-retaining structures* and Section 8 - Design of Structures of this *Design Guideline*. The absolute minimum design life shall be 60 years. Where access to the proposed retaining wall will not be practicable in the future for its reconstruction or replacement, or the wall is for a road formation, the design life must be increased to 100 years.

The design of batters shall be carried out using recommendations made by a Geotechnical Engineer who shall also identify any constraints on the use of adjoining areas of land and any ongoing maintenance requirements for batters. Batters shall not impose or create onerous constraints and maintenance requirements or result in unreasonable construction or maintenance costs.

The desirable gradient to batters within lots shall be 6:1, with a maximum design gradient of 4:1 except where written advice is provided by a qualified Geotechnical Engineer, which supports steeper batters.

5.7 Acoustic or Landscaped Mounds

Acoustic or landscaped mounds shall be provided in accordance with the approved drawings and/or engineering report.

Attention shall be given to provision for surface drainage flows around mounds in particular the consequences of concentration and diversion of runoff. The final grade of the acoustic or landscaped mounds shall take into consideration the need for workers to safely undertake maintenance activities. A grade of 5:1 is generally considered acceptable for worker safety.

5.8 Site Classification in Accordance with AS 2870

Preliminary residential lot "Site Classifications" in accordance with AS 2870 *Residential slabs and footings* based on anticipated site conditions shall be provided as part of the Geotechnical Engineer's site investigation report. This report shall be provided as supporting information for the earthworks design.

Final residential lot "Site Classifications" in accordance with AS 2870 *Residential slabs and footings*, which may be used for footing design purposes, shall be provided to Council prior to the issue of a Subdivision Certificate.

The lot "Site Classification" report (preliminary and final) shall be prepared by a Qualified Practising Geotechnical Engineer.

5.9 Effects on Utility Services

The Designer is to identify all services that are impacted by proposed earthworks. Refer to Section 13 - Utility Services Design and Installation of this *Design Guideline*.

Section 6 - Design Requirements for Roads Civil Works

6.1 General

Detailed Design Drawings and documentation shall describe the extent of works specified in the Development Consent, contract or project plan.

The Designer is to assume that the works will include but not be limited to signs, pavement marking, street lighting, safety barriers, utilities adjustments, transitions and tie-ins to existing structurally sound road pavements, stormwater drainage, concrete footpaths, shared paths, cycleways and remedial works or reconstruction or relocation of adjacent infrastructure necessary for the safe operation and use of the new works.

Design submissions shall be accompanied by a Design Report which addresses road design issues including provisions for safety, geometric constraints, stormwater drainage, public utilities, whole asset life consideration and justification for the design parameters adopted.

All designs must be in accordance with Austroads publications, Australian/New Zealand Standards, TfNSW Supplements and this *Design Guideline*. Deviations from any standards shall be expressly stated in the Design Report. For classified roads, refer to 3.10 Classified Roads and Applicable Standards.

The design of stormwater drainage and floodways relating to road design shall be in accordance with Section 10 - Stormwater Drainage Design of this *Design Guideline*.

6.2 Design Requirements for Roads

6.2.1 Road Carriageway and Verge Widths

Road carriageway and verge widths for new roads shall be in accordance with Table 6.1 Road Hierarchy and Road Width Schedule.

Consideration needs to be given to future proposals and matters such as:

- Current annual daily traffic (ADT) volume and type of use.
- Proposed road works or traffic management schemes.
- Proposed zoning changes or developments.
- Alignment and condition of constructed road pavement, kerb, etc.
- Drainage (location and adequacy) and topography (for access and verges).
- On-street car parking requirements.
- Standard of geometric design.
- Location of existing and proposed services and street trees.
- Requirements of TfNSW on Classified Roads.

Table 6.1 Road Hierarchy and Road Width Schedule

Road Type	Indicative Operating Speed (km/h) ²	Indicative Heavy Vehicles (%)	Indicative Number of Dwellings	Indicative Two-way ADT Volume	Minimum Width (m)			Maximum Longitudinal Gradient (%) ⁵	Minimum Path Type Width ⁶	Kerb Type	Minimum Design ESAs ⁷
					Road Reserve	Carriageway ³	Verge ⁴				
Lane	20	3	20	200	15	6	4.5 x 2	15	-	Edge restraint/ Roll top	6 x 10 ⁴
Access Road	30	3	50	450	17	8	4.5 x 2	15	1.5m wide (one side)	Barrier/Roll top	5 x 10 ⁵
Local Road	50	4 6	200	150 - 450 450 - 3,000	19 20	10 11 (bus route)	4.5 x 2	15	1.5m wide (one side)	Barrier Type SA	2 x 10 ⁶ 8 x 10 ⁶
Collector/ Distributor Road	50	7	200 - 400+	3,000 - 6,000+	20 21	11 (bus route) 12 (bus route)	4.5 x 2	15	1.5m wide (both sides)	Barrier Type SA	8 x 10 ⁶
Industrial Areas	50	15	-	TBD	22 23	13 14	4.5 x 2	10	1.5m wide (both sides)	Barrier Type SA	≥ 1 x 10 ⁷
Rural Road ⁸	50+	3	-	TBD	16	8	4.0 x 2	15	-	Dish gutter/ Roll top	6 x 10 ⁵

Notes:

1. **Location specific DCP** requirements take precedence over the values stated in the above table.
2. **Indicative operating speeds** are to assist in encouraging designs that influence lower speeds in line with safe system principles.
3. **Carriageway widths** for each road type shall be based on the applicable road function and traffic volume in achieving the required road hierarchy. Urban road centre and edge line markings shall only be installed on roads ≥11m wide, unless specifically required. Traffic lane widths on higher volume collector/distributor roads (say ADT >6,000), which are bus routes, shall be 3.5m min, resulting in greater road reserve widths. Both bus service and school bus routes shall be defined as bus routes for road design, pavement design and road width requirements.
4. **Verge widths** must be widened to accommodate shared paths and the widening shall be the difference in width between the shared path and a standard 1.5m wide footpath.
5. **Road grades** should be arranged and designed to achieve mobility requirements, where practicable.
6. **Shared path(s)** minimum 2.5m wide may be required on all the above road types.
7. **Design ESAs** for pavement designs shall be determined from traffic study volumes for the subject road based on a 40-year design life.
8. **Rural road operating speed, road width and geometric design** shall be based on Austroads Guide to Road Design, TfNSW Supplements and Rural Fire Service requirements.

6.2.2 Road Design Speed

6.2.2.1 Road Design Speeds and Gradients for New Roads

Road design speeds and gradients for new roads shall be in accordance with relevant parts of the Austroads publications, TfNSW Supplements and the indicative operating speed, as applicable in the Road Hierarchy and Road Width Schedule provided in Table 6.1 above unless otherwise approved by Council's Representative.

6.2.2.2 Road Design and Operating Speeds for Existing Roads

Design and operating speeds shall be determined by recent traffic count data or in accordance with relevant parts of the Austroads publications, TfNSW Supplements and indicative operating speeds, as applicable in Table 6.1 Road Hierarchy and Road Width Schedule unless otherwise approved by Council's Representative.

Where there is no recent traffic speed data, an operating speed of 10km/h higher than the posted speed limit should be adopted, which represents the typical desired speed of motorists unconstrained by geometric elements or other traffic unless otherwise approved by Council's Representative.

6.2.3 Geometric Design

6.2.3.1 Geometric Design Urban Roads

Geometric design of urban roads shall be determined in accordance with Australian Standards, Austroads publications and TfNSW Supplements.

The following general Design Controls shall also be applied in the geometric design of urban roads. However, there will be situations where alternative controls may be more desirable, and these shall be discussed with Council's Representative prior to their adoption.

General Design Controls shall include, but are not limited to the following:

- Desirably, roads should be crowned in the centre of the carriageway with the control line in the middle of the road reserve.
- Standard 3% crossfall shall apply to straight roads. Where the longitudinal gradient is less than 1% for longer than 100m, on steep road gradients and where the crossfall/superelevation is 3%, consideration should be given to increasing the crossfall/superelevation to 4% to assist surface drainage runoff (provided there is no superelevation transition involved).
- Use of superelevation, including transition curves and widening on urban and rural roads shall be in accordance with Austroads *Guide to Road Design Part 3: Geometric Design* unless otherwise approved by Council's Representative.
- Vertical curves in built up areas shall be designed for a minimum stopping sight distance for the nominated design speed.
- Where changes of longitudinal grade less than 1% occur, vertical curve lengths are not required.
- Sag vertical curves in built up areas shall be of a length to provide adequate riding comfort for the design speed.

- Sight distance calculation using a driver reaction time of 1.5s for design speeds $\leq 90\text{km/h}$ in accordance with TfNSW *Supplement to Austroads Guide to Road Design Part 3* unless otherwise approved by Council's Representative.
- Appropriate design vehicle(s) as indicated in Austroads *Design Vehicles and Turning Path Templates* and/or as approved by Council's Representative for each specific design element, including intersections, cul-de-sacs, vehicle access crossings, car parks, traffic calming devices and vertical clearance envelopes. Preferred practice is to use appropriate vehicle tracking software to perform vehicle swept path analyses.
- Cross sections shall be designed at a maximum of 1m intervals to enable the creation of an accurate design model unless otherwise approved by Council's Representative.
- Road design chainages and set out co-ordinates shall be provided for all control lines at a maximum of 15m intervals on straights and 10m intervals on curves, all changes in directions and curve tangent points.
- Impact on existing or future flood risk. Refer to 7.1.3 Roads within Floodways.

6.2.3.2 Geometric Design Rural Roads

Rural roads shall be designed in accordance with Australian Standards, Austroads publications and TfNSW Supplements.

6.2.3.3 Roads in Bushfire Prone Areas

In Bushfire Prone Areas, the requirements of the current NSW Rural Fire Services publication, *Planning for Bush Fire Protection, A Guide for Councils, Planners, Fire Authorities and Developers* shall be met in addition to any requirements for private and public roads, driveways and accesses applying from this Manual.

6.2.4 Intersection Design

Intersections shall be designed in accordance with Australian Standards, Austroads publications and TfNSW Supplements.

The appropriate sight distance must be provided on all legs on intersections in accordance with Austroads *Guide to Road Design Part 3: Geometric Design and Part 4A: Unsignalised and Signalised Intersections*.

Non-channelised intersections such as T-intersections or crossroads shall be detailed by cross sections at a maximum 10m interval and kerb return profiles on each leg of the intersection.

The desirable kerb return radius is 8m for urban residential areas and 10m for industrial areas measured from the face of kerb.

Channelised or signalised intersections shall be detailed on each leg by cross sections at 10m intervals. Traffic islands, kerb lines and medians within at least 40m of the intersection point shall be detailed by co-ordinates and design level at a maximum spacing of 5m in addition to the other geometric set out points such as tangent points and centre of circles.

At roundabouts the approach roads shall be defined by cross sections at 10m intervals up to as close as practical to the intersection. Within 50m or any additional distance necessary to accurately set out any curves in the various kerb lines, the intersection geometry shall be defined by co-ordinates and design level at a maximum spacing of 5m in addition to other geometric set out points such as:

- At all tangent points.
- For all centres of curves.
- At all drainage pits.
- At all kerb angle points.

The co-ordinates provided shall relate to appropriate control line positions and be clearly defined on the design plan. Co-ordinate values shall be expressed to 3 decimal places with reduced levels rounded off to the nearest 5mm.

Contour plans are to be provided (contoured at 100mm) to cover the whole project pavement area to confirm the road crossfall and drainage patterns. Critical areas where flat gradients (<1%), long flow paths or where surface flow could have safety implications, such as at intersections and associated pavement areas, superelevation transition areas, etc must be provided at a 1:500 scale.

Both concept and final design plans shall include a design surface contour plan, as detailed above.

6.2.4.1 Intersection Design Minor Intersections

In addition to the general intersection design requirements minor intersections shall adequately cater for the turning paths of the appropriate design and checking vehicle. The design and checking vehicle for each intersection must be determined and used in accordance with Austroads *Design Vehicles and Turning Path Templates Guide*. Desirable minimum kerb return radii will be 8m for Urban Residential areas and 10m for Industrial areas.

6.2.4.2 Intersection Design Classified Roads

Intersections or any traffic management proposals on or with Classified Roads shall be designed and constructed in accordance with TfNSW requirements. TfNSW review and consent is mandatory for Classified Roads in respect to the creation of any new intersection, the layout of any new or upgraded intersection, the geometric design, drainage design, pavement design and/or construction matters.

6.2.4.3 Traffic Signal Design

Traffic signals on any road require the approval of TfNSW must be designed in accordance with TfNSW publication 08.092 *Traffic Signal Guideline* and the applicable Austroads Guides and Australian Standards and any applicable TfNSW Supplements to these guidelines and standards.

6.2.5 Roundabout Design

Roundabouts shall be designed in accordance with Australian Standards, Austroads publications and TfNSW Supplements.

Design criteria shall include, but are not limited to the following:

- Appropriate sight distance for vehicles, pedestrians and cyclists approaching and entering the roundabout. This includes adequate sight distance for pedestrians and cyclists entering the roundabout at design road crossing points from adjoining paths.
- Provisions for the future needs of Service Authorities.
- Adequate drainage.
- Site specific designed street lighting.
- Signposting and pavement markings.
- Safe provision for pedestrians and cyclists.

The provision of safety barriers at roundabouts is not favoured. The need for such barriers should be avoided through careful design. Where barriers must be provided, they shall be TfNSW approved safety barriers.

Minor roundabouts for use as traffic calming devices in local roads must have signs and markings in accordance with AS 1742 *Manual of uniform traffic control devices* and the associated TfNSW Supplements. Preliminary geometric designs, design speed, design vehicle and the proposed formation of roundabout traffic islands shall be discussed with Council's Representative during the concept design stage.

Design vehicle turning paths shall be used to confirm that traffic within the roundabout will travel in compliance with the *Australian Road Rules*. Council's Representative will advise of the design vehicle for each individual site, based on the road hierarchy, land-use zone and Austroads *Design Vehicles and Turning Path Templates Guide*.

The provision of landscaping, when required, shall be designed so as not present any risk to the safe use of the roundabout. The design of landscaping needs to consider such matters as; the creation of hazards to errant vehicles, the loss of sight distance for vehicles and pedestrians throughout the growth cycle of any vegetation, interference to traffic and signs for maintenance, interference with street lighting and any requirement for abnormal road vehicle passage.

Measures shall be installed to protect the road pavement and other infrastructure from landscaping-related effects such as hard surface runoff, excess irrigation water, tree roots, or soft edges. Raised hard landscaping is not to be provided other than in the middle areas of large roundabouts and then by approved design. Council's Representative will advise whether it is appropriate to incorporate raised hard landscaping or other features within a roundabout.

6.2.6 Turning Facilities

6.2.6.1 Cul-de-sacs

Generally, permanent cul-de-sacs and turning heads are not supported by Council and through road networks are preferred. When permitted by the approved development plans, cul-de-sac layout criteria are as follows:

- Urban Residential - minimum 8.5m radius to face of kerb. Entry and exit radii as required for the design vehicle turning path but a minimum of 15m will be required.
- Rural Residential - minimum 8.5m radius to lip of dish gutter. Entry and exit radii as required for the design vehicle turning path but a minimum of 15m will be required.
- Industrial - minimum 16m radius to face of kerb. Entry and exit radii as required for the design vehicle turning path but a minimum of 15m will be required and adequate clearance for overhang.
- The following grades and crossfalls shall apply to cul-de-sacs:
 - Minimum 1%.
 - Maximum 6%.
 - Maximum vector sum grade of 6%.
- Parking facilities where required, shall be provided outside the turning area.

6.2.6.2 Turning Heads

Variations of hammer head turning facilities will be permitted where circumstances warrant. Turning heads must adequately cater for design vehicle turning paths.

The following grades and crossfalls shall apply to all hammer head turning facilities:

- Minimum 1%
- Maximum 6% (vector sum)

Where parking facilities are required, they shall be provided outside of the minimum turning path overhang plus a 600mm clearance envelope. These parking facilities shall be designed as an integral part of the public road and streetscape without adversely impacting on footpaths, services installations, opportunities for access to properties, manoeuvring at property accesses, nuisance to and privacy of existing and future homes.

6.2.6.3 Staged Development

A turning head shall be provided when there is the likelihood of a delay in the construction of a further stage of a subdivision which creates dead end roads of longer than 50m in length; a turning facility shall be provided to accommodate appropriate design vehicles. The turning head pavement shall be the same as the road it serves. Turning heads shall adequately cater for design vehicle turning paths.

When a proposed road is identified as a bus route and shall be constructed in stages and the accumulated or initial length warrants a bus service, a temporary turning facility shall be provided in accordance with this Specification.

6.2.7 Half Road Construction

Development of land, dual occupancies, townhouses, units, subdivisions and large developments fronting existing roads which are not kerb and guttered but contain a sealed portion of the carriageway will be required to provide a design and to construct road pavement shoulders and associated works including:

- Road shoulder or half road pavement construction including sealing and asphalt surfacing.
- Subsurface drainage - if required by the pavement design or extension of existing subsurface drainage lines.
- Stormwater drainage within the roadway and verge including provision for house drainage outlets - where made essential by the works.
- Kerb and gutter including vehicle access crossings for the new development.
- Verge formation - shaping to design standard profiles.
- Footpath/shared path paving.
- Table drains, tail in and tail out drains.
- Transitions of the new works to existing conditions beyond the site frontage.
- Adjustments of utility poles, mains and installations affected by the works.
- Provision of any signs, pavement marking, or other traffic control devices affected by or required by the works.
- Adjustment of fencing or driveways for adjacent properties affected by transitions.
- Restoration of disturbed areas.
- Retaining walls and batters.

Design of such works shall detail the above listed elements as applicable and any other works conditioned or required as a result of the conditioned works.

The design shall detail the ultimate full carriageway formation for the subject length of road plus a minimum length of 30m length each side of the subject design. This is to show that the proposed design will adequately tie into the adjacent road formation. Where the design adjoins intersection or roundabouts, details must be provided how the design/construction ties into the intersection or roundabout.

6.2.8 Shoulder Construction

Shoulder crossfalls must not be less than the existing adjoining pavement. The design edge of bitumen or lip of channel level should have a 3% crossfall from the ultimate design centre line levels as determined in the design. Crossfalls of the new pavement shoulders in the range of 2% to 6% may be acceptable provided the ultimate half road crossfall of 3% is achievable in the future.

The condition of the existing carriageway pavement and the ability to tie the proposed design levels to the existing pavements with appropriate transition lengths as defined in Council's *Civil Works Specification - Standard Drawings* will determine the extent of new pavement construction and/or reconstruction associated with the shoulder construction.

The cost of the relocation of utility services can be substantial. Where this becomes evident the designer shall discuss preliminary design issues and utility costs with Council's Representative.

6.2.9 Upgrading Rural Public Roads

Rural public roads shall be designed in accordance with Austroads publications and TfNSW Supplements.

Where the upgrading of a rural road is required, Council's Representative may advise on matters such as, but not limited to the following:

- Required road cross section.
- Required surfacing and pavement type and required pavement design.
- Design traffic loadings.
- Design Annual Exceedance Probability for flooding events for longitudinal and cross drainage.
- Table drain treatments and outlets.
- Effects on farm dams.
- Applicability of street lighting.
- Need to comply with NSWRFPS *Planning for Bush Fire Protection Guide*.

6.2.10 Extension of and Connections to Existing Roads

Where new works are required which extend or connect with an existing road, the Design Drawings shall detail connect 60m past the scope of works to detail connections.

Transitions shall be designed to safely and efficiently merge the new Works with existing road pavements, road shoulders, table drains, path width and shape, existing vehicle access crossings, driveways, traffic control devices and other features in the road reserve.

Transition designs must not create roadside hazards such as utility poles, vehicle access crossings, driveways, deep edge drains, steep path paving at the start and end of works. The design must address any identified hazards and be included in the scope of works.

6.2.11 Local Area Traffic Management (LATM)

Local Area Traffic Management (LATM) devices are required to reduce travel speeds to achieve nominated operating speeds. This is generally required where road geometry cannot satisfy the existing posted speed requirement. LATM devices may also be required by a Development Control Plan, Development Consent or LATM Plan.

LATM device design and spacing must be part of an overall traffic calming scheme within the local precincts or Local Area Traffic Management Plan.

LATM devices must be designed in accordance with Austroads *Guide to Traffic Management Part 8: Local Area Traffic Management*, AS 1742.13 *Manual of uniform traffic control devices - Local area traffic management* and Council's *Civil Works Specification - Standard Drawings*.

6.2.12 Traffic Facilities

Traffic facilities must be designed in accordance with Austroads publications and TfNSW Supplements.

6.2.12.1 Traffic Control Devices

Traffic control devices may incorporate or include signs, pavement marking, delineators, guide posts, traffic signals and traffic islands.

Traffic control devices shall be detailed in accordance with applicable Austroads publications, Australian Standards and TfNSW Guides, Technical Directions and Supplements.

6.2.12.2 Signs, Pavement Markings and Delineators

Signs and pavement marking must be provided to roads, intersections, traffic facilities, cycleways, car parks and other road elements in accordance with the TfNSW *Delineation Guidelines*. Where not covered by the TfNSW guidelines, acceptable treatment must be determined from Australian Standards and Austroads publications or as agreed with Council's Representative.

Prior to installation, all regulatory signs, pavement markings and delineators shall be approved by the Local Area Traffic Committee.

The following specific requirements apply to new roads:

- Roads having carriageways in excess of 6m may have centre line marking for a minimum of 10m on approaches to intersections and on horizontal bends. Raised reflective pavement markers (RRPMs) shall be provided along the centre line of the curve and for 15m each side of the tangent point at 3m centres.
- Road carriageways \geq 11m wide may have centre line markings and edge lines with RRPMs, or another form of pavement marking unless otherwise approved by Council's Representative.
- Centre line and edge lines should be provided on all rural roads, subject to the requirements of the TfNSW *Delineation Guidelines*. Edge lines shall not be used unless a dividing line exists and the pavement is at least 6.8m wide.
- Centre line, outlines and edge lines where provided shall be supplemented by RRPMs.
- Pavement markings shall be installed in accordance with Council's *Civil Works Specification - Construction Specification* and the applicable *Standard Drawings* and TfNSW *QA Specification R141 Pavement Marking*.

6.2.12.3 Guideposts

Guideposts shall be provided in accordance with TfNSW requirements as a minimum. Provision of additional guide posts may be required considering local conditions such as the prevalence of fog, use of the road, driver behaviour, likely driver awareness and the adjoining sections of road. Guideposts shall be provided on all rural roads.

6.2.12.4 Street Name Signs

Street name blade location and type shall be of the standard type and must be approved by Council's Representative. Refer to Council's *Civil Works Specification - Construction Specification* Section 16 – Traffic Signs, Pavement Marking and Road Safety Barriers and Council's *Civil Works Specification - Standard Drawings* for details.

6.2.12.5 “No Through Road” signs

"No Through Road" signs shall be provided and placed in accordance with AS 1742 *Manual of uniform traffic control devices* and Council's *Civil Works Specification - Standard Drawings* and details as advised by Council's Representative. In the instance of staged road extensions, the sign shall be relocated or removed as appropriate to suit new works.

6.2.12.6 Safety Barriers

Safety barriers shall be provided in accordance with the TfNSW standards and Austroads warrants, guidelines and TfNSW Supplements and shall be shown on the Design Drawings. Only TfNSW-approved safety barriers shall be accepted for use on Council's roads.

Elimination of hazards in lieu of installing safety barriers shall be considered prior to detailing any requirement for a safety barrier.

Safety barrier selection type shall be given due consideration to vulnerable road users. The use of Elsholz kerb in local roads is discouraged and shall only be used with approval by Council's Representative. Where Elsholz kerb is installed adjacent to a path or footway, an appropriate pedestrian fence shall be erected to protect pedestrians from the vertical drop to the road pavement.

All details of the specified barrier type and any impacts resulting from the proposal shall be addressed in the design documentation, including post embedment/foundation or base plate fixing details. Delineation of safety barriers is required in accordance with the TfNSW standards.

A sealed shoulder shall be provided extending to the rear of the safety barrier post to minimise maintenance activities.

Rub rails or safety railings shall be provided to the rear of the safety barrier where there is an adjoining pedestrian or shared path system.

6.2.12.7 Bus Stops

The locations of bus stops shall be determined using State Transit's Bus Infrastructure Stop Installation Guide and in consultation with the relevant bus company and Transport NSW. Bus stops and associated infrastructure shall be designed in accordance with the Australian Human Rights Commission's *Guideline for promoting compliance of bus stops with the Disability Standards for Accessible Public Transport (DSAPT) 2002, Disability Discrimination Act 1992* and Council's *Civil Works Specification - Standard Drawings*, in consultation with Council's Representative.

Bus stop shelters shall be provided at bus stop locations as determined by Council's Representative.

6.2.13 Road Batters for Road Formations

Road batters in rural roads may be influenced by matters including (but not limited to) the following:

- Terrain (environmental damage, drainage, benches, earthworks construction cost, etc).
- Safety (geometric design, clear zones, traversable slopes, safety barriers, etc).
- Sight distance requirements (curve and intersection benching, accesses, etc).
- Ground conditions (soil and rock properties, subsurface water, slope stability, etc).

- Constraints (existing/planned road boundaries, structures or services).
- Surface stabilisation and maintenance considerations.
- Appearance (constant width batters, batter slope treatments, non-obtrusive, etc).
- Placement of appropriate ground cover and planting with native vegetation.

The Designer needs to ensure that relevant information is available and that the design addresses pertinent matters. This may involve the preparation of design options to gain an approval.

Batters within the clear zone, particularly those in cuttings with a jagged rocky face, shall be either protected from vehicular impact by a safety barrier or be treated to promote sliding when impacted by a vehicle.

Batters must be designed as stable slopes complying with the following slopes unless advised by a Qualified Certified Geotechnical or Civil Engineer (NER Registered) or requested by Council's Representative. A Structural Engineer's design is required for rock batters greater than 1.5m in height.

Earth

The following maximum batter slopes shall apply to facilitate maintenance of grassed batters in road reserves (all given as Horizontal to Vertical slopes):

Fill batter:	Desirable maximum:	6:1
	Absolute maximum:	4:1
	Rural road design:	2:1 batters may be considered where adequate bank stabilisation is provided.
Cut batter:	Desirable maximum:	4:1
	Absolute maximum:	1.5:1 may be considered where landscaped bank stabilisation is provided.

Rock

Rock batters are not permitted between 0.75:1 and 1.5:1 without the investigations, risk assessment and recommendations of a Qualified Certified Geotechnical or Civil Engineer (NER Registered). The following maximum batter slopes shall apply:

Fill batter:	Faced with large angular rock:	Maximum 1.5:1
Cut batter:	Solid rock with few clay bands:	Maximum 0.25:1
	Less stable rock:	Maximum 0.5:1

Where only short lengths of rock cuttings are encountered (30m or less) the rock cut batters must match any adjacent earth cut batters to improve aesthetics.

For shallow batters (up to 1m in height) it is preferred practice to flatten batters as much as possible for improved appearance.

When a retaining wall is necessary the Service Provider must provide full engineering details of the proposed structure, including elevation(s) and typical cross section(s).

Batters shall be designed to provide adequate stability for existing physical features and improvements on the verge where practicable to avoid the need for relocations or adjustments.

Batters within new subdivisions or developments shall commence at the property boundary and intersect the natural surface prior to proposed building alignments. An easement for support shall be provided where fill batters steeper than four horizontal to one vertical (4:1) encroach on private land.

Lot access batters shall provide adequate sight distance in accordance with the design speed. This may require widening of level area behind the kerb to achieve the required sight distance.

Further guidance on the suitability of various batter surface stabilisation techniques can be found in the TfNSW publication *Guideline for Batter Surface Stabilisation using vegetation*.

6.2.14 Batters Outside Road Formation

Road batters shall extend for as little distance as possible into proposed urban lots, such as to allow free surface runoff and vehicle access gradients to the building line. Minor smoothing out of the batter alignment at top and toe is permitted.

Consideration shall be given to future vehicle access grades particularly where cut/fill building platforms will be utilised.

Permanent cut or fill batter slopes shall nominally comply with six horizontal to one vertical (6:1) maximum slope except when allowed under the following circumstances. An increased localised slope of four horizontal to one vertical (4:1) maximum slope may be considered where:

- The batter when stabilised can be reasonably maintained; **and**
- Due to the terrain, road batters would extend significantly beyond the lot building line over a number of consecutive lots; **or**
- Flatter batters would result in the destruction of important stands of trees or individual tree specimens; **or**
- Particular environmental or land stability issues are significantly adversely impacted by flatter batters; **or**
- The batter impacts significantly on utility mains.

An increased localised slope of two horizontal to one vertical (2:1) maximum slope may be considered where:

- A Geotechnical Engineer's report is provided containing relevant, investigations, site assessment and recommendation; **and**
- The batter is within proposed private property, does not obstruct access onto any lot and when stabilised can be reasonably maintained.

In rock cuttings, faces steeper than two horizontal to one vertical (2:1), up to 0.25:1 may be permitted only where:

- Particular environmental, land stability or unreasonable construction cost issues are impacted by the alternative use of flatter batters; **and**
- Geotechnical Engineer's report is provided for consideration which identifies an expected long-term stability, low potential for weathering and lack of any need for routine maintenance; **and**

- Upon completion of the cutting a Geotechnical Engineer's report is provided which confirms the expectations of the pre-construction report or provides alternatives supporting the as-constructed works for approval by Council's Representative.

In any instance the method of stabilising fill batters greater than six horizontal to one vertical (6:1) shall be endorsed by the Geotechnical Engineering Consultant both at the design stage by way of design recommendations and following construction.

6.2.15 Retaining Walls for Road Formations

As a minimum standard, retaining wall designs shall be carried out in accordance with AS 4678 *Earth-retaining structures* and Section 8 - Design of Structures of this *Design Guideline*.

Retaining walls to support public road formations may be permitted only where:

- Particular environmental, land stability or land use issues are significantly adversely impacted by the alternative use of batters; **and**
- Proposed construction materials of the retaining wall are durable natural stone, masonry units or some other masonry components associated with an engineered retaining system; **and**
- Retaining walls are designed to accommodate loadings from road plant used to construct and maintain works within the road reserve; **and**
- Retaining walls are designed to accommodate loadings and excavations by plant used in the installation and maintenance of utility mains and installations; **and**
- Retaining walls are constructed in a form which does not require routine maintenance; **and**
- Retaining walls are constructed wholly within the road reserve; **or**
- Where the retaining wall(s) is located within any lot, an easement for support, drainage and maintenance shall be created in favour of Council over the retaining wall(s) and include a minimum 2.5m wide maintenance area.

Retaining walls to support land above a public road reserve may be permitted only where:

- Particular environmental, land stability or land use issues are significantly adversely impacted by the alternative use of batters; **and**
- Proposed materials for construction of the retaining wall are durable natural stone, masonry units or some other masonry components associated with an engineered retaining system; **and**
- Retaining walls are designed to accommodate loadings from plant used to perform construction works for the subdivision or lot development; **and**
- Retaining walls are set back at least 300mm into lots from the road boundaries and are designed to be stable in the event of excavation of adjacent utility services to the depth of the original or proposed respective utility services' trench; **and**
- Extent of the retaining wall shall not unreasonably restrict the future use of a lot; **and**
- Retaining walls are contained wholly within the private land which it supports or within an easement over other private land which allows for the existence, maintenance and rebuilding of the wall; **and**
- All surface or subsurface drainage systems associated with the retaining wall are piped to an approved drainage system.

In any instance, the following shall apply:

- All retaining walls must be certified by a Qualified Certified Structural or Civil Engineer (NER Registered) and shall be fit for purpose.
- Council Representative's approval must be provided.
- Any batter or retaining wall at an intersection or defined point of access shall be of an alignment and profile which provides adequate sight distance for passing and entering vehicles, pedestrians and cycle traffic; **and**
- Extent of any batter or retaining wall fronting a lot, including frontages of public land, shall not obstruct access onto that lot or land.
- Minimum design life for retaining walls associated with road formations shall be 100 years.
- Finished appearance and any applicable heritage considerations shall be integral to the selection of the type of retaining wall.
- Construction and maintenance costs and constructability shall be integral to the selection of the type of retaining wall during the design process.

Section 7 - Design of Pavements

7.1 General

This Section outlines the minimum requirements for geotechnical investigations and the design of pavements for:

- Public roads (existing and proposed including minor works).
- Footpaths.
- Shared paths.
- Driveways and accesses.
- Public and private car parks.

7.1.1 Preparation and Council Acceptance of Reports

A Pavement Design Report covering all proposed pavements shall be prepared by a Qualified Certified Geotechnical or Civil Engineer (NER Registered) and submitted to Council for review. The report shall be accepted by Council prior to applying the report's recommendations to any works.

Pavement Investigation and Design shall be addressed with reference to current Austroads *Guide to Pavement Technology - Set*, other Austroads pavement design related publications and the relevant TfNSW Supplement(s) unless otherwise required in this *Design Guideline* or circumstances warrant otherwise, as agreed with Council's Representative.

7.1.2 Small Pavement Projects

For small pavement projects, up to 40m long and 3m wide and pavement restorations where Council's Standard Pavement designs apply, the requirement of a Pavement Design Report may be removed at the discretion of Council's Representative. Refer to Council's *Civil Works Specification - Construction Specification* Section 9.2.1 Flexible Pavement for Road Shoulder, Half Road and Kerb and Gutter.

7.1.3 Roads within Floodways

Roads within floodways that are designed to be inundated more than once every 20 years, or as a result of Sea Level Rise and roads over lands which are subject to inundation or saturation shall be designed to suit the specific site conditions. Poor subgrade material with the potential for subsidence shall be reviewed for the need to preload the site before placement of the design pavement. The Geotechnical assessment of the subgrade and pavement design is to be approved by Council's Representative.

7.1.4 Pavements for Private Ownership

Other than battle-axe driveways for subdivisions and vehicle access crossings (VACs) the information contained in this Section in relation to private accesses and car parking is for guidance only unless otherwise specified in a Development Consent.

Service Providers must be aware of requirements of the Building Code of Australia, any applicable Australian Standards, documents referred to in Development Approvals and product information

when specifying such matters as vehicle access crossings, driveways, parking areas and pathway pavement surface materials or surface finishes which will not become Council's assets.

7.1.5 Pavement Design Life

The minimum design life of new and upgraded public road pavements shall be 40 years unless otherwise specified in the conditions of Development Consent.

7.2 Pavement Design Report

The Pavement Design Report shall address the following matters as a minimum:

- Projected traffic loadings and vehicle impacts.
- Subgrade and underlying material evaluation including test results from a NATA Registered Laboratory.
- Expansive soils and moisture control.
- Subgrade and pavement subsurface drainage design details.
- Environmental factors found and considered.
- Consideration of consequences of other development works.
- Materials requirements if not in accordance with or specified in Council's *Civil Works Specification - Construction Specification*.
- Proposed use and suitability of recycled pavement and/or subsurface materials.
- Construction methods and issues.
- Pavement layer thickness design.
- Wearing surface details.
- All clarifications for the supply, placement and saw cutting requirements for heavily bound pavements shall be contained in the approved Pavement Design Report.

Other geotechnical matters pertinent to the works may be included in the Pavement Design Report or presented in separate reports. These matters may include but are not limited to:

- Topsoil stripping requirements.
- Slope stability.
- Rock strength and hardness.
- Suitability of materials for fill formations.
- Potential for subsidence.
- Identification of unsuitable materials.
- Groundwater issues, cut batters, fill formations (capillary action), fill batters, slope stability and drainage run-on.
- Foundation design criteria for structures.
- Construction vibration damage risk.
- Retaining wall design criteria.
- Actual and Potential Acid Sulphate Soil (ASS) sampling testing and management plan.
- Virgin Excavated Natural Material (VENM) sampling testing and management plan.
- Excavated Natural Material (ENM) sampling testing and management plan.
- Testing for salinity.
- Recommendations concerning road levels and treatments in relation to ground conditions arising from presence of hard rock, unsuitable ground and potential instability.

7.3 Design Traffic Loading

Pavement designs for all proposed public roads shall be based on the road types as defined in Table 6.1 Road Hierarchy and Road Width Schedule for a 40-year design life.

The design traffic loadings will be as nominated, in conditions of the Development Consent or by Council's Representative. Any submission to vary traffic loadings shall include full calculations.

Design of rigid pavements must be based on the ESAs and must be converted to the appropriate measurement using the methodology detailed in Austroads *Guide to Pavement Technology*.

7.4 Evaluation of Subgrade

Investigation by a qualified practicing Geotechnical Engineer and soils testing through a NATA registered laboratory will be required. Testing and test samples shall be undertaken at the approximate design subgrade level.

The design of rigid pavements requires the determination of an Equivalent Design CBR. This calculation considers subgrade material properties to a depth of 1m. See Austroads *Pavement Guide to Pavement Technology - Set* and the relevant TfNSW Supplement(s).

Investigation of materials below subgrade level is also necessary to assess subsurface moisture and to expose any weak layers below the subgrade. Test pitting, recording of bore logs and materials sampling shall be carried out to include materials to a minimum depth of 1m below design subgrade or to the next material layer change where ground is found to be soft or loose. Subgrade conditions including CBRs and depths to rock shall be confirmed by a practicing Geotechnical Engineer.

In deep cuttings, deep fills or other instances where testing of subgrade is possible only after bulk earthworks, pavement designs may be assumed for the purpose of submitting the Pavement Design Report for approval. In areas where pavement designs have been assumed, pavement investigations, sampling and testing shall be carried out in full upon excavations reaching subgrade level and then a Pavement Design Report shall be prepared and submitted for acceptance by Council's Representative.

7.4.1 Determination of Design Subgrade CBR

Sampling for laboratory CBR testing is to involve the following:

- Minimum of one sample at any sampling location for each subgrade material present to 1m below subgrade.
- Maximum spacing of **60m*** between subgrade sampling locations in residential roads or part thereof.
- Maximum spacing of **120m*** between subgrade sampling locations in rural roads or part thereof.
- Minimum of two subgrade sampling locations in each road within the proposed work site.

* Repeated laboratory CBR tests on the same material-type sampled throughout a site is not required provided that in-situ testing is undertaken to justify allocating a CBR based on a pair of laboratory results for that material. In-situ testing for determination of the CBR may be carried out using a cone

penetrometer for fine grained materials. A laboratory CBR test will be required for materials containing larger particles where consistent results are not obtained by a Cone Penetrometer.

7.4.2 Expansive (Reactive) Soils

Sampling and testing of subgrade materials is also to be carried out to determine their "Expansive Nature" classification in accordance with Austroads *Pavement Guide to Pavement Technology - Set* and the relevant TfNSW Supplement(s). Testing is to include the potential swell test in addition to the plasticity index test.

Design measures to control movement of the subgrade are required for pavements over expansive soils classified "high" or "very high". Design measures and subsurface drainage are discussed in Austroads *Pavement Guide to Pavement Technology - Set* and the relevant TfNSW Supplement(s). Preferred measures shall also be discussed with Council's Representative prior to inclusion in any Pavement Design Report.

Pavement subsurface drains generally are not to extend into highly or very highly expansive road subgrade soils.

Drainage lines and utility mains laid in sand or aggregate bedding material are not to be located in or in close proximity to highly or very highly expansive road subgrade soils.

The Geotechnical Engineer is to recommend appropriate treatments to control moisture variations in highly and very highly expansive subgrade soils, subsurface drainage treatments in general and general measures to prevent infiltration of surface water.

7.5 Subsurface Drainage

Subsurface drainage will be required for all new road pavements in order to:

- Prevent groundwater from entering and softening or saturating the subgrade or pavement materials.
- Remove trapped water that enters a pavement either from the side or from beneath the pavement.
- Control moisture levels in subgrade material to prevent reactive soils from damaging pavements.
- Prevent slope instability.
- Achieve consolidation in raised embankments over wet or unstable areas.

The general location for pavement subsurface drainage shall be located as shown on Council's *Civil Works Specification - Standard Drawings*. Pavement subsurface drainage shall be required on both sides of the roads.

Recommendations for subsurface drainage shall be made by the Geotechnical Engineer in the Pavement Design Report where different requirements to those shown on Council's *Standard Drawings* are considered necessary by the Geotechnical Engineer.

Recycled materials may be used, provided they meet the requirements of the relevant standards. The Service Provider shall obtain sample coarse particle size distributions from the manufacturer which is

representative of the material to be used on site and submit them to Council's Representative for approval prior to use.

Refer to the IPWEA *Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage 2010* for further information; and TfNSW QA *Specification 3154 Granulated Glass Aggregate* and TfNSW QA *Specification 3580 Aggregate Filter Materials for Subsurface Drainage* for the applicable material and subsurface application requirements.

7.6 Flexible Pavement Design

Asphalt surfacing of 40mm thickness or less over an unbound flexible pavement is not considered to contribute to pavement thickness structural design.

Notwithstanding other requirements of this Section, the design minimum compacted pavement thickness including asphalt surfacing shall not be less than 300mm on public roads or roads which shall become Council's asset following dedication.

Pavement wearing surface between 30mm and 45mm thick must utilise 10mm size aggregate. The use of 14mm aggregate for wearing surfaces must only be used in wearing surfaces greater than 45mm thick unless otherwise approved by Council's Representative.

In addition to the requirements of this *Design Guideline*, flexible pavement investigation and design shall generally be carried out in accordance with Austroads *Pavement Guide to Pavement Technology - Set* and the relevant TfNSW Supplement(s).

7.7 Rigid Pavement Design

Rigid pavements on public roads shall be designed in accordance with Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design* and as approved by Council's Representative.

The minimum requirements for rigid pavements for public roads, other than roundabout pavements, shall include a sub-base course of 125mm bound or 150mm unbound material and a concrete pavement thickness minimum 165mm 32MPa (3.5MPa flexural strength).

Jointing details for rigid pavements shall be detailed on separate Design Drawings and generally be in accordance Austroads publications, TfNSW Specifications and other Australian design publications on concrete pavement design, which may be relevant to the subject pavement. Details of documents referenced in detailing rigid pavement designs shall be provided to Council's Representative with the Design Drawings.

7.8 Asphalt Pavement Design

The following applications of asphalt for pavements may be acceptable. Details of individual pavement designs including or nominating materials specifications, if differing from Council's *Civil Works Specification*, shall be included in the Pavement Design Report:

- Dense Graded Asphalt.
- Full Depth Asphalt.

- Modified Full Depth Asphalt (MFDA).
- Deep Strength Asphalt.
- Wearing surface asphalt containing plastomer Polymer Modified Binder.
- Composite Pavements - initial sprayed seal on lean mix concrete or bound sub-base.
- Open Graded Asphalt.
- Warm Mix Asphalt.

Reclaimed asphalt pavement (RAP) material may be used in asphalt pavement mix design in accordance with the following specifications, subject to the Geotechnical Engineer's/Pavement Designer's approval and if agreed to by Council's Representative:

- TfNSW QA Specification 3152 Aggregates for Asphalt.
- TfNSW QA Specification 3153 Reclaimed Asphalt Pavement Material.
- TfNSW QA Specification R116 Heavy Duty Dense Graded Asphalt.
- TfNSW QA Specification R117 Light Duty Dense Graded Asphalt.

Refer to the IPWEA *Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage 2010* for further information and the relevant asphalt specifications for permissible level of RAP for the applicable product and pavement application requirements.

7.8.1 Sprayed Seal under Asphalt Surfacing

All asphalt surfacing shall be placed on a bitumen seal in accordance with Council's *Civil Works Specification - Construction Specification*.

7.8.2 Edge Drains for Asphalt Pavement Layers

In order to relieve moisture from asphalt pavement layers, effective edge drains are to be considered as part of the pavement cross section of full depth, deep strength, open graded and modified full depth asphalt pavements.

7.9 Interlocking Segmental Block Pavement Design

Interlocking segmental block pavement designs shall be approved by Council's Representative and shall comply with the following requirements:

- Interlocking segmental block pavements shall consist of concrete or similar pavers.
- All areas of paving shall be constrained by an approved concrete edge restraint.
- Provide adequate surface and subsurface drainage.
- Paving is not permitted on grades above 5%.
- Pavers shall have a minimum slip resistance surface classification of Class W under AS/NZS 4586 *Slip resistance classification of new pedestrian surface materials - Wet Pendulum Test Method* using Four S Rubber (simulated standard shoe sole rubber).

Further details are provided in Council's *Civil Works Specification - Standard Drawings*.

7.10 Roundabout Pavement Design

The pavement shall be designed to suit the roundabout size and design traffic loadings and vehicle turning movements. The following pavement treatments may be considered and shall be approved by Council's Representative.

7.10.1 Roundabout Full Depth Asphalt Pavement Design

The Pavement Design Report shall include justification of the selection of asphalt modulus values used in the design and specify wearing surface, layer thickness and aggregate size. The design modulus and volume of binder is to be determined via the Shell Nomographs presented in Section 6 of Austroads Guide to Pavement Technology using an appropriate WMAPT and a maximum design speed of 40km/h. Use 10km/h within 50m of intersections.

Roundabouts may have pavements constructed in Modified Full Depth Asphalt (MFDA) where the natural subgrade CBR is greater than 10% and the design traffic before factoring for torsion effects does not exceed 5×10^6 ESAs.

7.10.2 Heavily Bound Pavements

Heavily bound Pavement Design Reports shall include references to heavily bound pavement material specification and other construction requirements, including individual asphalt layers and asphalt mix type. All clarifications for the supply, placement and saw cutting requirements shall be contained in the approved Pavement Design Report.

Unbound or bound granular materials, other than heavily bound granular materials, are not permitted in roundabout pavements.

7.10.3 Roundabout Rigid Pavement Design

Rigid pavements for roundabouts shall be designed with reference to TfNSW *Concrete Roundabout Pavements, A guide to their design and construction* and any current information published by the TfNSW in relation to concrete roundabout pavements.

7.11 Industrial and Commercial Area Road Pavement Design

Pavement designs for roads in industrial and commercial areas shall consider the possibility of high-volume heavy turning movements with resulting surface torsion effects and braking forces. Thin asphalt surfacing, which may be suitable for residential subdivision pavements, are not considered suitable for industrial and commercial area road pavements.

A heavily bound pavement with a thick asphalt surfacing is one alternative that could be considered when designing pavement for these areas.

7.12 Council Standard Pavement Design

In some cases of minor pavement works on local access roads and minor roads a Pavement Design Report may not be necessary. These cases generally consist of pavement shoulder works of 40m or less length, 3m or less in pavement sub-base width and where the subgrade CBR is expected to be greater than or equal to 3.

7.13 Temporary Roadwork at Temporary Road Ends

The pavement design of temporary turning heads shall be as for the through road pavement. Consideration shall be given to:

- Surface drainage to be provided in the interim.
- Provision of subsurface drainage for the interim and ultimate conditions.

7.14 Temporary Side Tracks and Deviations

The design of temporary side tracks and deviation pavements required for construction shall be carried out to ensure that the following applies:

- Pavement will withstand the expected traffic loadings without deformation causing interference to traffic flow, speed or safety.
- Surfacing of the pavement will only require minor maintenance during the life of the pavement.
- Effects of surface and subsurface drainage are considered.
- Treatment of the interfaces with existing pavements is considered including subsurface drainage and interlocking of pavement courses.
- Minimum pavement depth requirements.
- Disturbed areas are returned to preconstruction condition at completion of the project.

7.15 Private Access, Paths and Battle-Axe Driveway

Private driveways may range from a single residential access to substantial internal road systems. These may provide access to a range of developments from single residences to major commercial or industrial developments involving high volumes of heavy vehicles. A design standard must be selected which is appropriate for the scale of the development, the anticipated life of the development and traffic type. The standard to be used may also be specified in the conditions of Development Consent.

Pavements for battle-axe lot driveways servicing residential properties within proposed subdivisions shall be constructed in accordance with the requirements of Council's *Civil Works Specification - Construction Specification* Section 9.2.3 Residential Lot Battle-Axe Handle Driveway Pavements.

7.16 Car Park Pavements

The design of car park pavements is to consider the variations in use and loading throughout the car park, e.g. through routes, locations of high turning movements, heavy vehicle routes. The selected design life of private car parks may give consideration to the life of the development, the practicality of undertaking renewal works, and the disruptions associated with periodic maintenance and renewal works. A design life less than 20 years will not normally be considered acceptable for permanent construction.

All loading bays and loading zones must be constructed in concrete to resist damage from diesel and fuel spills. Paving colours must be mottled to mask drip marks.

Car park wearing surfaces shall consist of either asphaltic concrete, rigid pavement or paving. Paving surfacing colours which would mask pavement markings must not be selected. Generally, porous pavements are only considered suitable for areas subject to light to medium traffic.

The placement of surface and subsurface drainage can be critical for pavement performance and shall be considered by the Pavement Designer. The impact of subsurface moisture can be influenced by issues which include steps in subgrades due to pavement depth variations, landscaped and irrigated traffic islands, service trenches, below ground tanks, potential groundwater problems due to boxing and/or filling over broad areas, adjacent water quality systems (e.g. rain gardens, bioswales) and the use of pavement surfaces for on-site stormwater detention.

The design of porous pavements is to consider subsurface drainage to the extent necessary to ensure subgrade support. This may involve the provision of additional porous pavement courses.

A detailed assessment of the need for surface and subsurface drainage must be made in the individual case.

Design standards applicable to a particular development may also be specified within the conditions of Development Consent.

7.17 Concrete Shared Paths

Concrete shared paths shall be constructed in accordance with the requirements of Council's *Civil Works Specification - Construction Specification* Section 10.2.4 New Reinforced Concrete Paths and Council's *Civil Works Specification - Standard Drawings* except where shared paths are proposed to be used for vehicle access for maintenance activities or similar. In these cases, a specific design of the shared path pavement shall be detailed on the Design Drawings.

7.18 Pavement Surfacing

In addition to the requirements of this section of the *Design Guideline*, other general requirements for pavement surfacing materials, thickness and finishes are specified in Council's *Civil Works Specification - Construction Specification*. However, where a particular circumstance is not covered in that Specification an appropriate treatment shall be discussed with Council's Representative prior to Council's acceptance for the use of the appropriate treatment.

Section 8 - Design of Structures

The design of structures such as bridges, large drainage structures and retaining walls shall be carried out in accordance with the current relevant Austroads publications, Australian Standards and *Australian Rainfall and Runoff: A Guide to Flood Estimation*.

Certification will be required from a Civil or Structural Engineer stating that the design has been prepared in accordance with the required guidelines, standards and Work Health and Safety legislation. Structural designs shall be accompanied by a Safety in Design Report that specifies the hazards relating to the design of the structure.

Design certification shall also be provided at construction stage to address the adequacy of the proposed formwork and construction methodology. Refer to Council's *Civil Works Specification - Construction Specification* for requirements.

Inspection certification from a certified practising Civil or Structural Engineer will be required confirming that construction has been carried out in accordance with the approved design. Refer to Council's *Civil Works Specification - Construction Specification* for requirements.

The design and manufacture of all precast structures shall be certified by a certified practising Civil or Structural Engineer as being in accordance with relevant standards. Refer to Council's *Civil Works Specification - Construction Specification* for requirements. Prior to approval for use of precast products all relevant technical information for installation shall be submitted together with the certification to Council's Representative.

8.1 Retaining Wall Design Requirements

Aesthetic and durability considerations shall be an important factor in the design of retaining walls, especially in road cutting situations. Natural stone products are the preferred material for use throughout the Central Coast region, due to the local source of these products and the desirable appearance of retaining walls constructed using these materials.

Retaining wall structures include, but are not limited to the following:

- Retaining walls.
- Mass gravity (durable natural stone, brick and mortar).
- Gabion baskets.
- Stacked masonry blocks.
- Post and panel/waler (composite).

Retaining wall construction materials shall be either of the following (treated pine is not permitted unless designed to achieve the required design life and is approved by Council's Representative):

- First grade quarry sawn sandstone logs (preferred).
- Masonry units.
- Precast reinforced coloured concrete panels/walers with galvanised steel universal beams.
- Some other components associated with an approved engineered retaining system.
- May need to consider any applicable heritage value for existing retaining walls.

A retaining wall design by a Qualified Civil or Structural Engineer is not required if the retaining wall height is less than 1m and is not:

- Supporting a batter or natural ground steeper than four horizontal to one vertical (4:1); and/or
- Subject to live loads.

In addition to the requirements listed in Section 5.6, the retaining wall design drawings shall also include, but are not limited to the following information:

- Component type.
- Component size.
- Buried components.
- Subsurface drainage and flush points.
- Location of existing and proposed public utility services in vicinity of retaining wall.
- MGA co-ordinates at each end of each site.
- Plan showing:
 - Horizontal alignment at toe.
 - Horizontal alignment at top.
 - Horizontal alignment of buried components; rock bolts, tie backs, etc.
- Longitudinal section.
- Typical cross section showing:
 - Footings.
 - Chainage.
 - Zone of influence for loading at back of retaining structure.
 - Zone of influence for excavation at toe of structure.

With reference to the above requirements, retaining walls designed by a Qualified Civil or Structural Engineer shall require the preparation of a Safety in Design Report, in accordance with the *Work Health and Safety Regulation 2011*, which should include the following information as a minimum:

- Purpose for which the item is designed.
- Hazards and risks to health and safety associated with the particular design for the whole life cycle:
 - Construction.
 - Operation.
 - Maintenance.
 - Demolition.
- Controls used to mitigate risks.
- Results of calculations, analysis, testing and examination.
- Hazardous properties of any substance.
- Conditions necessary to ensure safe use for the purpose it was designed or when carrying out associated activities.
- Residual risks.

The minimum design life for retaining walls associated with road cutting and embankment formations shall be 100 years.

Section 9 - Design of Property Access, Car Parks, Paths and Cycleways

9.1 General

This Section outlines the minimum design requirements for property access, car parks, paths and on-road cycleways. In addition to designs being in accordance with this *Design Guideline*, they shall also be designed in accordance with the appropriate Australian Standards, Austroads publication, TfNSW Supplements and Council's *Civil Works Specification - Standard Drawings*.

9.2 Vehicle Access to Properties

9.2.1 Earthworks and Maintenance

When earthworks are required, the access shall be considered as a road for the purpose of design and constructed accordingly. Refer to Section 5 - Site Earthworks Design of this *Design Guideline* and Section 5 - Site Clearing and Bulk Earthworks of Council's *Civil Works Specification - Construction Specification*.

Maintenance of a vehicle access crossing, including any adjacent retaining wall and/or embankment constructed as part of a vehicle access crossing (where the beneficiary is the property owner), is the property owner's responsibility under the *Roads Act 1993*.

9.2.2 Urban Property Access

Urban property vehicle accesses include entrances from a single dwelling residence to major developments, such as regional shopping centres, car parks, or entertainment venues.

Designs for urban vehicle access crossings need to consider the following:

- Road type adjoining property frontage.
- Land use of the property.
- Type of vehicles likely to use the access, such as cars, trucks and other heavy vehicles.
- Volume of traffic using the access.
- Street and property drainage.
- Existing and proposed utility services.
- Proximity to road features including but not limited to:
 - Intersections.
 - Other property accesses.
 - Street furniture.
 - Street trees.

And include provisions for the following:

- The vehicle access crossing is to include gutter and path crossings in accordance with Council's *Civil Works Specification - Standard Drawings*.
- A pavement design in accordance with *Civil Works Specification - Construction Specification* or an approved Pavement Design Report.

- The driveway gradient on the approach to the road boundary shall comply with Council's *Civil Works Specification - Standard Drawings*.
- The driveway gradients and surface material specification shall satisfy the relevant Australian Standards and *Building Code of Australia* requirements, including those regarding slip resistance for pedestrian access and mobility.
- The collection and discharge of driveway stormwater runoff including runoff from uphill areas. Driveway runoff is not permitted to flow onto any footpath, shared path or carriageway.
- Any batters or retaining structures shall not restrict development over adjoining land or pose risks of instability or erosion.
- Any requirements imposed in relation to fire either through the *Building Code of Australia* or in Bushfire Prone Areas, the NSW Rural Fire Services (such requirements may include controls on gradients, driveway widths, clearances and design vehicles for various travel paths).
- Completed works shall satisfy cover and clearance requirements for any utility authority mains and installations.

Vehicle access crossings of the road verge for residential developments shall be designed and constructed in accordance with AS/NZS 2890.1 *Parking facilities: Off-street car parking* and Council's *Civil Works Specification - Standard Drawings*. When roll top kerb has been provided, no provision or modification for vehicle access crossing will be allowed.

Where a minor road type access is required with kerb returns and drainage pits cannot be provided in the public roadway a dish gutter shall be provided in accordance with Council's *Civil Works Specification - Standard Drawings*.

The vehicle access crossing or driveway layout must:

- Provide single manoeuvre turns by the design vehicle.
- Provide adequate clearance between the design vehicle's turning path and physical constraints within the property.
- Avoid reversing movement into or out of the development (except in the case of individual residential houses).
- Provide safety for pedestrians by ensuring adequate sight distance.
- Minimise pedestrian/vehicle conflict areas and control vehicle speed across verges.

For local roads with low travel speed, less than 50km/h, driver expectation of interference reduces the likelihood of conflict. Minimum Gap Sight Distance (MGSD) of 4s relative to the design speed must be available for vehicles entering or exiting from a property. The requirement to comply with MGSD will not apply to individual residential houses in built up areas.

Entrances to major developments such as shopping centres need to be analysed thoroughly to minimise their effect on the through traffic flow. The intersection of such accesses with the frontage road may be required to be treated the same as the intersection of two public roads.

9.2.3 Residential Battle-axe Driveways

In addition to items listed in 9.2.2 above, designs for battle-axe corridors for urban residential developments shall also include provisions for the following:

- The continuation of the driveway into the main body of the lot to allow access to useable land either where the construction of that driveway later would impact on adjoining property or where topography, natural obstructions or poor ground conditions would make the driveway construction expensive.
- Unless a larger design vehicle is intended, the design vehicle for bends in driveway alignment shall be a single unit truck (small commercial removalist vehicle). Pavement widths shall be increased to accommodate tracking of design vehicles.
- In long and multiple user driveways passing bays shall be provided at appropriate intervals and at unavoidable blind crests, side roads and curves.
- Any requirements imposed in relation to fire either through the *Building Code of Australia* or in Bushfire Prone Areas, the NSW Rural Fire Services (such requirements may include controls on gradients, driveway widths, clearances and design vehicles for various travel paths).
- Completed works shall allow unobstructed routes for the future provision of private service pipes (where this cannot be achieved those services or appropriate conduits shall be installed in full as part of the works).

9.2.4 Multi-unit Residential, Commercial and Industrial Battle-axe Driveways

Battle-axe corridors for large residential, commercial and industrial developments shall be designed with jointed reinforced concrete, concrete pavers or clay pavers. Kerb will be required on at least one side of the pavement.

In addition to items listed in 9.2.2 above, driveway designs shall also include provisions for the following:

- A pavement design, in accordance with an approved pavement design and/or report.
- Unless a larger design vehicle is intended, the design vehicle for bends in a driveway alignment shall be a single unit truck. Pavement widths shall be increased to accommodate tracking of design vehicles.
- Where a driveway layout is approved as a single lane width, passing bays shall be provided at appropriate intervals and at unavoidable blind crests, side roads and curves.
- The grading of vacant areas within the corridor shall suit adjacent property levels at the boundary.
- Any requirements imposed in relation to fire either through the NCC (Building Code of Australia) or in Bushfire Prone Areas, the NSW Rural Fire Service (such requirements may include controls on gradients, driveway widths, clearances and design vehicles for various travel paths).
- Completed works shall allow unobstructed routes for the future provision of private service pipes (where this cannot be achieved those services or appropriate conduits shall be installed in full as part of the works).

9.2.5 Rural Property Access

Treatment of access to rural properties is dependent upon several criteria including through traffic volumes, turning volume, design vehicle type, single or divided carriageway, land use and general topography.

The location for a point of access will be governed by the following:

- Sight distance.
- Median width/storage space (if available).
- Largest design vehicle to utilise the facility.
- Distance to intersection.
- Possible confusion with intersections.
- Deceleration/acceleration movements.
- Drainage and flooding.
- The existing and proposed utility services.
- Site restrictions.

There must be adequate sight distance for vehicles entering and exiting the property access. Safe Intersection Sight Distance must be provided for the through traffic and 5s Minimum Gap Sight Distance (MGSD) with a 0.65m to 1.10m height sight line for entering vehicles. Care must be taken to ensure MGSD is not affected by the location and height of roadside furniture, especially for accesses located on the inside of horizontal curves. Roadside landscaping, trees or structures are not to interfere with horizontal and vertical sight lines.

A single unit truck shall be the minimum design vehicle for any rural access. However, accesses must be designed for the largest vehicle likely to use them (e.g. prime mover with semi-trailer, B-double).

To enhance safety for the turning vehicle and minimise interference to through traffic, a widened shoulder or short auxiliary lane will be required where vehicles are required to make a right-hand turn manoeuvre on dual carriageways. Similarly, on two-lane two-way roads, shoulder widening will be required to enhance safety for all movements.

Sufficient length between the edge of road and any gate shall be available to store the parked design vehicle to allow for the occupants attending a gate. Where the design vehicle is a single unit truck then 15m must be allowed and in the case of an articulated vehicle 22m is the required offset.

At locations where there is high demand for articulated vehicles (e.g. timber mill, quarry, truck station, etc) a road intersection design shall be required.

The design of the vehicle access crossing shall include provisions for the following:

- The driveway is to include, as applicable, table drain, gutter and path crossings in accordance with Council's *Civil Works Specification - Standard Drawings*.
- A pavement design in accordance with an approved Pavement Design Report.
- The continuation of the driveway into the main body of the lot to the vicinity of any approved building envelope.
- The driveway gradient on the approach to the road boundary shall comply with Council's *Civil Works Specification - Standard Drawings*.
- Where practicable, the design of driveway levels, crossfalls and batters to allow sheet flow to cross the driveway in a manner which does not cause any concentration of stormwater flow or erosion potential. Where sheet flow across the driveway may create a nuisance to adjoining properties or cause erosion, the collection and discharge of driveway stormwater runoff including runoff from uphill areas is required. Driveway runoff shall be collected and piped to the street drainage, Council drainage system or watercourse.
- Where the collection and discharge of driveway stormwater runoff is required, in part or in full, based on hydrologic and hydraulic calculations the driveway will be provided with

standard profile gutters and kerbs, or formed shotcrete drains, or turfed drains (where grades < 8%).

- Any batters or earth retaining structures shall not restrict development over adjoining land or pose risks of instability or erosion.
- Any requirements imposed in relation to fire either through the *Building Code of Australia* or in Bushfire Prone Areas, the NSW Rural Fire Services (such requirements may include controls on gradients, driveway widths, clearances and design vehicles for various travel paths).
- Completed works shall satisfy cover and clearance requirements for any utility authority mains and installations.
- The future provision of private service pipes and poles must be considered.

9.2.6 Rural Residential Battle-axe Driveways and Internal Driveways

Battle-axe corridors for rural residential developments shall be constructed as a minimum of asphalt surfaced, flexible road pavement.

In addition to items listed in 9.2.5 above, designs for rural battle-axe and internal driveways shall also include provisions for the following:

- The continuation of the driveway into the main body of the lot to allow access to useable land either where the construction of that driveway later would impact on adjoining property or where topography, natural obstructions or poor ground conditions would make the driveway construction expensive.
- Unless a larger design vehicle is intended, the design vehicle for bends in driveway alignment shall be a single unit truck. Pavement widths shall be increased to accommodate tracking of design vehicles.
- In long and multiple user driveways, passing bays shall be provided at appropriate intervals and at unavoidable blind crests, side roads and curves.

9.2.7 All Weather Access in Private Property

The standard of roads over and within rural properties may vary depending primarily on:

- The intended duration, frequency and type of rural use.
- The route terrain and ground conditions.
- Risks to users, e.g. provision of safety barriers, type of surfacing for traction, flooding.
- Risks to the environment e.g. erosion, pollution, watercourse ecology, flood levels.
- Use for bush firefighting purposes and as fire escape routes.
- Construction difficulty, particularly achieving compaction and sealing on steep gradients.
- Maintenance considerations including the potential for obstruction of drainage pipes.

As a guide, a road to a rural residence would require:

- A single lane minimum 4m wide flexible road pavement, table drains (pavement courses are extended to free drain into table drains), batters and provision for cross drainage.
- Passing bays provided at appropriate intervals and road widening at any blind crests, side roads and curves.

- Unless a larger design vehicle is intended, the design vehicle for bends in road alignment shall be a single unit truck. Pavement widths shall be increased to accommodate tracking of design vehicles.
- A single coat bitumen seal centrally aligned 3m wide. The pavement seal shall be widened to 6m at sections of road containing passing bays, widening for tracking and through blind crests, side roads junctions and curves.
- A pavement designed in accordance with an approved Pavement Design Report. A pavement report is to include details of any necessary subsurface drainage.
- High side grassed table drain developing into a lined drain where scour may become an issue.
- Low side provision for road runoff to sheet flow away.
- Cross drainage shall be provided and designed to appropriately convey the 20% AEP. Depth indicators shall be provided as required by AS 1742.
- Cross drainage lines shall extend to the alignment of the table drain invert.
- Headwalls and associated rock protection shall be provided to cross drainage.
- The gradient on the approach to the road boundary shall comply with the relevant part(s) of AS/NZS 2890 *Parking Facilities Set*.
- Cut and fill batters shall be adopted for the ground conditions such as not to pose risks of instability.
- All cut and fill batters (and other remaining disturbed areas) shall be protected from erosion by vegetation.
- Any requirements imposed in relation to NSW Rural Fire Services (such requirements may include controls on gradients, driveway widths, clearances and design vehicles for various travel paths).
- Completed works shall satisfy cover and clearance requirements for any utility authority mains and installations.
- The future provision of any private service pipes and poles must be considered.
- Consider need or desirability of safety barriers, guide posts, reflectors and warning signs.

9.2.8 Non-standard Vehicle Access Crossings

A non-standard vehicle access crossing (VAC) is a proposed VAC that is unable to be designed and constructed to AS/NZS 2890.1 *Parking facilities: Off-street car parking* and Council's *Civil Works Specification - Standard Drawings*, due to topographical or physical restrictions affecting the site.

In steep locations where grades restrict the positioning of the VAC from commencing in the road at the proponent's property frontage, the following may apply:

- VAC may start from the formed road at the frontage of an adjoining or neighbouring property, as determined by Council.
- VAC constructed in the road may be further extended in the road to provide access for other properties not already serviced by a VAC, as determined by Council. In such instances the maintenance and repair of jointly accessed VACs becomes the responsibility of property owners sharing the access.

Proposed VACs that are assessed generally as non-standard due to site constraints may require submission of plans of survey, cross section and longitudinal section details to enable Council to verify grades, crossfalls, access widths, structural details, drainage requirements or other issues in order to properly review the proposal.

Non-standard VACs are not recommended and are only considered by Council to facilitate access when there are no other feasible options and as such Council cannot take responsibility for the performance, risk/safety and liability arising from the approval and construction of a non-standard VAC, notwithstanding its reviewing role.

Plans and certification from a suitably qualified and experienced Civil or Structural Engineer are required as part of this process.

9.3 Car Park Design

9.3.1 Non-domestic Parking Areas and Design Standards

Non-domestic parking areas shall be designed applying the requirements of AS/NZS 2890 *Parking Facilities Set* as a minimum.

The Designer shall consider but not be limited to:

- Design vehicles.
- Pedestrian, cyclists and persons with disabilities.
- Driveway widths.
- Parking bays and aisle dimensions.
- Driveway locations.
- Driveway and vehicle access crossing intersections with public roads.
- NCC fire requirements.
- Bushfire protection requirements.
- Drainage and flood impact.

9.3.2 Design vehicles

The design shall provide for all design vehicles expected to use the development.

Allowances for manoeuvres of commercial vehicles within the public roadway and in the entry driveway shall be appropriate for the vehicle's turning capabilities and frequency of servicing by those vehicles.

Access by inappropriate vehicles shall be constrained where practicable. Internally, vehicles shall be controlled by physical barriers and signs.

9.3.3 Layout Compliance

The layout shall be consistent with the approved development plan particularly in respect of:

- Fixed setbacks.
- Fixed aisle and parking bay geometry.
- Locations and treatment of entries and exits.

The layout shall address detailed building design matters including:

- Intrusion of structural components such as columns.
- Overhead intrusion of ramps, escalators and stairs.

- Ground clearance and headroom.

9.3.4 Travel Paths for Pedestrians, Cyclists and Persons with Disabilities

The design of internal driveways, paths and parking areas to be used by pedestrians, cyclists, delivery persons or persons with disabilities shall be appropriate for that usage.

The designer shall consider and make provision for:

- Desirable travel routes.
- Protection measures for travel path users.
- NCC compliance.
- Facilitating use by persons with disabilities.
- Avoiding conflicts with travel paths of commercial vehicles or concentrations of cars.

9.3.5 Access Driveways

Access driveway layouts shall be appropriate for use by the types of vehicles accessing the development and with regards to the traffic and geometric characteristics of the public road.

Adequate sight distance shall be available for drivers leaving the site to vehicular traffic on the road and pedestrians on the path having regard as appropriate to the speed of vehicles on the road and the lane configuration of the road. Refer to 9.2 Vehicle Access to Properties.

9.3.6 Vehicular Control Points and Gates

Queuing areas shall be adequate for any vehicular control points and shall consider:

- User class.
- Road traffic volume.
- Entry/exit performance.
- Capacity of the car park.
- Parking turnover patterns.
- Control point operation.
- Provision for persons with disabilities.

9.3.7 Elevated Ramps and Ramps to Basements

The use of ramped sections of internal driveways and parking areas shall incorporate provisions for:

- Meeting acceptable gradients generally, at approaches to boundaries, control points and gates and as appropriate for use by persons with a disability where relevant.
- Appropriate alignment for the design vehicle usage.
- Achieving adequate sight distance for entering and emerging vehicle drivers.
- Separation of car parking bays from the ramp ends.
- Separation of any pedestrian crossing and informal pedestrian route from the ramp ends.

9.3.8 Vehicular Traffic Control

The use of road humps shall consider pedestrians, other modes of access and be appropriate for use in accordance with geometric requirements for:

- AS/NZS 2890.1 *Parking Facilities: Off-street car parking* Type 1.

- AS/NZS 2890.1 *Parking Facilities: Off-street car parking Type 2.*
- AS 1742.13 *Manual of uniform traffic control devices: Local area traffic management.*

9.3.9 Commercial Vehicle Manoeuvring

The design shall provide for travelling, turning, standing, reversing and other activities associated with the servicing of the development by commercial vehicles in respect of the following:

- Appropriate classes of design vehicles.
- Frequency of visits made by commercial vehicles.
- Allocation of service bays, service area aprons and the "service area" as a whole (i.e. the area of the development set aside for the manoeuvring, parking and loading or unloading of commercial vehicles for the delivery or removal of goods, freight or waste).
- Suitability of any area of the development in addition to the service area which shall be used by commercial vehicles in common with other vehicles.
- Conflicts with other vehicle travel paths.
- Avoidance of pedestrian travel paths.
- Turning circles including reversing while turning, and swept travel paths.
- Loading/unloading operations.
- Roadway widths.
- Overhanging of medians, islands, landscaping.
- Mountable design of kerbs, medians, islands and roundabouts.
- Clearances to adjacent buildings and obstructions, lighting and signposting poles.
- Separation from pedestrians.
- Provision of signs and pavement markings to keep commercial vehicle travel paths separate from car parking.

9.3.10 Protection of Pedestrians

Adequate measures shall be provided to separate vehicular and pedestrian traffic including the use of:

- Kerbs or low barriers.
- Bollards.
- Handrails or fencing including childproof fencing.
- Pedestrian refuges.
- Kerb blisters in roadways.
- Marked pedestrian crossings.
- Grade separation using footbridges or underpasses.
- Alternative travel paths.
- Ramps in kerbs for prams, trolleys, wheelchairs and scooters.
- Separation of any pedestrian crossing and informal pedestrian route from the ends of vehicle driveway ramps.

9.3.11 Shopping Trolley Bay Locations

The locations of shopping trolley bays shall be considered at the detailed design stage regarding the following:

- Access to the bays must at all times be clear of commercial vehicle manoeuvring areas and where practicable circulating traffic routes.

- The proximity must be open and well-lit for user personal safety and to enhance visibility of trolleys abandoned on the surrounding.
- Surface gradients must be minimal to allow ease of control of the trolleys.
- Surface drainage flows must be minimal so as not to discourage use of the bays in wet weather.

9.3.12 Bicycle Parking Facilities

The design of bicycle parking facilities and their access shall make provision for the following:

- Class of bicycle parking facility.
- Type and set out of parking rails and racks.
- Need for lighting.
- Need for weather protection.
- Specified clearances to pedestrian and vehicular traffic.
- General avoidance of immediate proximity to pedestrian doorways, attachments for blinds and awnings, pavement service access covers, street furniture, bus stops, loading zones, pedestrian crossings and areas over which car doors may be opened.
- Signs for locating and using the facilities.
- Security, access and ease of use for the relevant class of facility.

9.3.13 Pavement Surfaces

Pavement surface finishes shall be appropriate for roadways, accesses, pathways, ramps including kerb ramps, parking area and loading dock pavements in respect of use by:

- Motor vehicles including motorcycles and motorised wheelchairs.
- Bicycles and wheelchairs.
- Pedestrians.
- Persons with disabilities.
- Persons with prams.
- Manual handling of goods.

The design shall provide for:

- Tactile ground surface indicators or tactile markers.
- Colour contrasting with their surroundings of tripping hazards such as kerbs, wheel stops and low barriers.
- Raised pavement markers specified shall not be greater than 3mm in height.
- Lipless kerb crossings for trolley access on main pedestrian paths.
- Physical controls or traffic management devices shall not obstruct or impede access or create a hazard on travel paths by reducing the available width to less than 1m or forcing unsafe manoeuvres.

9.3.14 Gradients for Pavement Areas

The grading of pavement areas shall comply with requirements for:

- Domestic driveways.
- Maximum gradients for vehicular traffic aisles.
- Maximum length wise gradients for car spaces.

- Maximum crossfalls for car spaces.
- Minimum gradients for pavement surface drainage.
- Minimum gradients for pavement edge drainage.
- Changes of gradients in driveways.
- Gradients at vehicular control points and associated queuing areas.
- Gradients in access driveways approaching boundaries.
- Gradients across paths.
- Where applicable maximum longitudinal gradients for cyclists, pedestrians, persons with disabilities and associated vehicles.
- Where applicable maximum crossfalls for cyclists, pedestrians, persons with disabilities and associated vehicles.
- Maximum gradients and crossfalls including superelevation for circulation roadways and ramps.
- Containment of shopping trolleys.
- Maximum gradients for special loading/unloading parking spaces.

9.3.15 Signs

Appropriate street signs shall be included for:

- Signifying car park entries.
- Signifying other entries.
- Warning of vehicles entering traffic.
- Warning of aged or disabled pedestrians or schoolchildren.

Appropriate signs shall be included within the site for:

- Controlling traffic movement and driver behaviour.
- Warning of hazards for vehicles or persons.
- Identifying sections or rows of car parking spaces.
- Identifying bus routes and lay-bys.
- Identifying en route car, motorcycle and bicycle parking and roadway destinations.
- Directing pedestrians to travel paths, stairs, lifts and amenities and showing the layout of the development.
- Assisting persons with disabilities.
- Controlling noise, car lights or other environmental nuisances.

9.3.16 Landscaping

The landscaping design shall address:

- Instances where there is a need or likelihood that vehicles will overhang kerbs.
- Avoid the creation of obstructions that could affect the safe and effective use of parking spaces.
- Performance and sufficiency of street lighting and proposed development lighting.
- Adequacy of sight lines for vehicular traffic entering and exiting the development.
- Adequacy of sight lines for users of all internal travel paths.
- Visibility of signs.

9.3.17 Surface Drainage

The proposed stormwater drainage system and pavement grading shall prevent nuisance flooding of the pavement at:

- Areas of car spaces used to get into or alighting from vehicles.
- Main pedestrian and other travel paths.
- Kerb ramps.
- Approaches to pedestrian crossings.
- Approaches to intersections.
- Special loading and unloading spaces.
- Accessible parking spaces.
- Loading docks.
- Bicycle parking facilities.
- Taxi ranks and bus stops.
- Any area used by pedestrians or cyclists.

The proposed stormwater drainage system with the pavement grading shall prevent any flooding of the pavement at:

- Any building doorway or stairway.
- Any pavement or floor drained directly or indirectly to a sewer.
- Any vulnerable surface installation or pit containing machinery, electrical equipment, pipe inlet/outlet fittings or storage tank for the servicing the development.

9.4 Footpaths and Shared Paths

9.4.1 Design Standards and Guidelines

Footpaths and shared paths shall be designed with reference to, but are not limited to the following:

- AS 1742.10 *Manual of uniform traffic control devices: Pedestrian control and protection.*
- AS 1743 *Road signs - Specifications.*
- AS/NZS 2890 *Parking Facilities Set.*
- AS 3727.1 *Pavements: Residential.*
- Austroads *Guide to Road Design*, including *Part 6A: Paths for Walking and Cycling.*
- Relevant TfNSW Supplements.
- Council's *Civil Works Specification - Standard Drawings.*
- Council's Floodplain Risk Management Plans.

9.4.2 Designing for Pedestrians and Mobility Impaired People

Consideration shall be given to designing for pedestrians and mobility impaired people in applicable aspects of the design of roads and road related areas, to address the requirements of the *Disability Discrimination Act 1992* and AS 1428 *Design for access and mobility: General requirements for access - New building work.*

Provision shall be made for the use of all public pathways by mobility impaired people.

Provision for use by mobility scooters shall be made where such use is likely or where required by an approval. Examples include access for aged care facilities, shopping centres and in passive recreation areas.

9.4.3 Paths in Road Reserves

New paths shall be minimum 1.5m wide and shall comply with Council's *Civil Works Specification - Standard Drawings*.

Paths in road reserves must have a longitudinal grade the same as the roadway. Where grades exceed 15% special consideration shall be given to alternative access for pedestrians.

Crossfalls on paths shall be between 1% and 2.5% sloping towards the kerb, where practicable.

Consideration shall be given to the requirements of lot access, the volume and type of pedestrians and Service Authority requirements for existing and proposed utility services.

Kerb ramps shall be provided at road crossing points. Kerb ramps shall be designed and constructed in accordance with Council's *Civil Works Specification - Standard Drawings*.

9.4.4 Public Paths Not in Road Reserves

Public paths may be required to be constructed outside a road reserve to:

- Complete a path system.
- Be used in conjunction with an overland flow path. Refer to Council's *Civil Works Specification - Standard Drawings*.
- Provide access to a specific facility.
- Facilitate a maintenance activity.
- Provide for recreational, scenic or tourist purposes.

Paths shall be shown on Design Drawings where:

- Nominated by an applicant as part of the development works.
- Required separately by conditions of a Development Consent.

The standard of design may vary depending on the volume and type of pedestrians expected, streetscape, public safety and other considerations. The requirement of Austroads Guides and AS 1428 publications shall be used when designing paths and any associated pedestrian bridges.

Path pavements shall be constructed in accordance with Council's *Civil Works Specification - Standard Drawings*.

Alternative details to Council's *Standard Drawings* may be required to cater for a particular circumstance. Approval from Council's Representative will be required. Refer to Section 7 - Design of Pavements.

The design of off-road paths may require consideration of matters not encountered in providing paving in formed road paths including:

- Catch drains to control uphill runoff.
- Protection of batters.
- Provision of handrails, barriers, fences or bollards.
- Cross drainage.
- Additional lighting.
- Public safety.
- Minimisation and facilitation of maintenance activities.

9.4.5 Public Pathways used as Overland Flow Paths

Pathways used as overland flow paths shall generally have:

- Preferred crossfall of 2.0% (2.5% maximum).
- An integral 150mm kerb on the low side unless flows are of such a magnitude to warrant special treatment.
- Sufficient capacity to carry the flows with required freeboard.
- Velocity x depth flow criteria for safety to be in accordance with *ARR 2019*, in particular: Chapter 7 (Safety Design Criteria) within *Book 6 (Flood Hydraulics)*.

Other forms of pathways for overland flow paths may be considered by Council. Concepts shall be discussed with Council's Representative prior to preparation of detailed designs.

9.4.6 Pathways used as Shared Bicycle Facilities

Where a public pathway is stipulated as a shared path, the applicable design requirements for cycleways and bicycle facilities shall also be met.

9.4.7 Ramps and Stairs

The provision of stairs will only be permitted in steep sections of pathways where no reasonable alternative or ramp arrangement can be provided and the limitation of use of the pathway is accepted by Council's Representative.

Ramps in excess of 7% (14:1), other than paths adjacent to the road, and stairs shall be provided with handrails, tactile indicators and lighting unless otherwise approved by Council's Representative.

Specific design details including geometric and structural design shall be provided for ramps and stairs. Refer to Council's *Civil Works Specification - Standard Drawings* for details on concrete stairs.

9.5 Shared Paths, Cycleways and Bicycle Facilities

Consideration shall be given for cyclists in all aspects of road design and road related areas. Shared paths and other facilities such as cycle parking facilities shall be included in the design where specifically nominated in a Development Consent, Central Coast Council's *Bike Plan* and *Pedestrian Access and Mobility Plan* (PAMP), or other applicable documents.

Shared paths and bicycle facilities shall be designed in accordance with the requirements of Austroads publications and TfNSW Supplements. Issues not covered by Austroads publications shall be discussed with Council's Representative.

Shared paths and bicycle paths shall be reviewed and endorsed by the local Traffic Committee due to their regulatory function.

Where shared paths, cycleways and bicycle facilities are required, all related issues including the following shall be considered and detailed on the Design Drawings:

- Location, horizontal and vertical alignment.
- Width (2.5m minimum) and crossfall (increase width for regional and recreational shared paths).
- Sight distance.
- Drainage.
- Signs and pavement markings for pedestrians, cyclists and motorists.
- Vertical and lateral clearance to structures, top of embankments, hazards.
- Minimisation of projections into the cycleway (service pits, etc).
- Maintenance and access crossings. Thickening, reinforcing and highlighting of such areas.
- Provision of adequate safety railings, rub rails and barrier fences.
- Provision of shared path handrails at intersections and road crossings, where warranted.
- Need for the provision of lighting.
- Measures to ensure the distinctiveness of presence and continuity of cycleways, e.g. through changes in pavement types or character of the facility.
- Any identified need for path terminal treatments to deter or restrict motor vehicle access. Where this need is identified and approved by Council's Representative, terminal treatments shall be designed and installed in accordance with Council's *Civil Works Specification - Standard Drawings*.

Section 10 - Stormwater Drainage Design

10.1 General

Council's *Civil Works Specification - Design Guideline* shall be read in conjunction with the associated *Construction Specification* and Council's Policies and Plans relating to flooding.

The broad objectives seek to achieve an optimum urban environment within the principles of ecologically sustainable development.

Stormwater objectives are considered as being achieved when the following applies:

- Planning, design and construction of new facilities is adequate to service new and future developments consistent with both the engineering, environmental, asset management and planning best practice.
- There is compatibility with existing facilities, operational methods and maintenance techniques.
- Facilities provide adequate environmental, community and asset protection consistent with accepted design and construction requirements set out in this document and with developments in technology as approved from time to time.
- Whole-of-catchment-based approach for design is taken.

The Designer is to provide a design report that sets out the basis for the design of stormwater drainage (stormwater quantity and quality). This should include explanatory text including all relevant assumptions and input parameters, together with supporting tables and diagrams, sufficient for Council's Representatives to confirm the adequacy of the design without the need to obtain further information. Although the onus is on the Designer to provide sufficient information in the design report, there will be some cases where Council's Representatives will stipulate specific information to be included in the design report.

10.2 Design Philosophy

10.2.1 General

In preparing stormwater drainage designs, Council requires use of the latest edition of *Australian Rainfall and Runoff: A Guide to Flood Estimation (ARR 2019)*. Where it is necessary to provide a full reference for ARR, the following description should be used:

- Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia.

The following restrictions shall apply when preparing stormwater drainage designs:

1. Use of the Probabilistic Rational Method to determine peak discharges on rural catchments is not permitted.
2. Use of the urban Rational Method with the hydraulic grade line approach (HGL), as outlined in *ARR 1987*, is not permitted.

Other current Australian published design guides, for example Austroads Guides, and Australian Standards may also be applied to particular design situations. Design parameters specified in *ARR 2019* shall be used, unless agreed with Council's Representative to use alternative parameters.

The probability of design flood events is to generally be described in terms of the Annual Exceedance Probability (AEP), as discussed in Chapter 2 (Fundamental Issues) within *ARR 2019 Book 1 (Scope and Philosophy)*. The previously used terminology Average Recurrence Interval (ARI) is not encouraged. Given that ARI terminology has in the past been used extensively, the Designer is referred to Figure 1.2.1 in Chapter 2 of *Book 1* for a comparison of AEP and ARI for different event probabilities.

An AEP/ARI comparison for frequencies in the range 63.21% to 0.1% AEP (1-year to 1000-year ARI) is shown below:

1	63.21% AEP is equivalent to 1-year ARI ¹	7	5% AEP is equivalent to 20-year ARI
2	50% AEP is equivalent to 1.44-year ARI	8	2% AEP is equivalent to 50-year ARI
3	39.35% AEP is equivalent to 2-year ARI ¹	9	1% AEP is equivalent to 100-year ARI
4	20% AEP is equivalent to 4.48-year ARI ¹	10	0.5% AEP is equivalent to 200-year ARI
5	18.13% AEP is equivalent to 5-year ARI	11	0.2% AEP is equivalent to 500-year ARI
6	10% AEP is equivalent to 9.49-year ARI ¹	12	0.1% AEP is equivalent to 1000-year ARI

Note 1: For practical purposes in day-to-day practice, the 60%, 40%, 20% and 10% AEP events are taken to be equivalent to the 1-year, 2-year, 5-year and 10-year ARI events respectively.

For events more frequent than 50% AEP, expressing frequency in terms of AEP is not particularly meaningful since AEP is constrained to a maximum of 100%. For example, a 1-month ARI has a 99.999386% AEP and a 3-month ARI event has a 98.168436% AEP. Consequently, events more frequent than 50% AEP should be expressed as 'X' Exceedances per Year (EY). For example, 12 EY and 4 EY are equivalent to 1- and 3-month recurrence intervals respectively and more meaningful than their AEP equivalents.

An EY/ARI comparison for the more common frequencies in the range 12 EY to 1 EY (1-month to 1-year ARI) is shown below:

1	12 EY is equivalent to 1-month ARI	4	3 EY is equivalent to 4-month ARI
2	6 EY is equivalent to 2-month ARI	5	2 EY is equivalent to 6-month ARI
3	4 EY is equivalent to 3-month ARI	6	1 EY is equivalent to 1-year ARI

For determining design rainfalls, particular attention is to be given to the following chapters in *ARR 2019 Book 2 (Rainfall Estimation)*:

- Chapter 3 (Design Rainfall) - refer in particular to Section 3.9 (Application).
- Chapter 5 (Temporal Patterns).

The approach to temporal patterns has changed considerably in *ARR 2019* to account for the significant variability in temporal patterns between rainfall events of similar magnitude, and the effect

differing patterns can have on peak flow estimates. This has led to the concept of modelling an ensemble of temporal patterns to account for the variability of patterns. Hence for each AEP of interest, using multiple temporal patterns for each storm duration results in a range of peak discharges (or volumes) at each duration - when multiple results are graphed for each duration this presents as a 'duration box plot' as shown in Figure 2.5.17 in Chapter 5 (Temporal Patterns) of *Book 2 (Rainfall Estimation)*.

When assessing temporal patterns using *ARR 2019*, the Designer is to be cognisant of the following matters:

1. Temporal patterns derived by the regional burst approach are recommended for general use.
2. The use of an ensemble of 10 temporal patterns at each duration is recommended to appropriately represent the variability in observed patterns.
3. If 10 temporal patterns are not available for a given region, duration and frequency then patterns can be taken from other similar regions.
4. When selecting a small ensemble of temporal patterns it is important to capture the typical variability of the observed events.
5. Testing of large numbers of ensemble patterns show results tend to cluster around the mean and median, which should be preferred in design. Generally, temporal patterns representing the worst (or best) case are not suitable for design.
6. Where two-dimensional hydraulic model run times are excessive using 10 temporal patterns (for multiple durations), the pattern closest to the average is likely to be suitable. Alternatively, doubling the grid cell size will decrease run time eightfold.
7. Using an ensemble of 10 temporal patterns provides a range of plausible answers. The Designer should also consider the benefits of investigating a larger number of temporal patterns with a Monte Carlo simulation for sensitive designs and solutions.

Where appropriate for a particular catchment, the design rainfall assessment is to also consider the following chapters in *ARR Book 2*:

- Chapter 4 (Areal Reduction Factors).
- Chapter 6 (Spatial Patterns of Rainfall).

The following approaches in *ARR 2019*, which were not available in *ARR 1987*, are to be used where circumstances warrant:

1. Regional Flood Frequency Estimate Method can be used to estimate peak discharges on small to medium rural catchments - refer to Chapter 3 (Regional Flood Methods) within *Book 3 (Peak Flow Estimation)*.
NOTE: Alternatively, and for larger catchments, flood hydrograph approaches are applicable - refer to Chapter 6 (Flood Hydrograph Modelling Approaches) within Book 5 (Flood Hydrograph Estimation).
2. Blockage of Hydraulic Structures - refer to Chapter 6 (Blockage of Hydraulic Structures) within *Book 6 (Flood Hydraulics)*.
3. Safety Design Criteria for people, vehicles and buildings - refer to Chapter 7 (Safety Design Criteria) within *Book 6 (Flood Hydraulics)*.
4. Interaction of Coastal and Catchment Flooding - refer to Chapter 5 (Interaction of Coastal and Catchment Flooding) within *Book 6 (Flood Hydraulics)*.

The stormwater drainage design for new subdivisions shall be based on a Flood Study undertaken previously by a suitably qualified professional as deemed appropriate by Council's Representative.

All designs shall be calibrated to the current flood study which is available on Council's website.

10.2.2 The Major/Minor Stormwater Systems

The provision of stormwater drainage consists of a pipe system for controlling nuisance flooding (minor system) combined with a continuous overland flow path or floodway system (major system) to accommodate less frequent flood events and flows in excess of the minor systems. The major/minor concept may be described as a 'system within a system' for it comprises two distinct but conjunctive drainage networks.

All new urban development shall be provided with a major drainage system designed with sufficient capacity and freeboard to ensure that flood flows up to 1% Annual Exceedance Probability (AEP) do not encroach upon private land.

The major drainage system typically consists of the arrangement of pavements, roadway reserves, engineered flow paths and waterways, detention basins, flood protection levees, and major cut-off drains planned to convey a design flow up to 1% AEP in conjunction with the available capacity of the minor drainage system.

10.2.3 Provision for Failure

If failure of stormwater drainage system components occurs during periods of extreme rainfall, the risk to life and property could be significantly increased.

It is important to ensure that the combined major/minor system can safely cope with reasonable surcharge due to blockages and flows in excess of the design AEP.

In establishing the layout of the pipe network, Designers shall ensure that surcharge flows will not discharge onto private property during flows up to and including 1% AEP. For flows in excess of 1% AEP, Designers shall ensure that the likelihood of nuisance flooding or damage to private properties is considered, minimised and the likelihood of catastrophic consequences are considered and averted.

All stormwater detention basins and ponds involving dams shall be assessed by the Designer under the *Dams Safety Committee (DSC) Guidelines*. The assessment report shall be submitted to Council for concurrence and referred by the Designer to the DSC where required.

10.2.4 Natural Drainage Paths

The major and minor drainage systems shall be planned and designed to conform to natural drainage patterns and discharge to natural drainage paths in the catchment. If the Designer deems that natural drainage paths require modification to accept the higher peak flows resulting from urban development, the Designer shall seek advice from Council's Representative before proceeding with the drainage design.

Runoff must be discharged from a development in a manner that will not cause adverse impacts on downstream property, stormwater systems and natural watercourses or become a source of

hazardous material. In general, runoff from development sites within a catchment shall be discharged at the existing natural drainage outlet(s). If the Designer wishes to change discharge points or apportionment of catchment flows between discharge points, they must demonstrate that the change will not have unacceptable adverse impacts on downstream properties or stormwater systems.

10.2.5 Surface Flows

Surface flow safety criteria must be applied to minimise both nuisance flooding and major hazards from flooding of roadways, buildings and other areas that have regular public access. Refer to the latest edition of *Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia* and the *Queensland Urban Drainage Manual* for further guidance.

10.2.6 Interallotment Drainage

Interallotment drainage shall be provided for every allotment which does not drain directly to its street frontage and for high side properties fronting roads with either kerb unable to satisfactorily accommodate kerb outlets, or where carriageways have one-way crossfall. Interallotment drainage shall be deep enough to serve the entire allotment; property inlets shall be constructed at the low corner of each lot in accordance with Council's *Civil Works Specification - Standard Drawings*. Refer to Section 10.7 Interallotment Stormwater Drainage of this *Design Guideline* for further details.

10.3 General Requirement for Developments

The level of runoff control required is dependent on the type of development proposed. Flow control requirements are stipulated for the following:

- New developments.
- Redevelopment of existing sites.
- Augmentation of existing stormwater systems.

10.3.1 New Developments

Each new development shall be considered individually regarding existing and proposed drainage systems, location in the catchment and other matters relating to stormwater.

Generally, it can be expected for new development proposals that, the post-development peak flow from the outlet point(s) of the site to the downstream public drainage system or receiving water shall not exceed the pre-development peak flow for both the major and minor system design storm AEP. Pre-development peak flow shall be the estimated flow from the site based on known or estimated catchment conditions prior to the new development.

To reduce peak outflows, the stormwater system may be provided with flow attenuation measures such as infiltration devices, detention basins and water quality control ponds and/or the compensating augmentation of existing drainage systems.

Design storm AEPs for the major and minor drainage systems shall be selected in accordance with Section 10.4.2 Design Annual Exceedance Probability of this *Design Guideline*.

The provision of additional stormwater infiltration, retarding, detention, storage or other control facilities may be required by Council after consideration of relevant stormwater drainage analysis and concept plans required as part of the development application documentation.

10.3.2 Redevelopment of Existing Developed Sites

Each redevelopment proposal shall be considered individually regarding existing and proposed drainage systems, alteration or abandonment of existing infrastructure, location in the catchment and other pertinent matters. Preferred treatment of abandoned infrastructure is removal of the disused asset. Other options shall be approved by Council's Representative.

Redevelopment includes land redevelopment and subdivision redevelopment. Land redevelopment is the redevelopment of single lots or multiple adjacent lots where all the stormwater system will be privately owned. This includes both Unit and Dual Occupancy developments. Subdivision redevelopment is redevelopment where all or parts of the stormwater system will become part of the public drainage system.

Generally, it can be expected for redevelopment sites that, the post-redevelopment peak flow from the outlet point(s) of the redevelopment site to the existing downstream public drainage system or receiving water shall not exceed the pre-redevelopment flow for both major and minor system AEP.

The pre-redevelopment peak flow shall be the estimated flow from the site based on the development conditions (including any existing flow attenuation facilities) prior to redevelopment. The degree of runoff control required will depend on the scale of the development and the net change in impervious area. Flow control will be required for any redevelopment where the density (measured as the total equivalent impervious area) of the redevelopment is greater than that of the existing development.

The stormwater drainage design for redevelopment site is to ensure that the redevelopment does not create or worsen any capacity problems in the existing public drainage system. This will generally require the construction of on-site and/or off-site public detention/retention systems and/or the compensating augmentation of existing drainage systems.

The major and minor system design storm AEPs referred to shall be those appropriate for the existing development in accordance with Section 10.4.2 Design Annual Exceedance Probability of this *Design Guideline*. Note that these are the AEPs that the existing public drainage system must have been designed for, not the as-constructed capacity of the system.

The requirements for the provision of stormwater retarding, detention, storage or other control facilities shall be determined by Council's Representative after consideration of relevant stormwater drainage analysis and concept plans required as part of the development application documentation. Augmentation of Council's existing drainage system may be considered in lieu of on-site detention systems, subject to approval by Council's Representative.

10.3.3 Stormwater System Augmentation

Stormwater system augmentations are undertaken in existing urban catchments to alleviate flood hazards due to under-capacity major and/or minor drainage systems. The main objectives for such

augmentation works shall improve flood protection for land and to increase pedestrian safety and vehicle stability on roadways.

The potential to increase the flow carrying capacity of existing roadways is usually limited.

To achieve the objectives of the stormwater drainage augmentation it may be necessary to increase the AEP capacity of the minor drainage system above that specified in Table 10.1 Major/Minor System Design in order to ensure that:

- The 1% AEP "gap flow" on roads (refer to Section 10.4.2 Design Annual Exceedance Probability) meets the surface flow criteria limits.
- Overland flow from storms up to and including the 1% AEP is not discharged through easements over private land on the low side of road verges, particularly at steep T-intersections and trapped road low points.

10.3.4 Stormwater Inlet and Outlet Discharge

The following requirements shall apply to the design of system inlets and outlets:

- Where no Council drainage system exists, the maximum permissible site discharge from a development to either the kerb and gutter or table drain shall be up to 25L/s at any one discharge point. Discharge points shall be at least 15m apart.
- For other than single residential or dual occupancy developments, Council's Representative shall confirm the maximum discharge that will be allowed to discharge into the street surface drainage system.
- Design of all inlets and outlets shall ensure that there are no adverse impacts arising from any changes of upstream and downstream water surface levels, flow velocities and flow direction.
- The Designer shall design for scour protection at inlets and outlets to suit local conditions. Consideration shall be given to current best practice. Detailed design calculations shall be provided to support the need for and type of energy dissipation devices.
- The Designer shall design inlets and outlets with due diligence, considering public safety requirements based on a risk assessment methodology. Refer to the latest edition of *Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia* and the *Queensland Urban Drainage Manual* for further guidance.
- At points of discharge of gutters or stormwater drainage lines or at any concentration of stormwater from or to adjoining properties, Council will require the Service Provider to enter into a Deed of Agreement with the adjoining owner(s) granting permission to the discharge of stormwater drainage and the creation of any necessary easements with all costs being met by the Service Provider prior to development approval.
- Where the drainage is to discharge to an area under the control of another statutory authority e.g. the Crown or Public Works, the design requirements of that Statutory Authority shall be met.
- Stormwater drainage systems discharging to or through reserves, if permitted under the relevant plan of management, shall be taken to a natural watercourse and discharged through an approved outlet structure or alternatively taken to the nearest stormwater line. All works shall be subject to detailed design. The creation of easements may be required.

10.3.5 Stormwater Quality Control

Urban development will generally result in an increased level of export of a wide range of non-point source pollutants. To protect the quality of local streams, lakes, and river systems, the provision of stormwater quality control strategies acceptable to Council shall be considered. These may include, but will not be limited to the following:

- Establishment of urban lakes, primarily as biological treatment systems.
- Utilisation of water quality control ponds (WQCP) and constructed wetlands, as physical and biological treatment systems, upstream of urban lakes.
- Incorporation of gross pollutant traps (GPTs) on inlets to urban lakes and WQCPs to intercept trash and debris and the coarser fractions of sediment.
- Incorporation of 'off-stream' sediment interception ponds (SIP) in land development works to intercept and treat runoff prior to its discharge to the stormwater system.
- Signs/tags (imprinted on the concrete lintel) at pit entry "No dumping to drains" or similar.

The Service Provider and their consultants must consult with Council at the stormwater drainage concept plan stage which strategies have been implemented or planned to be implemented for the catchment in which the development is located.

The Service Provider will be required to demonstrate by recognised modelling and other calculation that stormwater quality treatment objectives quoted in the *Australian Runoff Quality - A Guide to Water Sensitive Design* published by Engineers Australia can be met and maintained by implementation of a stormwater quality strategy for the Development.

10.3.6 Landscaping and Stormwater Infrastructure

The following landscape requirements are intended to ensure that the stormwater drainage system will enhance an area while ensuring that tree planting does not result in flooding or tree root intrusion problems.

Tree planting must be restricted within 3m of a stormwater drainage system, except in the case of tree planting in street verges. Vigorous rooting tree species shall not be planted within 10m of a stormwater drainage system. Where a drainage system passes near or under existing mature trees, consideration shall be given to the use of an alternative alignment.

Allowance shall be made for the effects of landscaping in the hydraulic calculations of floodways and engineered waterways. Approval from Council's Representative is required for the design factors used.

The design of landscaping shall also consider any increased frequency and the facilitation of maintenance of the stormwater system infrastructure.

10.3.7 Maintenance

The stormwater drainage system shall be designed to be readily and economically maintained. Allowances for maintenance including adequate and stable access for maintenance machinery shall be detailed in the design.

Designs incorporating the need for special or unusual equipment must not be prepared without the prior approval of the Council. This approval also extends to the use of special techniques or the hire of special equipment.

The Designer shall refer to Council's Representative for specific maintenance requirements for situations not covered by this document.

10.4 Hydrology

10.4.1 Design Principles

Design methods and data for urban drainage shall be based on *ARR 2019*, in particular:

- Chapter 6 (Flood Hydrograph Modelling Approaches) within *Book 5 (Flood Hydrograph Estimation)*.
- Book 9 (Runoff in Urban Areas).

For catchment areas greater than 50 hectares, two recognised flow estimation methods shall be used for comparative purposes.

Design methods for internal drainage of developments and improvements within a single allotment shall generally be in accordance with the most current version of AS/NZS 3500.3 *Plumbing and drainage: Stormwater drainage* and the *National Construction Code: Volume 3 (PCA)*.

10.4.2 Design Annual Exceedance Probability (AEP)

The major/minor drainage system design AEP shall be selected in accordance with Table 10.1 below:

Table 10.1 Major/Minor System Design AEP

Major System		AEP (%)
Overland Flow Paths and Trunk Drainage		1
Minor System		AEP (%)
Land Use	Urban Residential (single allotments)	20
	Urban Residential (medium-high density - see text below)	5
	Commercial	5
	Industrial	5
	Rural Developments	10

The following provisions also apply to adoption of the design AEP:

- Design AEP for shared paths and bridges shall be consistent with Austroads design guides.
- Analysis carried out by the Designer shall in any instance consider the possibility of property damage or danger to life that might occur in specific situations outside the recommended design AEP.
- Major overland flow paths within developments such as pathways or roadways shall cater for the 1% AEP event minus 50% of the minor flow (piped system, e.g. 20% AEP, see above). This is generally referred to as the "gap flow".
- Trunk drainage is excluded from the above "gap flow" design procedure and shall cater for the 1% AEP flow within the drainage structure and provide a secondary flow path that will cater for a 50% blockage.

In addition to the above, where a development is designed in such a way that the major system flows involve surcharge across private property, the underground system (both pipes and inlets with designated blockage factors) shall be designed to capture and contain 1% AEP flows from the upstream catchment. An emergency overland flow path shall also be provided for these systems. Easements shall be provided in private property over such pipe systems and overland flow paths. Restrictions shall also be placed on the property so as not to permit changes in surface levels or the construction of certain structures within these easements.

10.4.3 Impervious Area Assumptions

10.4.3.1 Minimum Lot Design Impervious Fraction

The following minimum design impervious percentages shall be used for design purposes unless alternative percentages which are based on site specific details of a proposed development are justified. Justification shall be provided to and approval shall be sought from Council's Representative.

The minimum design impervious percentage for single residential lots shall be:

- 85% for lots 450m² and smaller.
- 80% for lots 450m² to 700m².
- 75% for lots greater than 700m².

The minimum design impervious percentage for other lot types shall be:

- 5% for non-urban lots.
- 90% for medium and high density residential.
- 95% commercial or industrial developments.

10.4.3.2 Composite Areas

For modelling of urban catchments, sub-catchments are typically composite areas that include land, road reserves and open space areas, etc.

The Designer shall assess whether the adoption of typical values shown in Table 10.2 below are accurate enough for the purposes of the drainage analysis. This may be sufficient for preliminary design or master planning; however, a more accurate assessment of total impervious area may be necessary for the investigation of stormwater system failures or detailed design. For values different to those in Table 10.2 below, justification shall be provided to and approval shall be sought from Council's Representative.

Table 10.2 Composite Impervious Area Guidelines

Type of Development	Design Impervious Area (%)
Single Residential Lot Subdivisions	80
Multi-Units	90
Commercial and Service Trades	90
Group and Neighbourhood Shopping Centres	90
Town Centres	90
Industrial	90

10.5 Road Drainage

10.5.1 Road and Street Network

Urban road stormwater drainage systems are required to operate in an effective manner with minimal maintenance requirements.

The following provisions shall apply to road drainage design:

- Gutters shall be provided for all kerbs where pavement areas drain to the kerb.
- Adequate pipe and pit inlet capacity shall be provided such that surface flows up to the minor system design AEP are drained from the surface.
- Consideration must be given to the placement and location of pit inlets to minimise driveway conflicts and to adequately intercept surface water from steep grades. This particularly applies where a steep side street intersects a cross street at a T-intersection.
- The design of vehicle access crossings across the verge must take account of water flowing in the street. The verge and vehicle access crossing/driveway profile must maintain a positive grade for sufficient distance behind the kerb to avoid road flows in excess of the pipe system capacity up to the 1% AEP level from entering adjacent land.
- The use of high inlet capacity pits (0.5m³/sec) must be avoided wherever possible.
- Grate only inlet pits will not be permitted except in carriageways with narrow verges or no verges and where a kerb inlet type sump would conflict with other services.
- A cul-de-sac which falls toward the head shall have an overland flow drainage reserve from the low point in the head to ensure that flows in excess of the capacity of the pipe system, up to 1% AEP, do not cause flooding within properties. The verge shall be shaped to direct overflows to the drainage reserve.

10.5.2 Surface Flow Criteria

Surface flow criteria must be applied to minimise both nuisance and hazardous flooding conditions on roadways. The criteria shall comprise three basic limits, depending on the road lane configuration and the design storm AEP as follows:

- Flow width limit.
- Pond or flow depth limit.
- Flow velocity x depth limit (for stability of pedestrians and vehicles).

Kerb flow widths may be estimated in accordance with the procedure contained in *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Queensland Department of Main Roads (Australia) methods, or using various drainage software programs.

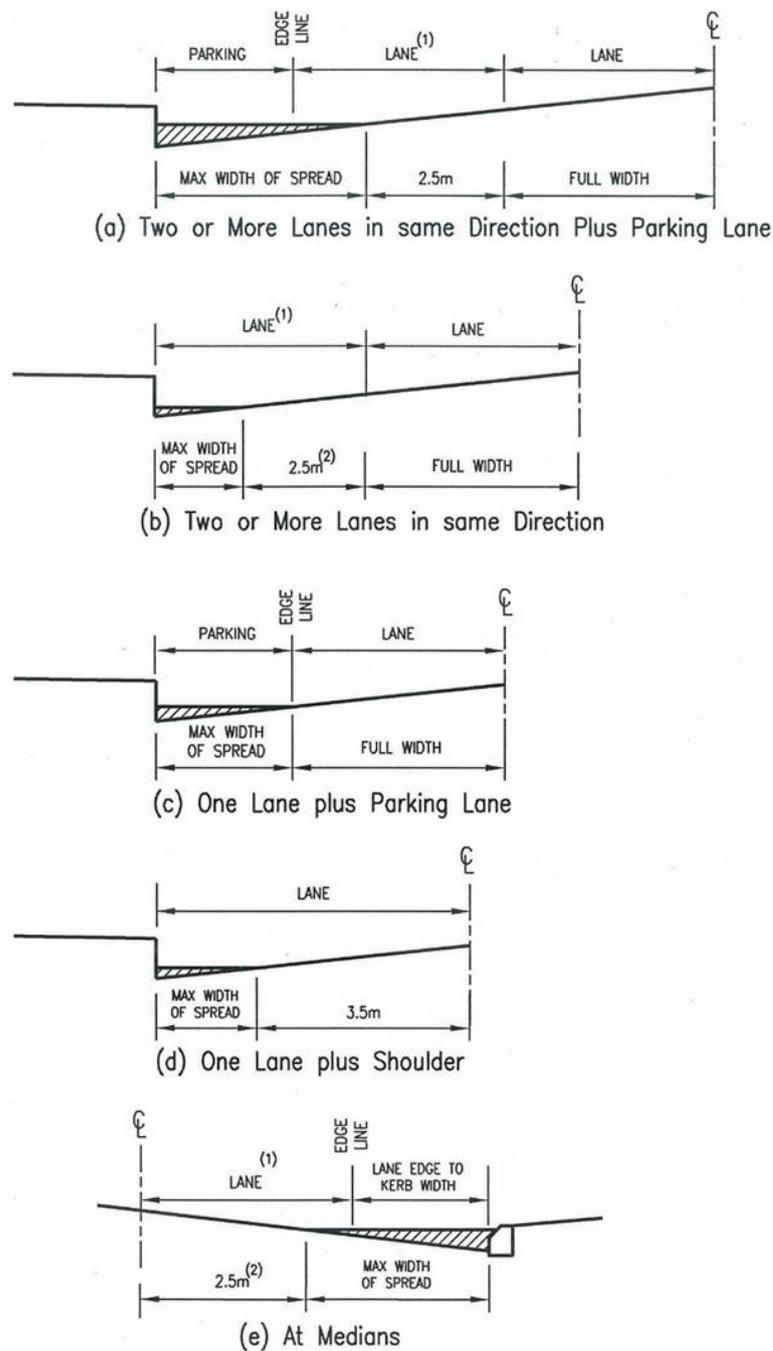
10.5.2.1 Surface Flow Criteria for Roads in Minor Storm Flow

Adopting the 20% AEP flood as that arising from the design minor storm of the same Annual Exceedance Probability, flow width criteria are shown in Table 10.3, Figure 10.1 and Figure 10.2 below.

Table 10.3 Surface Flow Criteria for Roads in Minor Storm Flow(Source: adapted from *Queensland Road Drainage Manual* Chapter 11, 2015)

Minor System Flow (20% AEP)		
Situation Code	Situation Description	Surface Flow Limit
a	Two lanes (or more) in the same direction plus parking lane	The inside and any lane-locked lanes clear plus 2.5m clear width in the remaining lane i.e. water kept out of the wheel paths of lanes
b	Two lanes (or more) in the same direction	The inside and any lane-locked lanes clear plus 2.5m clear width in the remaining lane
c	One lane plus parking lane	Water is not allowed to spread past the edge of the through lane
d	One lane plus shoulder	A minimum clear width of 3.5m is to remain in the lane
e	At medians	2.5m clear width in the traffic lane next to the median
f	At intersections without left slip lanes	The allowable width of spread adjacent to the kerb is 1.0m
g	At intersections with single left slip lanes	The allowable width of spread leaves 3.5m clear width in the slip lane
h	At intersections with dual left slip lanes	The allowable width of spread leaves 2.5m clear in outer turning lane
i	For road of lesser importance, in situations where it is difficult to achieve the required clear width of 2.5m in cases (b), (e) and (h) above	The clear width may be reduced to 1.0m. This practice is not recommended for reasons of consistency, and the use of a reduced clear width must be specified in design brief and/or contract documents or approved by Council's Representative
j	Where pedestrians will cross the road	<i>No more than</i> 0.45m width of spread (100% AEP flow); Where risk of injury is reasonably foreseeable, velocities must be limited by: $d_g V_{avg} \leq 0.4 \text{ m}^2/\text{s}$ Where: d_g = flow depth in the channel adjacent to the kerb (m), and V_{avg} = average velocity of the flow (m/s).

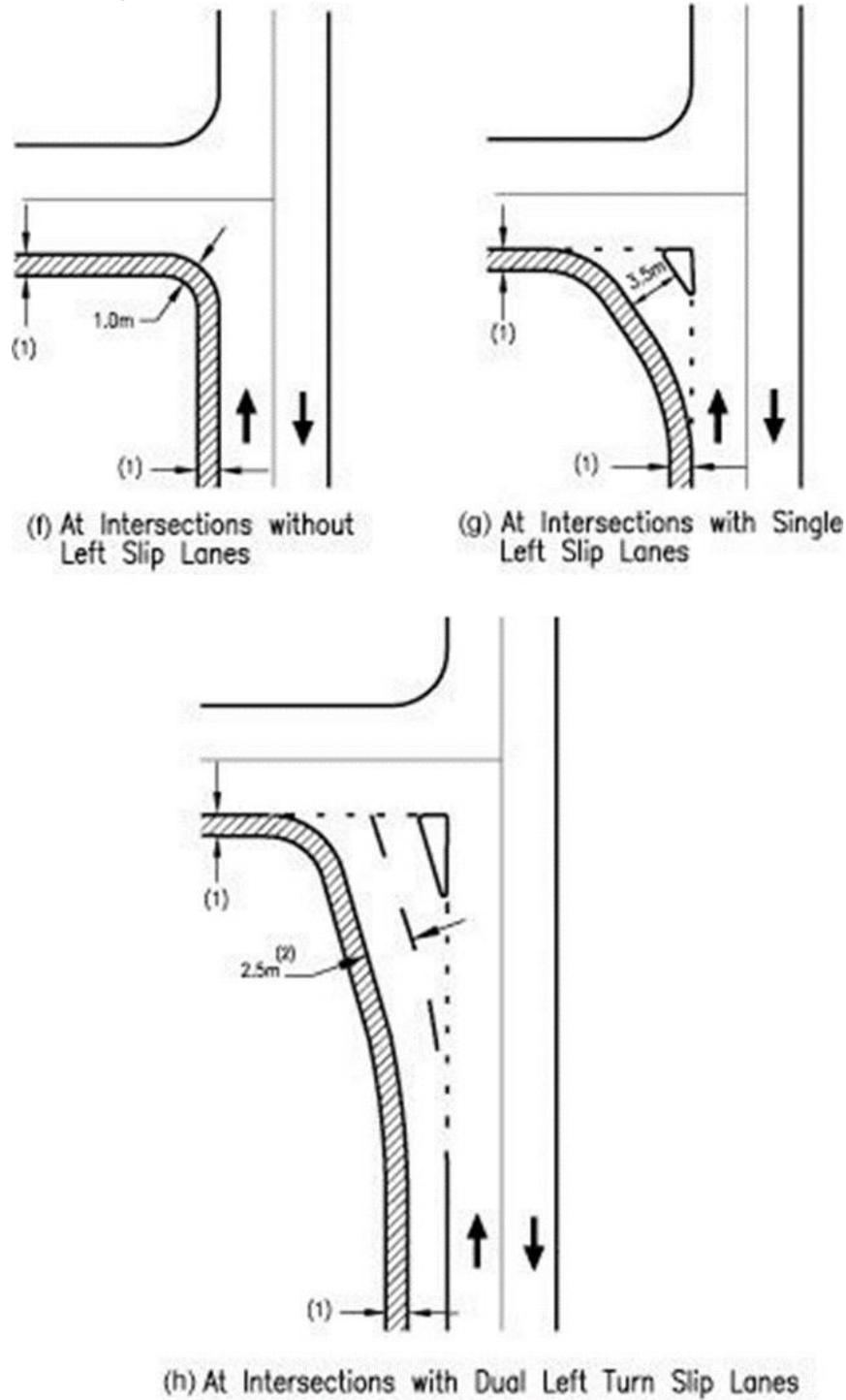
**Figure 10.1 Allowable Flow Widths on Roadways - 20% AEP Flood
(cross section views)**



Notes:

1. Lane includes auxiliary lanes and any parking lane that has the potential in the future to become used as a through lane for full or part time.
2. In situations where it is difficult to achieve the required clear width of 2.5m, the clear width may be reduced to 1.0m for roads of lesser importance (refer Table 10.3 above).

**Figure 10.2 Allowable Flow Widths on Roadways - 20% AEP Flood
(plan views)**



Notes:

1. Refer to *Figure 10.1*.
2. In situations where it is difficult to achieve the required clear width of 2.5m, the clear width may be reduced to 1.0m for roads of lesser importance (refer to Table 10.3 above).
3. At pedestrian crossings check both width and velocity (refer to Table 10.3 above).
4. See Section 10.5.2.2 for allowable widths in Major Storms.

10.5.2.2 Surface Flow Criteria for Roads in Major Storm Flow

The 1% AEP flood must be used as the major storm flow for consideration of any detrimental effects.

Table 10.4 below gives roadway flow limits for a major storm, with particular reference to floor levels of adjacent buildings, pedestrian and vehicle safety.

At sags in State-controlled roads, additional inlets and underground drainage must be provided, if necessary, to limit ponded water in a 2% AEP storm so that there is:

- One lane in each direction of travel, free of water, in a multi-lane road; or
- Width of 3.5m clear of water down the centre of a two-lane road.

Table 10.4 Surface Flow Criteria for Roads in Major Storm Flow

(Source: adapted from *Queensland Road Drainage Manual* Chapter 11, 2015)

Major System Flow (1% AEP)		
Situation Code	Situation Description	Surface Flow Limit
k	Where floor levels of adjacent building are above road level	Total flow contained within road reserve. Peak water levels at least 300mm below floor level of adjacent buildings (i.e. freeboard of at least 300mm)
l	Where floor levels of adjacent buildings are less than 350mm above top of kerb. <ul style="list-style-type: none"> • where fall on footpath towards kerb is greater than 100mm; • where fall on footpath towards kerb is less than 100mm; Where no kerb is provided	Water depth to be limited to 50mm above top of kerb. Water depth to be limited to top of kerb in conjunction with a footpath profile that prevents flow from the roadway entering onto the adjacent property. Above depths shall be measured from the theoretical top of kerb
m	Pedestrian Safety # (a) No obvious danger (b) Obvious danger	$d_g V_{avg} \leq 0.6 \text{ m}^2/\text{s}$ $d_g V_{avg} \leq 0.4 \text{ m}^2/\text{s}$
n	Vehicular Safety	Maximum energy level of 300mm above roadway surface for areas subject to transverse flow
Notes: d_g = flow depth in the channel adjacent to the kerb i.e. at the invert (m) V_{avg} = average velocity of the flow (m/s)		

Major System Flow (1% AEP)

Obvious danger is interpreted as areas where pedestrians are directed to or most likely to cross water paths (such as marked crossings and corners of intersections).

10.5.3 Major Traffic Routes

Major traffic routes (arterials and sub-arterials) shall remain at least partially operational during major storm events. Where drainage from major traffic routes is connected to urban drainage designed for a lower AEP, consideration shall be given to making the drainage for the two systems compatible to address any potential system surcharging issues.

10.5.4 Protection Drains

Carriageways in cuttings and cut batters must be adequately protected from runoff originating beyond the limits of the road. This protection will generally be cut-off drains or dished gutters.

10.5.5 Major Drainage Crossings

Crossings (e.g. bridges, culverts, etc) over major floodways and natural waterways shall be designed with reference to AS(/NZS) 5100:2017 *Bridge Design Series*; *Austrroads Guide to Bridge Technology - Set*; and *Austrroads Guide to Road Design - Drainage Set*.

Unless a full blockage analysis is undertaken in accordance with Chapter 6 (Blockage of Hydraulic Structures) within *ARR 2019 Book 6 (Flood Hydraulics)*, the following shall apply:

- Waterway crossings with diagonal openings equal to or less than 6m, shall be designed for 50% blockage - applied from the bottom up, where applicable.
- Larger waterway openings shall be designed for 20% blockage - applied from the bottom up, where applicable.

10.5.6 Pedestrian Underpasses

Pedestrian underpasses shall be provided with sufficient longitudinal grade to facilitate free drainage wherever possible.

Where a self-draining underpass is not possible, the underpass drainage system shall be designed for a 1% AEP capacity.

Where an underpass is part of an engineered waterway, the free draining underpass drainage system shall be designed for a 20% AEP. The level of footpaths and/or cycleways shall be above the 40% AEP flood level in the engineered waterway. A floodway advisory sign shall be provided on each approach to the underpass.

10.6 Stormwater Drainage Systems

10.6.1 General Stormwater Drainage Conduit Requirements

Stormwater drainage conduit types shall be in accordance with the requirements of Council's *Civil Works Specification - Construction Specification* Section 6.2 Acceptable Materials for Stormwater Pipes and Box Culverts.

Reinforced concrete is the preferred material for stormwater drainage systems. The use of polypropylene (PP) pipe materials is acceptable for pipe systems up to 600mm diameter. Proposals for the use of other materials shall be referred to Council's Representative for consideration.

The minimum pipe size shall be nominal 375mm diameter. The minimum internal dimensions of any box culvert in a Council drainage system shall be 600mm width and 300mm depth.

All pipes proposed for use shall be manufactured, supplied and used in accordance with relevant Australian Standards.

Pipes need to be capable of resisting mines subsidence, root intrusion, hydraulic pressure, soil and construction loading, and have some flexibility at joints. Pipe jointing types shall be as required by Council's *Civil Works Specification - Construction Specification* Section 6.6.1 Pipes.

The maximum allowable pressure head for all pipes shall be in accordance with the appropriate Australian Standard and the manufacturer's specifications for use.

10.6.2 Locations and Alignments

10.6.2.1 Roadway Reserves

The longitudinal alignment of pipes and culverts in roads shall be located under the kerb alignment and the back outside face of the pipe or culvert shall not extend behind the back of the kerb.

The alignment of standard grated gully pits with extended kerb inlet shall comply with Council's *Civil Works Specification - Standard Drawings*.

Straight drainage alignments are preferred. However, curved alignments may be permitted with approval of Council's Representative (refer to Section 10.9.11 Curved Pipelines).

10.6.2.2 Private Land

New stormwater systems through existing private land must be avoided. However, where such works cannot be avoided, the Designer shall refer the proposed design to Council's Representative for review before completion of the design.

Generally, a stormwater system shall not be located within proposed private land, except where it is intended solely for the purpose of providing interallotment drainage. Stormwater systems shall be located such that access for maintenance and future upgrades can be readily achieved and restrictions imposed on the use of the land due to the presence of the stormwater system are minimised.

Generally, no buildings or overhanging structures are permitted over Council's stormwater drainage system, to enable access and maintenance and to ensure that any required overland flow path is not impeded, particularly by debris blockage, unless specifically approved by Council's Representative.

Wherever stormwater systems are required along common boundaries, they must be located along the low side of the uphill property.

Stormwater systems proposed to be constructed in parallel to sewers shall generally be shallower than the sewer to facilitate future connections.

Where a proposed development abuts undeveloped land, which has the potential to be developed, the possibility of shared stormwater drainage shall be considered as it is undesirable to maintain unnecessary parallel drainage systems. Co-ordination of stormwater drainage to avoid future doubling up of services shall be discussed with Council's Representative.

Alignments shall be offset sufficient distance from building lines to allow working room for excavation equipment and all excavation trenches shall be outside the zone of influence of any structures.

10.6.2.3 Public Lands

Proposals to locate stormwater systems within public land such as open space shall be brought to the attention of the Council's Representative. Alignment of stormwater systems on public lands shall be located with consideration to public safety, maintenance access and future land use.

10.6.2.4 Clearance from Other Services and Utilities

Minimum clearances have been established to reduce the likelihood of damage to stormwater systems or other services and utilities, and to protect personnel during construction or maintenance work. Refer to Council's *Civil Works Specification - Construction Specification* Section 7.7.2 Stormwater Drainage.

Under no circumstances shall stormwater systems be:

- Locally deflected from their proposed alignment to avoid other services, utilities or other obstacles.
- Located longitudinally directly above or below other underground services or utilities in the same trench.

Where a stormwater system crosses or is constructed close to an existing service, potholing shall be undertaken to confirm depth, alignment and asset details at the design stage. Design documentation shall instruct the Service Provider to confirm the location and level of the existing services prior to constructing the proposed stormwater system.

Minimum clearances between stormwater systems and other underground services and utilities shall be in accordance with requirements specified by the service or utility asset owner. **It is the Designer's responsibility to obtain the current minimum clearances from each service or utility asset owner. The required minimum clearances shall be clearly stated on the Design Drawings so that the Service Provider is able to confirm that the required clearances can actually be achieved.**

Where a stormwater system will be located within close proximity to another service, the Designer shall ensure that the requirements of the relevant Authority are met, and the estimated clearance is clearly labelled on the Design Drawings.

Stormwater systems shall be designed such that maintenance and future upgrades can be performed without the risk of inadvertent damage to the assets of other Authorities.

10.7 Interallotment Stormwater Drainage

Interallotment drainage shall be provided for every allotment which does not drain directly to its street frontage and for high side properties fronting roads with either kerbing that is unable to satisfactorily accommodate kerb outlets or where the road has one-way crossfall. The interallotment drainage shall be deep enough to serve the entire allotment; property inlets shall be constructed at the low corner of each lot in accordance with Council's *Civil Works Specification - Standard Drawings*.

A maximum of **10 allotments** shall be served by an interallotment drainage system. Council reserves the right to restrict the maximum number of allotments served based on catchment characteristics and potential for runoff concentration onto downstream properties.

Interallotment drainage in residential areas shall be designed to accept concentrated drainage from buildings and paved areas on each allotment for **5% AEP design flow rates** unless otherwise advised by Council's Representative for other land use zones.

Stormwater discharge from adjoining existing lots onto proposed development sites shall be catered for by the Service Provider by the provision of an interallotment drainage system providing a point of connection for each existing adjoining lots. This will necessitate the construction of the drainage system and creation of easements in favour of the existing properties.

Interallotment drainage shall be placed centrally within easements with a minimum width of 1.5m. The easements shall be created in favour of benefiting allotments. Ongoing maintenance of interallotment drainage remains the responsibility of the benefitting allotments.

Where future developed impervious areas cannot be determined, the assumed impervious surface areas in Table 10.5 below shall be used.

Table 10.5 Assumed Impervious Surface Area

Development Type	Minimum % of Lot Area
Residential lots	85
Industrial	90
Commercial	90

Pipes shall have a minimum diameter of 225mm and designed to flow full at the design discharge without surcharging of pits. Consideration shall be given where connections are proposed to other systems designed under pressure.

Interallotment drainage systems shall be constructed from the following pipe types and joints types shall be rubber rings:

- Fibre-reinforced concrete pipe - AS 4139:2003 *Fibre reinforced concrete pipes and fittings*.
- Reinforced concrete pipe - AS/NZS 4058:2007 *Precast concrete pipes (pressure and non-pressure)*.
- uPVC pipe - AS/NZS 1254 PVC-U pipes and fittings for stormwater and surface water applications.

Pipes shall have a minimum cover of 300mm and a desirable minimum grade of 1%.

Where interallotment drainage and sewer mains are laid adjacent and parallel to each other they shall be aligned at 750mm between pipe centre lines unless pipelines are greater than 300mm diameter for which the minimum clearance between pipes shall be at least 450mm. The sewer shall be located closest to the dwelling being served and may need to be contained within a separate easement.

Where sewer mains are in close proximity to interallotment drainage lines they shall be shown on the interallotment drainage plan.

10.7.1 Interallotment Drainage Pits

Inter-allotment drainage pits shall be located at the low corner of each lot, at all changes of direction and at distances no greater than 60m.

All pits shall be cast in-situ and/or precast concrete to the relevant Australian Standards, as required by specific pit dimensions and constructability requirements. Council reserves the right to approve the type and quality of any proposed precast products prior to installation and shall require all quality documentation to be submitted in support of the proposed products prior to approval.

Connection of roof water drainage for single residential dwellings shall be provided by connecting a minimum 100mm diameter stub into the side of the pit.

The use of pits other than precast or cast in-situ are prohibited, i.e. pits shall not be constructed of plastic or fibreglass.

All pit grates shall be hinged and lockable. Grates not complying shall be removed and replaced with hinged and lockable grates, i.e. drop-in grates are not acceptable. All pit grates shall be locked at all times and re-locked after final inspection and acceptance of pits by Council's Representative.

Minimum pit sizes; inlet and grate types shall be in accordance with Table 10.6 Pits in Driveways (Right of Carriageway, Right of Way and Access Handle) and Table 10.7 Interallotment Drainage Pits (for Pits not Situated in Driveways).

Pits located in driveways (Right of Carriageway, Right of Way and Access Handle) shall be cast in-situ. Where an inlet is located in an open drain, the inlet shall be a raised grated inlet.

Pits in excess of 3.5m in depth require a design by a Structural Engineer with details submitted to Council for approval. Certification shall be provided to Council following construction of the pits.

The minimum length of kerb inlet shall be 900mm. Where the flow rate and/or grade warrant, an extended kerb inlet shall be used. In circumstances where physical constraints such as width do not permit a kerb inlet, an adequate number of grated inlet pits shall be installed.

Table 10.6 Pits in Driveways (Right of Carriageway, Right of Way and Access Handle)

Depth to invert D (mm)	Internal Pit Size (mm)	Inlet type	Grate size and type
D < 1800	900 x 670	Kerb Inlet	900 x 450 Heavy-duty hinged grate
D ≥ 1800	900 x 900	Kerb Inlet	900 x 450 Heavy-duty hinged grate

Table 10.7 Interallotment Drainage Pits (for Pits not Situated in Driveways)

Depth to Invert D (mm)	Internal Pit Size (mm)	Inlet Type	Grate size and type
D < 450	450 x 450	Grated Surface Inlet	450 x 450 hinged grate
450 ≤ D < 900	600 x 600	Grated Surface Inlet	600 x 600 hinged grate
900 ≤ D < 1200	900 x 600	Grated Surface Inlet	900 x 600 hinged grate
1200 ≤ D < 1800	900 x 600	Grated Surface Inlet	900 x 600 hinged grate
D ≥ 1800	900 x 900	Grated Surface Inlet	900 x 900 hinged grate

10.8 Stormwater Drainage Easements and Reserves

10.8.1 General Requirements - Easements

A drainage easement shall be wide enough to contain the pipeline and provide working space on each side of the pipeline for future maintenance activities. Stormwater pipelines shall be laid centrally within the easement unless approved by Council's Representative.

Only pipelines up to and including 675mm diameter may be located in easements within private properties. Larger diameter pipelines shall be located outside private properties in open space or in separate drainage reserves.

In some developments, direct maintenance access to a stormwater system within a lot may be difficult or prevented entirely. In such cases, easements and interallotment pipelines shall not terminate at a dead end but shall be extended to a point where access may be gained from a road reserve or other

public area with direct access. A junction pit shall be located on both ends of the pipeline to facilitate access. Easements shall be provided in private property over public and interallotment drainage systems and overland flow paths. The minimum width of easement shall be as follows:

Table 10.8 Minimum Easement Widths

Pipe Diameter (mm)	Minimum Easement Width (m)
Interallotment drainage (≤ 300 maximum)	1.5
375 to 675	2.5
750 to 900	3.0
1050 to 1200	3.5
1350 to 1500	4.0
1650 to 1800	4.5

For multi-cell pipes/culverts a minimum clearance of 500mm from the outer edge of the pipes/culverts will be required for the easement width, with the easement width increasing in 500mm intervals.

Where the depth of stormwater pipe is greater than 3m the easement width shall be approved by Council's Representative.

Generally, no buildings or overhanging structures are permitted over drainage easements for Council's stormwater drainage system. Overland flow paths within drainage easements shall require property restrictions to ensure the shape, alignment and capacity of the overland flow path remains unaltered.

10.8.2 General Requirements Drainage Reserves

Consideration shall be given to the multi-purpose use of drainage reserves such as open space or pedestrian corridors.

Minimum widths of drainage reserves or pathways and public reserves containing stormwater pipes shall be in accordance with Table 10.9 below unless otherwise directed by Council's Representative.

Table 10.9 Minimum Drainage Reserve Widths

Drain Width (mm)	Reserve Width (m)
0 – 3.0m deep	
Less than 750	3.0
750 to 900	3.5
1050 to 1200	As directed
3.0 – 6.0m deep	
Less than 525	3.5
525 to 675	4.0
750 to 900	4.5
1050 to 1200	As directed

Note: Where other services are located within the same reserve, the required reserve width shall be increased to provide adequate clearance between services.

10.9 Hydraulic Design and Pipeline Design

10.9.1 Hydraulic Grade Line (HGL)

Hydraulic calculations shall be undertaken by a qualified person experienced in hydrological and hydraulic design, and be based on *ARR 2019*, in particular:

- Chapter 4 (Numerical Models) within *Book 6 (Flood Hydraulics)*.
- Chapter 5 (Stormwater Conveyance) within *Book 9 (Runoff in Urban Areas)*.
NOTE: The approach will be reviewed upon completion of Chapter 6 (Modelling Approaches - currently in preparation) within Book 9 (Runoff in Urban Areas).

The hydraulic design shall be calculated assuming full pipe flow and shall be described in the Design Drawings and supporting documentation by:

- Hydraulic grade line on pipe profiles with accompanying levels at inlets, pits and outlets.
- Calculations of adopted water level controls, tail water levels and flood levels applying to the site.
- Appropriate allowances for climate change shall form part of the design flow rate.
- Tabulation of calculations in association with hydrological calculations.
- Inclusion of listings of all software program input and output.

Downstream hydraulic grade line level requirements for design are available from Council's Representative and shall be determined from the following criteria:

- If the outlet is into a Coastal Lagoon, then the adopted HGL at the downstream outlet shall be equal to the adopted "let out" level adopted at that time for that particular lagoon.
- If the outlet is at a location where Council has flood mapping available, then the 20% AEP (5-year ARI) flood level at that location shall be adopted. This will apply for estuaries, creeks and areas of overland flooding.

10.9.2 Design Criteria

Pipes shall be designed by a hydraulic grade line (HGL) method assuming full pipe flow using appropriate pipe friction and drainage structure head loss coefficients.

The hydraulic grade line level in drainage pits shall be limited to 150mm below the gutter invert, 150mm below surface inlet level and 150mm below the underside of the lid for junction pits unless otherwise approved by Council's Representative.

10.9.3 Grades

The longitudinal grade of a pipeline between drainage structures shall be calculated from midpoint to midpoint of such structures. A minimum of 50mm fall shall be allowed in all drainage structures which shall be shown by the level difference of the inflowing pipe(s) and the out flowing pipes at the midpoint. In areas where this cannot be achieved approval shall be obtained from Council's Representative.

10.9.4 Minimum Grades and Velocity

Stormwater pipelines shall be designed and constructed to be self-cleansing, e.g. free from accumulation of silt. The desirable minimum grade for pipelines with a diameter less than or equal to 600mm is 2% and with a diameter greater than 600mm is 1.0%. The minimum pipe full flow velocity shall be 0.6m/s.

A minimum grade of 0.5% may be acceptable where steeper grades are not practicable. Such instances require the approval of Council's Representative prior to finalising designs.

10.9.5 Maximum Grades and Velocity

Pipeline grades shall be chosen to limit the pipe full flow velocity to a desirable maximum value of 3.5m/s. The manufacturer's guidelines shall not be exceeded. Where the manufacturer's guidelines allow greater than 3.5m/s, approval from Council's Representative is required. Particular care shall be taken to consider the requirements of high energy flows on pit design, pipeline joint pressure capabilities and the potential need for pipe outlet scour protection measures.

10.9.6 Scour Stops, Trenchstops, Bulkheads

Pipelines laid on steep slopes and in relatively impervious materials such as rock shall be protected from failure due to wash-out of bedding and backfill by the use of scour stops, trenchstops or bulkheads. Measures shall be considered by the Designer and detailed on the drawings. Details will be required for all pipeline grades are greater than 20%. Refer to Council's *Civil Works Specification - Standard Drawings*.

10.9.7 Vertical Angles

Stormwater pipelines shall be constructed so that the bore of the pipe has no point where debris can lodge and cause reduction in capacity. The use of vertical angles shall not be permitted.

10.9.8 Allowable Pipe Diameters

10.9.8.1 Minimum Diameters

Council Drainage Systems

The minimum diameter for stormwater pipelines is 375mm.

Interallotment Drainage Systems

The minimum diameter for stormwater pipelines is 225mm other than for individual residential stubs and connections which may be 90mm diameter where capacity is sufficient.

Private Drainage Systems

The minimum diameter for stormwater pipelines shall be in accordance with AS/NZS 3500.3 *Plumbing and drainage - Stormwater drainage*.

10.9.9 Structural Design of Pipelines and Box Culverts

10.9.9.1 Minimum Design Service Life

Pipelines and culverts shall be designed and installed for a minimum effective service life of 100 years. All stormwater conduits subject to continual submergence, particularly at stormwater system outlets

into waterways, coastal locations or other potentially corrosive environments, shall have a marine grade durability classification.

10.9.9.2 Minimum Depth

The minimum cover over stormwater pipe lines that will become Council's Asset shall be 700mm from top of pipe to finished surface level or gutter invert level for road drainage.

Pipe depth shall satisfy the cover requirement for the nominated class of pipe, bedding type and construction loadings determined from AS/NZS 3725 *Design for installation of buried concrete pipes*.

Box culvert depths shall satisfy the cover requirement for box culvert roadway load class, bedding type and construction loadings determined from AS 1597.1 and AS 1597.2 *Precast reinforced concrete box culverts*.

10.9.9.3 Maximum Depth

The maximum depth of stormwater pipelines to invert level shall be 6m.

In special cases (e.g. for a short length of pipeline through a ridge), approval must be obtained from the Council's Representative to exceed this limit.

10.9.9.4 Reinforced Concrete Pipe and Box Culvert Class

Pipe class shall be selected to provide adequate strength to meet overburden and traffic loads determined from AS/NZS 3725 *Design for installation of buried concrete pipes*. Pipe class shall be calculated assuming a HS support condition for pipes under road pavements and for pipes not under a road pavement.

In calculating pipe class consideration shall be given to design loading and assumed construction loads. Where load limits are intended to apply, the location and load limitation shall be clearly shown on the drawings along with appropriate signs to be installed identifying the load limit.

Box culvert roadway load class shall be selected to provide adequate strength to meet overburden and road traffic loads determined from AS 1597.1 and AS 1597.2 *Precast reinforced concrete box culverts*.

When designing box culverts for use in marine environments, requirements for exposure classification in accordance with AS 3600 *Concrete structures* shall be provided on the Design Drawings.

Drainage pipes installed within road reserves where TfNSW is the roads authority shall be RCP Class 4.

10.9.10 Connection to Structures

Where pipes are connected to rigid structures or are embedded in concrete, flexible joints shall be provided to minimise damage caused by differential settlement. Details of required flexible joints and their locations shall be detailed on the drawings.

Private connections into Council's stormwater drainage system are to be made at a drainage pit. Direct connections into Council's drainage pipelines are not favoured and are generally not permitted. However, Council may consider a direct connection into a drainage pipeline with a 150mm diameter or smaller PVC pipe connection using a proprietary connection fitting system, which shall be approved by Council's Representative.

10.9.11 Curved Pipelines

Curved stormwater pipelines may be utilised wherever there are significant advantages in their use. Ad hoc curving of pipelines to avoid obstacles such as trees, power poles, gas mains, etc is not permitted. Curved pipelines should be positioned to follow easily identifiable surface features, e.g. parallel to a kerb line.

When curved pipelines are used the following shall apply:

- Curved pipelines shall have a constant radius.
- Curved pipelines shall have a single horizontal plane only (no vertical curves or reverse curves).
- The maximum deflection angle shall be as recommended by the pipe manufacturer for a particular pipe.
- Splayed pipes may be used to construct a curved pipeline provided that the curve is totally formed by the splays. Splayed pipes shall be factory formed.

Design Drawings shall show the following curve information:

- Centre line radius.
- Pipe type (normal or splayed).
- Effective length of individual pipes (if other than standard length).
- Type of jointing.
- The Designer shall provide documentation to show that the above details are within the pipe manufacturer's specifications.

10.9.12 Dead End Pipelines

Dead end pipelines are not permitted. All Council or proposed Council stormwater pipes shall terminate at pits or inlet/outlet structures. Short lengths of pipe may be detailed at end pits to facilitate future connection.

10.9.13 Interallotment Drainage Connections

Connection of interallotment pipe systems to Council's drainage systems shall be made at a Council stormwater pit or by way of an approved discharge structure into an open channel or watercourse.

Where a new junction pit is required to accommodate interallotment drainage connection approval is required from Council's Representative.

10.10 Road Culvert Design

A culvert is a stormwater drainage structure designed to satisfy the hydraulic requirement associated with conveying water under roads and to have structural strength to carry construction or highway traffic loads and loads associated with the road formation.

10.10.1 General

Box and pipe culverts shall be designed in accordance Austroads - *Guide to Road Design - Drainage Sets - Part 5, Part 5A and Part 5B*.

Design of pipe or box culverts shall consider and make provisions acceptable to Council for maintenance of the culvert.

10.10.2 Major System Requirements

Box or pipe culverts may be used as part of the major stormwater system in engineered waterways for road crossings.

Culvert crossings shall be designed for a 1% AEP flow and be in accordance with Council's Flood Policy. The policy requires that new structures do not increase the 1% flood level more than 10mm for areas outside the development site both upstream and downstream of the structure or outside the immediate site. Appropriate allowances for climate change shall form part of the design flow rate.

An upstream freeboard of at least 600mm, for a 1% AEP flow, shall be provided, unless an alternative is approved by Council's Representative.

Culvert crossings shall be designed without afflux unless otherwise agreed with Council's Representative.

Major structures within rural area shall be designed to accommodate the 1% AEP flood events. A maximum 200mm depth of flow combined with a maximum velocity of 1m/s is permitted over the top of the structure (Refer to 10.12.1 General Requirements – Flow Paths).

A minimum clearance of 500mm between the 1% AEP flood level and the underside of any bridge superstructure is required to allow for passage of debris without blockage.

Certified structural design shall be required on bridges and other major culvert structures and may be required on some specialised structures. The design shall be carried out in accordance with AS(/NZS) 5100 *Bridge Design Series* and Austroads *Guide to Bridge Technology*.

Culverts (either pipe or box section) shall be designed with due regard being given to inlet and exit losses, inlet and outlet control and scour protection.

10.11 Stormwater Pits – Inlet and Junction

10.11.1 General

Stormwater pits shall be designed to efficiently conduct storm flows from the design surface to the underground pipe system.

When designing pit locations, consideration shall be given to stormwater overland flow widths, hydraulic efficiency, vehicle, bicycle and pedestrian safety, debris collection potential and maintenance. A risk assessment approach shall be applied when designing stormwater pit and pipe inlets that may be accessed by the public. Inlet pipe diameters greater than 300mm shall be covered with a grate, grille and/or safety screen structure with a maximum gap of 150mm to prevent entry by a child. Refer to the latest edition of *Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia* and the *Queensland Urban Drainage Manual* for further guidance.

10.11.2 Council Standard Pit Types

Pits shall conform to Council's current *Civil Works Specification - Standard Drawings*. Where a proposed pit does not comply with Council's *Standard Drawings*, the pit shall be detailed on the Design Drawings and approved by Council's Representative.

Inlet capacities of kerb inlet pit shall be documented within the design report.

10.11.3 Design Kerb Inlet Sizes

Kerb inlet lengths (lintels) shall be a minimum of 1.2m and maximum of 3m. Kerb inlet lengths of 900mm may be considered by Council's Representative in justifiable circumstances. Kerb inlet lengths refer to clear opening.

All grates within road reserves and pathways shall be 'bicycle friendly'.

All grate types shall have a load rating suitable for the location of the grate and adjacent areas. Heavy-duty grates shall be a minimum requirement in all locations. However, extra heavy-duty grates shall be used where frequent heavy vehicle loading will be encountered. The load rating of the grate shall be specified on the Design Drawings. Lintels and grates in road reserves shall be specified in the design and installed with a minimum **Load Class D** rating in accordance with AS 3996 *Access covers and grates*.

10.11.4 Location

Inlet pits shall be located to prevent ponding and to limit flow widths and depths to acceptable levels in accordance with this *Design Guideline*. Preference shall be given to the location of drainage pits at the upstream side of lots, upstream side of pedestrian crossing points and kerb returns.

Pits shall be provided as follows:

- To enable access for maintenance.
- At changes in pipeline direction, grade, size, level or class of pipe (if required due to dimensional difference).
- At junctions of pipelines.
- At low points in road gutters, i.e. sag pits.
- Within overland flow paths.

Pits within the road pavement shall be avoided unless otherwise approved by Council's Representative. Future maintenance requirements shall be considered as part of this approval.

Kerb inlet pits for all roadways shall be located such that gutter flow widths do not exceed the surface flow limits specified in Section 10.5.2 Surface Flow Criteria.

10.11.5 Maximum Pit Spacing

The maximum recommended spacing of pits where flow widths are not critical is 80m. However, closer pit spacing (say 50m maximum) is desirable for pipe grade control and future pipe maintenance requirements.

10.11.6 Junction Pits

Junction pits may be used where there is no requirement at the pit location to collect surface water. Refer to Council's *Civil Works Specification - Construction Specification* Section 6.9.6 Access Opening Covers for Junction Pits and Drainage Structures.

10.12 Flow Path and Open Channel Design

10.12.1 General Requirements – Flow Paths

Flow paths shall be designed in accordance with *ARR 2019*, in particular:

- Chapter 5 (Stormwater Conveyance) within *Book 9 (Runoff in Urban Areas)*, and
- Chapter 7 (Safety Design Criteria) within *Book 6 (Flood Hydraulics)*.

Flow path designs shall address the following items as a minimum:

- Velocity depth criteria for safety of vehicles and pedestrians.
- Containment of flows within the designated flow path area.
- Transition of flows between different flow path formations to ensure no inundation of private property.
- Surface treatment of the flow path to ensure ongoing flow path capacity with minimal maintenance.

10.12.2 General Requirements – Open Channels

Open channels that form part of the trunk drainage system to cater for major event (1% AEP) flows shall be designed to have smooth transitions with adequate access provisions for maintenance and cleaning.

Design of open channels shall be in accordance with:

- Chapter 2 (Open Channel Hydraulics) within *ARR 2019 Book 6 (Flood Hydraulics)*.
- Chapter 5 (Stormwater Conveyance) within *ARR 2019 Book 9 (Runoff in Urban Areas)*.
- Chapter 7 (Safety Design Criteria) within *ARR 2019 Book 6 (Flood Hydraulics)*.
- Austroads - *Guide to Road Design - Drainage Set* unless otherwise specified.

Open channel systems shall be designed to contain the major flow with the required freeboard.

Designs shall be carried out to adequately accommodate the following:

- Hydraulic jumps/supercritical flows.
- Transitions and constrictions of the channel - backwater effect.
- Superelevated flows (around bends).
- Freeboard/provisions for debris under structures, etc.
- Prevention of persons falling or being swept into the open channel.
- Permit easy escape by persons from flood waters.
- Catch rails, side bays or other escape devices as required.
- Minimise velocities or average velocity depth products recognised to safe limits.

Surface treatments of open channels shall be designed to retain channel capacity with minimal maintenance. Due allowance in design capacity shall be made to cater for proposed fully established vegetation treatments. Proposed surface treatments shall be discussed with Council's Representative at the preliminary design stage.

The open channel design must be in accordance with the current, NSW Department of Primary Industries, NSW Office of Water and NSW Local Land Services requirements.

Suitable exclusion fencing acceptable to Council's Representative shall be provided along open channel sections that cannot satisfy safety criteria. Fencing shall make adequate allowance for other safety treatments, maintenance and emergency access.

Calculations supporting the design of all open channels shall be provided as part of the approval process for Design Drawings.

10.12.3 Location

Flow paths and open channels shall be located wholly outside private property unless specifically approved by Council's Representative.

Open channels shall generally be located along the alignment of existing watercourses and drainage depressions. Diversion of open channels away from natural drainage paths shall not be permitted.

10.12.4 Freeboard

The minimum freeboard above the "gap flow" for flow paths shall be as shown in Table 10.10 below. Where Table 10.10 does not address a particular situation, freeboard requirements shall be discussed with Council's Representative.

Table 10.10 Minimum Freeboard Flow Paths

Flow Path Type	Minimum Freeboard [#] (mm)
Where adjacent to habitable floor levels	500
Swales and pedestrian pathways adjacent to property boundaries	300
Open channels to the top of channel formation	300

Additional allowance for sea level rise (SLR) shall be applied in accordance with the current Council policy and/or relevant Floodplain Risk Management Study or Plan.

The minimum freeboard above the 1% AEP design flow level for open channels shall be 300mm to the top of the channel formation. This shall be increased to 600mm in mine subsidence areas.

10.12.5 Grades

10.12.5.1 Minimum Grades

Open Channels and flow paths shall be constructed with sufficient longitudinal grade to ensure that unintentional ponding and/or the accumulation of sediment does not occur, particularly in locations where sediment removal would be difficult.

Flow paths shall generally have a minimum longitudinal grade of 0.5%.

10.12.5.2 Maximum Grades

Open Channels and flow paths shall be designed with longitudinal grades that minimise:

- Hydraulic jumps.
- Dangerous conditions for the public.
- Potential erosion.

Longitudinal grades shall be chosen such that the 1% AEP flow or "gap flow" will not exceed the average velocity limits shown in Table 10.11 below.

Table 10.11 Maximum Average Flow Velocities

Location	Average Flow Velocity (m/s)
Open channels	2
Swales and flow paths	2
Open channel low flow inverts	4

10.12.5.3 Drop Structures

Drop structures must be provided to reduce waterway longitudinal grades such that 1% AEP average flow velocities meet the requirements of Table 10.11 Maximum Average Flow Velocities above.

Drop structures shall be in accordance with the current NSW Department of Primary Industries, NSW Office of Water and NSW Local Land Services requirements.

Scour protection shall be provided at the upstream edge and downstream toe of the structure.

10.12.6 Advisory Signs

Floodway advisory signs shall be provided adjacent to open channels, natural waterways and flow paths where pedestrian safe velocity depth ratios cannot be achieved, refer to Section 10.12.1 General Requirements – Flow Paths. The location of signs shall be shown on the Design Drawings.

The signs shall be located at points of anticipated pedestrian traffic and shall be discussed with Council's Representative prior to incorporation into any design.

10.12.7 Batter Slope Requirements

Batter side slopes on open channels and flow paths shall generally not exceed six horizontal to one vertical (6:1) for reasons of public safety. Steeper side slopes up to a maximum of four horizontal to one vertical (4:1) may be allowed where adequate provision for public safety have been incorporated into the design. The use of steeper batter slopes shall be discussed with Council's Representative prior to incorporation into any design.

10.12.8 Low Flow Provision

Low flow provisions in open channels (man-made or altered channels) will require low flows to be contained within an approved treatment generally at the invert of the main channel.

The low flow system shall be designed to convey as a minimum a 1 in 3-month return interval flow. Adequate scour protection shall be provided adjacent to and within the above ground low flow system and any other areas as required.

The low flow system may also incorporate water quality treatment measures. Subsurface drainage may be required for grass-lined low flow channels to prevent waterlogging of the channel.

10.12.9 Erosion and Scour Protection

The design average flow velocity limits specified have been selected to prevent erosion and scour of surfaces under normal flow conditions. However, waterways may be subject to intense local erosion or scour at obstructions (e.g. bridge piers and pipe headwalls), sudden changes in waterway cross sections, drops, regions of changes in waterway bed materials and other similar conditions.

Locations where specific erosion and scour prevention measures shall be considered include:

- Transitions - any changes in cross section or changes in the channel or flow path surface material. Particular attention must be paid to the region immediately alongside low flow inverts.
- Bends - the outside bank on bends subject to higher flow velocities.
- Pipeline outlets - flows from pipelines will normally be of relatively high localised velocity.
- Tributaries - other open channels entering the main channel/natural system may cause turbulence and erosion of the channel invert and banks.
- Energy dissipater structures - changes in the flow regime will usually occur immediately upstream and downstream of drop structures and energy dissipation basins.
- Culverts - exit velocities from culvert crossings will normally be supercritical.
- Bridges and underpasses - flow velocities around piers and abutments may be higher than the waterway limit.

Permanent erosion and scour protection must be provided to suit the location soil characteristics. Measures shall be detailed on the Design Drawings. Advice from a Geotechnical Engineer or soil erosion consultant may be required to identify soil characteristics.

All measures based on the identified soil characteristics shall be detailed on the Design Drawings.

10.13 Detention Basins

10.13.1 General

Detention basins may be provided as an integral part of the major drainage systems to either:

- Provide a more economic system by reducing downstream flow rates and waterway reserve widths; **or**
- Meet a specific planning or floodplain risk management plan requirement that downstream flow rates do not exceed pre-development values for both the major and minor system design AEP.

It must be recognised that the provision of a detention basin is only one method in several techniques available to manage stormwater runoff and therefore must be tested against other drainage strategies to arrive at the optimum solution to meet either of the above objectives.

The provision of detention basins in the drainage system must be planned and designed as part of an overall catchment drainage strategy.

The Designer shall satisfy the requirements of the NSW Dams Safety Committee. Submission of design plans and risk assessment may be required.

Embankments shall be designed and constructed such that they will not breach under any operating conditions for all flows up to and including 1% AEP. Generally, the maximum inundation period during the critical duration 1% AEP design storm shall be 72 hours to prevent long term damage to surfaces. However, this will depend on any secondary usage of the basin.

Detention basins shall not cause floodwaters up to and including the 1% AEP event to inundate upstream roads or land.

10.13.2 Analysis

The Designer shall model the performance of the basin using a range of design storms and long-term records of rainfall to determine the maximum storage requirements and the size of outlets for the basin.

A hydrograph estimation technique shall be used to estimate appropriate inflow hydrographs to the basin. Inflow hydrographs shall be routed through the basin using full reservoir routing calculations to determine the basin characteristics and resultant outflow hydrographs.

Modelling of flood routing shall demonstrate that the basin does not have an adverse impact on the total catchment mainstream flooding, and be based on *ARR 2019*, in particular:

- Chapter 5 (Flood Routing Principles) within *Book 5 (Flood Hydrograph Estimation)*.

- Chapter 4 (Stormwater Volume Management) within *Book 9 (Runoff in Urban Areas)*.

10.13.3 Outlet Design

10.13.3.1 Bypass Flows

Provision shall be made in a detention basin design to bypass low flows through or around the basin. This is necessary to ensure that the basin floor, particularly if it is grassed, is not inundated by small storms or continually wetted by dry weather base flow. The minimum amount of bypass shall be the 12 EY flow or required environmental flow.

In existing developed areas, it may be desirable to bypass a larger amount than the 1 EY flow if a chosen site has insufficient capacity to attenuate both the major and minor system design storms. However, the level of flow bypassed should not exceed the downstream minor system design AEP.

10.13.3.2 Primary Outlet

To achieve the design flow control requirements, the primary outlet configuration will generally consist of a multi-outlet structure or several outlet structures combined to provide multi-stage outlet control.

The Designer shall ensure that the stage-discharge relationship adequately reflects the range of different flow regimes that the structure will operate under. The outlet hydraulics for multi-outlet structures may be complicated and difficult to analyse. Care must be taken to ensure that the stage-discharge relationship adequately reflects the range of different flow regimes that the structure will operate under. In some cases, particularly if the consequence of failure of the structure is high, the stage-discharge characteristics may need to be verified by physical modelling

Primary outlets shall be designed to minimise the risk of blocking. The consequences of partial blockage of primary outlets shall be investigated and accounted for in the basin design if found to be significant.

Where a headwall or an open type structure is provided at the entrance to an outlet, consideration must be given to minimising the effect of vortex on the entrance to the outlet to maximise hydraulic efficiency. The need for venting of the outlet must also be investigated.

Pipe systems shall contain the design flow through the detention basin wall and be suitably protected to prevent infiltration of water between the pipe outer surface and the basin wall.

Consideration must be given to the need to protect the toe of the basin embankment and the bed and banks of the downstream waterway from erosion by high velocity outlet discharges.

10.13.3.3 Secondary Outlet

A secondary outlet to allow a non-catastrophic means of failure above the 1% AEP event shall be provided. The most common outlet is a high-level weir crest and overflow spillway. Spillway design criteria shall be based on the Australian National Committee on Large Dams (ANCOLD) publications and guidelines by the NSW Dams Safety Committee.

The high-level outlet to any detention basin must have a capacity to contain the 1% AEP flood event. Additional spillway capacity may be required due to the hazard category of the structure. The hazard category must be determined by reference to ANCOLD publications and guidelines by the NSW Dams Safety Committee.

The design water level of the emergency spillway, when in operation, shall have a minimum 500mm freeboard to the floor levels of dwellings. An additional 300mm freeboard shall be provided in mine subsidence areas.

The surfaces of the embankment and secondary outlet (normally an overflow spillway) must be protected against damage by scour when subject to high velocities. An open stilling basin may be considered at the bottom of the spillway prior to discharge into the downstream waterway.

10.13.4 Embankment and Floor Slopes

Retention basin embankment slopes shall generally have a maximum batter of six horizontal to one vertical (6:1). Slopes up to four horizontal to one vertical (4:1) may be approved in special circumstances by Council's Representative. In any case the design of the basin embankment shall be verified by a suitably qualified engineer.

The floor of the basin shall be designed with a minimum fall of fifty horizontal to one vertical (50:1) to minimise the likelihood of ponding.

10.13.5 Safety

It is inevitable that people will have access to a detention basin, especially if it is designed for multi-purpose usage. A detention basin must be designed with public safety in mind both when the facility is in operation and also during periods between storms when the facility is empty. Measures to prevent and discourage the public from being exposed to high-hazard areas during these periods shall be incorporated into the design, based on a risk assessment methodology.

The Designer must consider the following safety measures in the basin design:

- Provision of signs that clearly indicate the purpose and potential danger of a basin during storms. Signs must be located such that they are clearly visible at public access points and at entrances and exits to outlet structures.
- Gratings and trash racks at the inlet of a primary outlet structure shall ensure that a person will not be held under the water against the grating or trash rack. These must be inclined at an angle of 60° to the horizontal and placed a sufficient distance upstream of the inlet to a location where the velocity through the rack is low.
- Safety fencing on steep or vertical drops, such as headwalls and wingwalls, at the inlet and outlet to a primary outlet structure to discourage public access. Safety fencing can also prevent a person inadvertently walking into or falling off these structures during periods when the basin is not in operation.
- Screening of outlet structures with bunds or shrubs to reduce their attraction potential to playing children or curious adults during periods that the basin is not in operation.
- Side slopes shall be a maximum of six horizontal to one vertical (6:1) to allow easy egress.

- Water depths shall be, where possible, less than 1.2m in the 5% AEP storm event. Where this requirement is not practical or economic, greater depths may be acceptable. In that case the provision of safety refuge mounds must be considered.
- Depth indicators must be provided indicating maximum depth in the basin.

10.13.6 Landscaping

Wherever possible, designs must incorporate naturally shaped basins with landscaped banks, and selective planting of vegetation to help enrich the area and provide a focal point for surrounding development. Design shall ensure that the inlet and outlet capacity is not inhibited, and maintenance costs are minimised.

Trees and shrubs shall not be planted on basin embankments as they may increase the danger of embankment failure by 'piping' along the line of the roots.

10.13.7 Access

Retention basins shall be provided with adequate access for its intended and secondary use and maintenance machinery to remove silt or debris from the floor of the basin. Access for maintenance shall also be provided to the primary and secondary outlets.

10.14 On-site Stormwater Detention

On-site stormwater detention (OSD) may be required for individual building developments and on redevelopment sites to attenuate the runoff to discharge levels expected from the pre-developed site for the major and minor storm events.

The stormwater drainage design shall ensure that the works do not create or worsen any capacity problems in the existing public drainage system.

On-site detention calculations shall include any upstream catchments which contribute to the runoff. The use of on-site stormwater detention within lower catchment areas shall be assessed to ensure it does not adversely impact peak flows within the public system.

Various storm durations shall be modelled to determine the critical duration both pre-development and post-development. The on-site detention system must be designed to limit post-development flows back to pre-development flows for all design storms up to and including the 1% AEP. A runoff routing method must be used in the design and analysis of the proposed system.

The temporary storage of water shall be contained within the site and is not to encroach onto adjacent properties or public and road reserves. Pedestrian access is not to be included within the storage area unless readily available alternative routes are provided.

The on-site detention is not to be located within private courtyard, drainage easements, or secondary flow paths.

The maximum water depth for the 1% AEP event is 200mm for car parks and 600mm for gardens.

An overland flow path (or spillway) must be provided for the on-site detention area. A minimum freeboard of 300mm must be provided to floor levels (including adjacent properties) for the 1% AEP event, assuming 100% blockage of the piped discharge.

The piped discharge from the detention area is to connect directly to the street drainage system, Council drainage easement, and/or an interallotment drainage system that discharges to a public stormwater system. However, other discharge locations may be considered.

10.15 Other Drainage Structures

All other drainage structures such as flood protection levee banks, constructed wetlands, prescribed dams and infiltration devices shall be designed in accordance with the relevant Australian Standard and industry guidelines and approved by Council's Representative.

Section 11 - Water Sensitive Urban Design (WSUD) and MUSIC Modelling Guidelines

11.1 General

Council's *Civil Works Specification - Design Guideline* shall be read in conjunction with the associated *Construction Specification* and *Standard Drawings*, and any applicable Council Policies and Plans relating to WSUD. Council's *Development Control Plans* are to be referenced for requirements applying to different development types in the Central Coast Local Government Area.

This Section provides guidance on modelling parameters and approaches to be used when modelling WSUD elements in *MUSIC (Model for Urban Stormwater Improvement Conceptualisation)*. It is applicable to Proposed Development in the Central Coast Council Local Government Area.

Water Sensitive Urban Design (WSUD) is a set of principles that can be applied to sustainably manage water, providing opportunities for the development industry, local government and their communities to achieve more liveable cities with vibrant and healthy waterways.

Urban development using conventional approaches can have a negative impact on the natural water cycle. WSUD seeks to minimise the impact of urbanisation on the water cycle by integrating developments with a site's natural features and promoting the integration of stormwater.

Application of these principles includes:

- Minimise the volume of stormwater runoff.
- Reduce stormwater runoff and peak flows from urban developments by local detention basins and minimising impervious areas.
- Treating urban stormwater to best practice standards for reuse and/or discharge to receiving waters.
- Reducing potable water demand through water efficiency, stormwater harvesting and wastewater reuse.
- Minimising wastewater generation and treatment of wastewater so that it can be reused.
- Integrating vegetated stormwater treatment into the landscape, to provide increased biodiversity, amenity and micro-climate benefits which can reduce the heat island effect.
- Providing green infrastructure and green links to improve habitat corridors.

This Section supports those submitting MUSIC models relating to development within the Central Coast Council Local Government Area and has been developed to:

- Ensure a consistent and uniform based approach is applied when submitting MUSIC models to Council.
- Provide guidance on parameters to be used when using MUSIC to assess compliance with Central Coast Council's stormwater management objectives.
- Reduce the time taken by Central Coast Council in assessing and reviewing models.

This document should be read in conjunction with the *MUSIC User Manual*. Users of these guidelines are expected to know how to use MUSIC software and be sufficiently trained in the use of MUSIC software.

11.2 WSUD Requirements for Developments

The development types that are required to meet Council's Water Sensitive Urban Design Requirements are identified in Council's *Development Control Plans*.

11.2.1 Stormwater Quality

Recent developments in urban stormwater quality modelling software have resulted in a significant advancement in the ability to simulate the pollutant removal efficiency of a range of stormwater treatment devices. Specifically, MUSIC developed by the Cooperative Research Centre for Catchment Hydrology (CRC-CH) now provides stormwater practitioners with a conceptual design tool that estimates stormwater pollutant generation and the performance of stormwater treatment measures.

The program can be used to estimate pollutant generation from a catchment and to demonstrate the performance of stormwater quality improvement systems. Central Coast Council requires treatment of stormwater so that annual pollutant loads achieve the minimum targets set out in the *Best Practice Environmental Management Guidelines* (BPEMG) and the Engineers Australia publication - *Australian Runoff Quality* (Wong, 2006) - *A Guide to Water Sensitive Urban Design* these are:

**Table 11.1 Minimum Pollutant Removal Performance Targets
(Australian Runoff Quality 2006)**

Pollutant	Performance Requirements (Targets)
Total Suspended Solids (TSS)	80% reduction in the post-development mean annual load
Total Nitrogen (TN)	45% reduction in the post-development mean annual load
Total Phosphorous (TP)	45% reduction in the post-development mean annual load
Gross Pollutants	90% reduction in the post-development mean annual load (for pollutants greater than 5mm in diameter)
Hydrology	The post-development peak discharge must not exceed the pre-development peak discharge for flows for the 5, 20 and 100% AEP event

There are however, many cases where individual treatment measures will have different targets, for instance if the receiving aquatic ecosystem is identified as being of very high value, then Central Coast Council may require a higher treatment level in accordance with a site-specific Development Control Plan (DCP) for new urban release areas.

The design intent for any treatment system must be clearly documented and discussed with Council's Representative early in the conceptual design stage. Central Coast Council uses MUSIC to assess the impacts of proposed development against adopted performance targets. If alternative methods or models are used, the developer must demonstrate to Council's Representative satisfaction that

performance targets can be achieved. This document provides guidance on input parameters and modelling approaches for MUSIC modelling that are recommended by Central Coast Council.

11.2.2 Proposed Updates to MUSIC (and this guideline)

At the time of writing this guideline, the current version of the MUSIC software was version 6.3. eWater MUSIC version 6 introduced the MUSIC-**link** function. This new feature streamlines the process of assessing the compliance of water sensitive urban designs submitted against guidelines from a council or other Local Government Authority. MUSIC-**link**, allows developers and their consultants the ability to streamline the assessment by using pre-defined parameters applicable to the particular Local Government Area to which the development is located. Central Coast Council has set-up MUSIC-**link** functionality within MUSIC for this purpose and encourages the Service Provider to self-validate results prior to submitting with Development Application and/or Construction Certificate documentation to Council.

Figure 11.1 Screenshot of the MUSIC-link Interface for Central Coast Council LGA

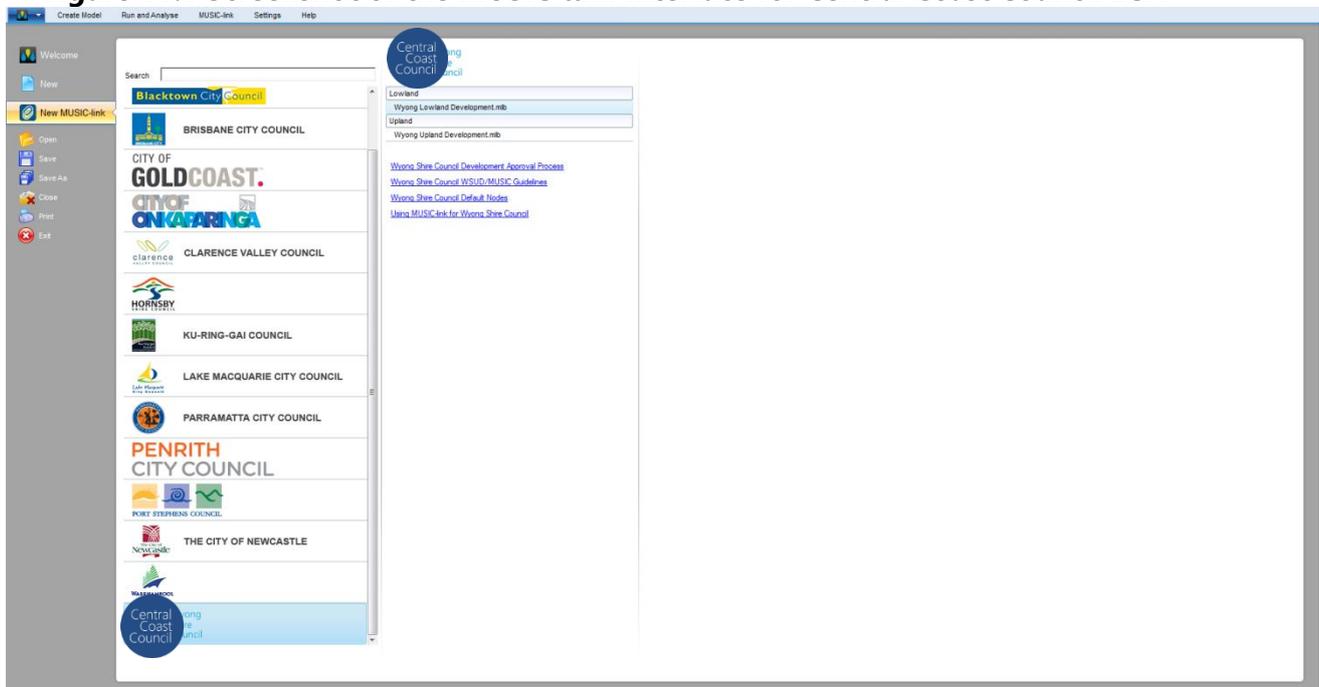


Figure 11.2 MUSIC-link Validation Report for Central Coast Council LGA

Results

Parameter	Min	Max	Actual	Result
Receiving Node				
REPORT				
% Load Reduction	None	None	67.5	✓
GP % Load Reduction	90	None	99.7	✓
TN % Load Reduction	45	None	78.4	✓
TP % Load Reduction	45	None	78.6	✓
TSS % Load Reduction	80	None	86.6	✓
Source Nodes				
Urban Source Nodes				

Next Steps

OR

B) The parameters and/or targets are outside the required ranges and you believe the use of these parameters or the output results can be justified, please follow the steps below:

STEP 1) Generate a Wyong Shire Council MUSIC-link PDF report for submission with your model. **NOTE:** Any parameter breaches must be justified for the model to be considered by Wyong Shire Council.

STEP 2) Provide reasons for model assumptions that are outside of default parameter ranges in the

Further updates to the guideline will occur on a regular basis (every 1 - 2 years) in response to new science and research into stormwater quality and stormwater treatment.

Note: The consultant preparing the MUSIC model shall also include an appropriate background image when prompted when setting up the model to aid in the assessment process and the visualisation of proposed treatment measures. This process is outlined in the MUSIC User Manual.

11.2.3 Submission Requirements for Development Applications

To demonstrate compliance with Council requirements as outlined above, a Water Cycle Management Plan (WCMP) must be submitted with the development application. A WCMP details the WSUD strategy and the water management measures to be implemented on a proposed development site including water conservation objectives and stormwater quality control to meet Council's stormwater quality targets.

The main elements to be included within a WCMP are:

- Background Information and Site Analysis.
- Proposed development description.
- WSUD objectives applicable.
- MUSIC-link modelling results report demonstrating compliance with parameters and targets and an electronic copy of the MUSIC file (.sqz) for internal review.
- Costs and maintenance requirements.

Table 11.2 outlines the detail required under each of the headings and provides links to supporting information and key resources and tools available to assist in the preparation of the WSUD Strategy. The supporting information is contained both within this document as well as in external documents which are available on the internet.

Table 11.2 Contents of a WSUD Strategy and Tools and Resources Available

Outline Contents	Details to be Provided in the WSUD Strategy	Supporting Information
Background Information and Site Analysis	Summarise any background information available on the site, including previous studies, existing site conditions and constraints and details of the development – layout, size catchments, topography, land use etc.	
Proposed Development	Describe the proposed development at the site, including boundaries, land uses, existing/proposed infrastructure, staging etc.	<i>Proponents supporting DA documentation</i>
WSUD Objectives	This section should identify the WSUD objectives which apply to the development including water conservation and stormwater quality objectives and how the treatment measures will integrate with the development layout and the surrounding area.	
Stormwater Quality control measures and modelling	<p>Establish a conceptual stormwater quality (MUSIC) model for the proposed development to predict expected pollutant loads generated from the development and develop an appropriate strategy to achieve the performance targets. Run a MUSIC-link report for Central Coast Council LGA.</p> <p>The information submitted with the WSUD Strategy should include:</p> <ul style="list-style-type: none"> • Schematic of the model including, Location (<i>including background image</i>) and layout of stormwater treatment train measures. • Provide a copy of the results and MUSIC-link report in an appendix demonstrating compliance with the parameters and performance targets. A functional electronic copy of the MUSIC (.sqz) program file is to be provided. • Any variation from the recommended MUSIC parameters must be reported and suitable justification provided. 	<p><i>MUSIC modelling software (e-water)</i></p> <p><i>Standard MUSIC parameters for Central Coast Council (Section 3 of this document and MUSIC-link)</i></p> <p><i>NSW MUSIC Modelling Guidelines (BMT WBM 2015)</i></p> <p><i>WSUD Conceptual Design Guidelines (external link section)</i></p>

Outline Contents	Details to be Provided in the WSUD Strategy	Supporting Information
Cost – Operation and Maintenance	<p>Prepare capital and operation and maintenance cost estimates of the proposed water cycle management measures.</p> <p>Both typical annual maintenance costs and corrective maintenance or renewal/adaptation costs should be included.</p>	<p><i>Concept Design Guidelines for WSUD (external link Section)</i></p>

11.3 Supporting Information for the Preparation of a Water Quality Strategy for a Development Application

When preparing supporting documentation for a Development Application, a proponent is required to employ the services of appropriately qualified and experienced practitioners for the development of an appropriate WSUD strategy for their site.

The following information should be referenced when developing the strategy:

1. **MUSIC Model:**

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC), derives default water quality parameters for a range of pollutants generated from various land use types. As presented in *Australian Runoff Quality* (Engineers Australia) most verified and published Australian water quality research has been synthesised and incorporated into MUSIC. The latest version of MUSIC is version 6.3 (2018) and is available for purchase at [MUSIC by eWater](#). The MUSIC model includes a modelling guideline which should be referred to when using the MUSIC software. Location specific parameters for the MUSIC model in the Central Coast Region are outlined in this document and have been implemented into MUSIC-*link*.



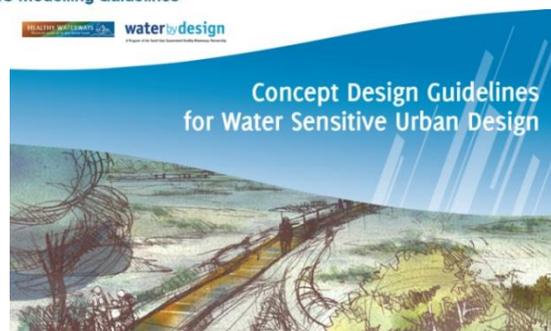
2. **MUSIC Modelling guide:**

The development of a MUSIC model requires specific inputs and parameters. For proposed developments in the Central Coast Region LGA key parameters for undertaking any MUSIC modelling are outlined in Section 11.4 of this Guideline and provided in MUSIC-*link* documentation. Further information on MUSIC modelling best practice is available in the *NSW MUSIC Modelling Guidelines 2015 (BMT WBM)*.



3. **WSUD Conceptual Design Information:**

Information on specific WSUD elements (such as rainwater tanks, bio-retention/raingardens



and wetlands) and where they are appropriate is available in the South East Queensland's (SEQ) *Water by Design* program's Concept Design Guidelines for WSUD. This document provides an industry standard and seeks to assist multi-disciplinary teams conceptualise and develop design solutions that integrate best practice sustainable urban water management within the urban form.

11.3.1 Engaging a Consultant to Develop a WSUD Strategy

Applicants and Service Providers are required to engage the services of appropriately qualified and experienced practitioners for the development of the Water Management Plan. The benefit of using consultants with demonstrated capacity to undertake a WSUD strategy will generally reflect a smoother and straight forward approval process. Consultants should possess the following skills:

- Advanced MUSIC modelling training and experience.
- Demonstrated experience in designing WSUD elements.

11.4 MUSIC Modelling for the Central Coast Region

This section provides guidance on modelling parameters to be used when modelling WSUD elements in MUSIC for development within the Central Coast Council Region. These guidelines are provided to ensure Service Providers have a consistent and uniform approach to stormwater quality modelling in the Central Coast LGA.

The approaches and parameters outlined in this section shall always be used when developing a WSUD Strategy to meet the minimum targets specified above. Further information on MUSIC Modelling is available in the most current version of the *NSW MUSIC Modelling Guideline* (BMT WBM). The information is an adaptation of the *NSW MUSIC Modelling Guideline* and should be read in conjunction with the *eWater MUSIC User Guide* which is provided with the MUSIC software when installed.

This guideline provides specific guidance on rainfall and evaporation inputs, source node parameters, rainfall runoff parameters, pollutant generation parameters and stormwater treatment nodes. Any MUSIC models that are not consistent with this guideline must provide suitable justification for the differences in parameters and/or assessment methods.

These guidelines should be read in combination with the most current version of the *NSW MUSIC Modelling Guidelines* and the *MUSIC User Guide*, which outlines all the definitions, assumptions and methodologies provided within the MUSIC tool.

11.4.1 MUSIC Model Setup

A MUSIC model requires a significant amount of information during the model set-up stage. These steps include the selection and input of the following information:

- Appropriate meteorological data (rainfall and evaporation inputs).
- Defining catchment areas (source nodes) to be incorporated into the model.
- Appropriate soil properties (rainfall runoff properties).
- Pollutant generation characteristics for selected source nodes.

11.4.2 MUSIC Parameters

11.4.2.1 Rainfall and Evaporation Inputs

Stormwater runoff is represented as both surface runoff and baseflow in the MUSIC model. It is generated in MUSIC through the interaction of rainfall, evapotranspiration and the MUSIC Rainfall-Runoff Model (see *MUSIC User Manual* for full description of Rainfall-Runoff Model). The following sections outline Council’s preferred rainfall and evapotranspiration datasets to be used when undertaking stormwater quality designs and hydrologic investigations for stormwater harvesting.

11.4.2.2 Rainfall Data for Water Quality (WSUD) Modelling

Council requires the following approach to rainfall simulation be adopted for stormwater quality modelling:

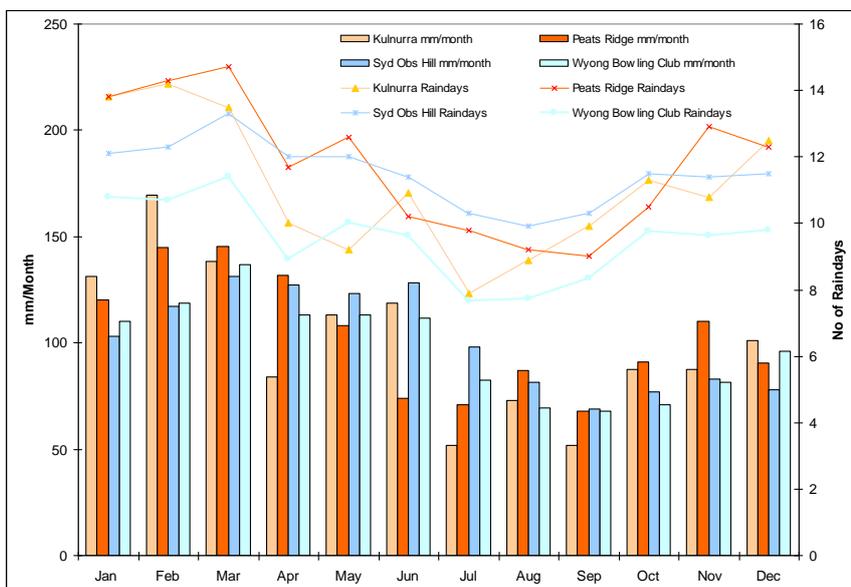
- Continuous simulation of 5 years minimum to 10 years (ideal).
- A 6-minute time step is to be utilised as this allows for the appropriate definition of storm hydrograph movement through small-scale stormwater treatment processes such as vegetated swales and bioretention systems.

To provide a consistent approach to stormwater modelling, Council has identified an appropriate rainfall station for the Central Coast Region LGA, and periods of modelling to be utilised within the MUSIC model. Three 6-minute rainfall data (i.e. pluviography) stations were investigated for their suitability. These included rainfall stations at:

- **Kulnura** (William Road), approximately 25km west of Wyong.
- **Peats Ridge**, approximately 20 km west-southwest of Wyong.
- **Sydney** (Observatory Hill), approximately 70-75 km south-southwest of Wyong.

Comparison of rainfall at various stations within the Central Coast Council LGA and Sydney Observatory Hill are shown in Figure 11.3 below.

Figure 11.3 Six-Minute Rainfall Station Comparison



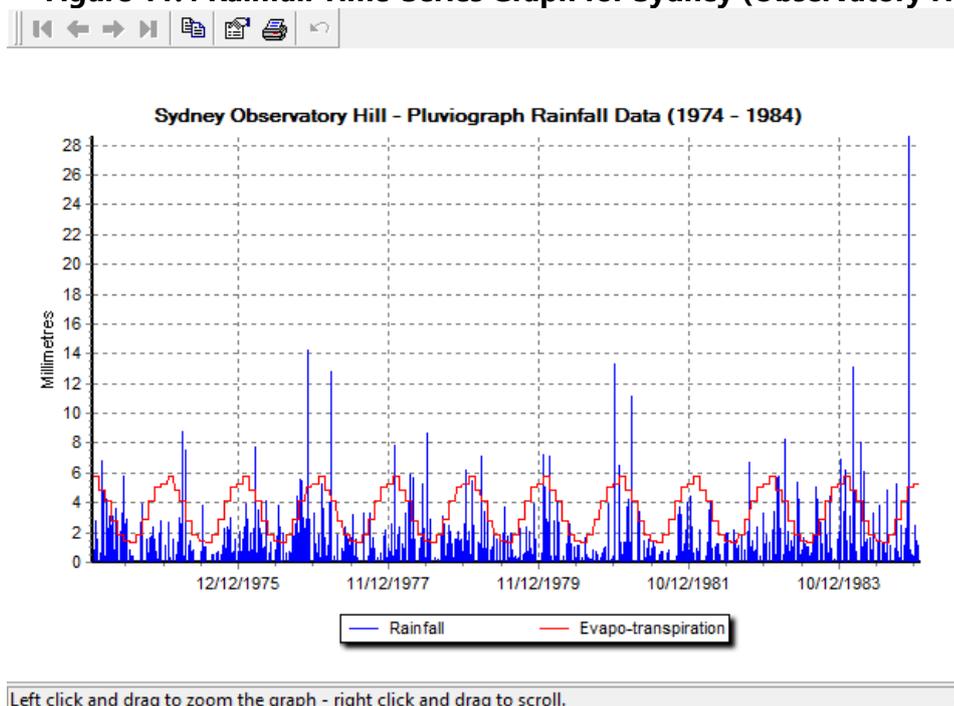
Central Coast Council has identified that the 6-minute rainfall data record at Sydney Observatory Hill (over 150 years of recorded rainfall data) best represents the rainfall variability experienced in the Central Coast Region, with the rainfall and number of rain days per month, when compared to Kulnura, Peats Ridge and Wyong Bowling Club rainfall records. It consistently has about one more rain day a month than Wyong, suggesting that rainfall at Wyong Bowling Club is more intense than at Sydney. The Kulnura station has limited, and incomplete pluviograph data and Peats Ridge has significant missing data periods in the 30 years of rainfall records. The average annual rainfall for the period chosen for modelling closely matches the long-term average for the Central Coast Region for the Peats Ridge rainfall station of 1249mm.

Given the above, Council requires all stormwater quality modelling in MUSIC to be undertaken using the **Sydney Observatory Hill** rainfall data and the modelling period between 1974 and 1984 (refer Table 11.3).

Table 11.3 Recommended 6-Minute Rainfall Station

Rainfall Station	Modelling Period	Average Annual Rainfall (mm)
Sydney (Observatory Hill) :066062	01/01/1974- 31/12/1984	1238

Figure 11.4 Rainfall Time-Series Graph for Sydney (Observatory Hill) – 1974-1984



11.4.2.3 Rainfall Data for Water Quantity (Hydrologic) Modelling

The following approach is to be undertaken for water quantity/hydrologic assessment modelling. That is, modelling required for stormwater harvesting analysis and stormwater storage design in response to wetland hydrology and waterway stability objectives.

Continuous simulation of 10 years minimum to **20 years** (ideal) should be used, including:

- Daily time step is to be utilised for simulating stormwater storage.

- The rainfall data contains a wet, dry and average rainfall year.

Central Coast Council has identified two appropriate daily rainfall stations to be utilised within the MUSIC model for hydrologic modelling. Sydney Observatory Hill is the preferred rainfall station. However, if daily rainfall data is required, then the Wyong Bowling Club rainfall records can be used.

Table 11.4 Recommended Daily Rainfall Station

Rainfall Station	Modelling Period ¹	Average Annual Rainfall (mm)
Sydney (Observatory Hill) (preferred)	01/01/1963 - 31/12/1984	1237
Wyong Bowling Club	1918-1965	1184

11.4.2.4 Evapotranspiration Data

Central Coast Council found that Sydney evaporation data closely matches that from the Central Coast region (although slightly higher) and is therefore suitable for use in MUSIC modelling for water quality and hydrology. The monthly evapotranspiration values for Sydney are shown in Table 11.5 and the comparison with Peats Ridge and Kulnura is illustrated in Figure 11.6.

Figure 11.5 Potential Evapotranspiration Data for Sydney (Observatory Hill)

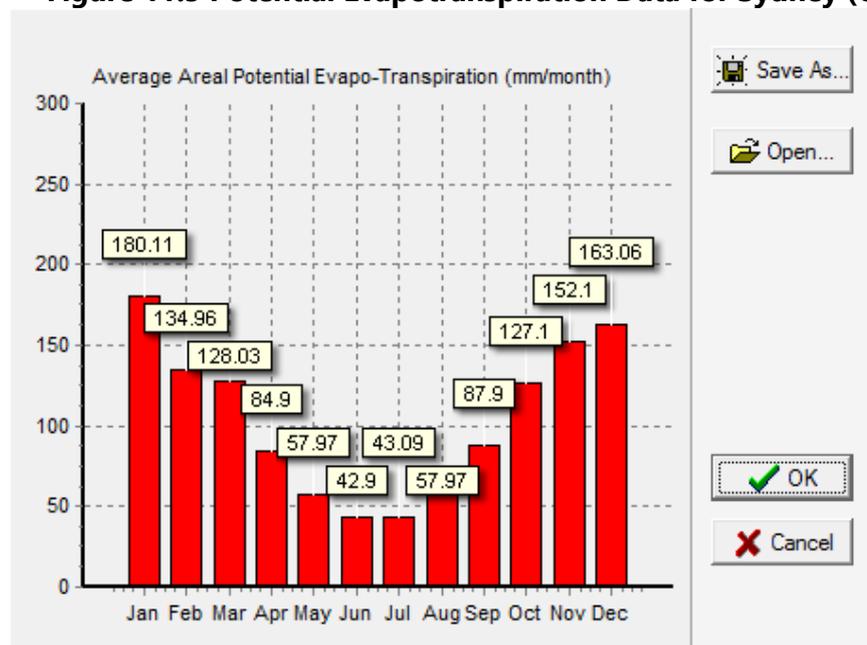
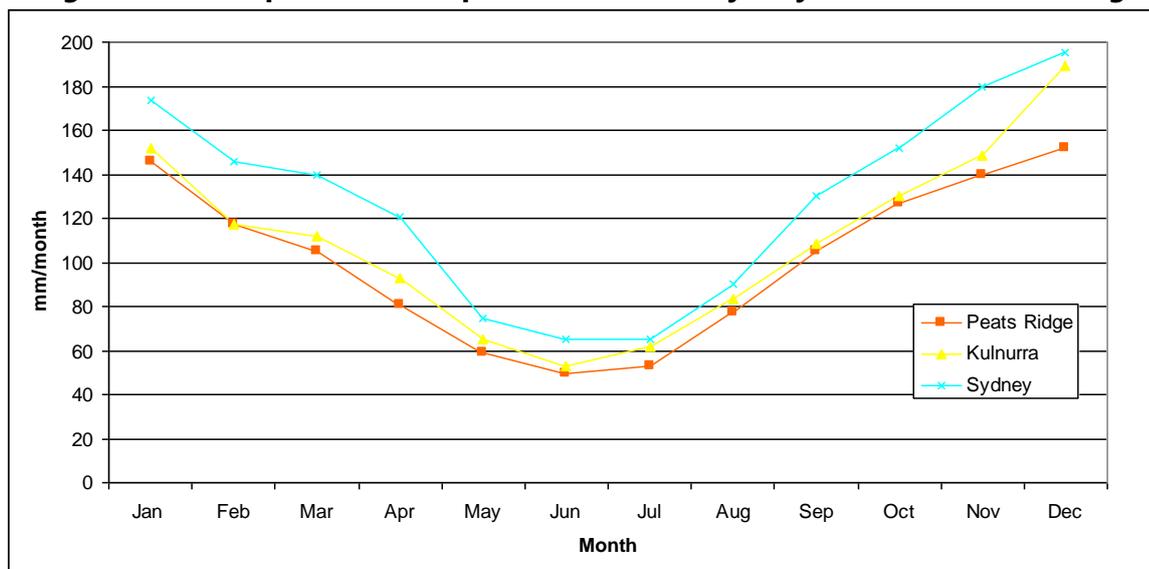


Table 11.5 Monthly Evapotranspiration Values

Month	J	F	M	A	M	J	J	A	S	O	N	D
Evapotranspiration (mm)	180	135	128	85	58	43	43	58	88	127	152	163

¹ Select a period that has minimal gaps in the data

Figure 11.6 Comparison of Evaporation Data for Sydney and Central Coast Regions

11.4.2.5 Rainfall Runoff Parameters

Stormwater runoff (represented as storm flow and baseflow) is generated in MUSIC through the interaction of rainfall, evapotranspiration and the MUSIC Rainfall-Runoff Model. A full description of the MUSIC Rainfall-Runoff Model is provided in the *MUSIC User Manual*.

MUSIC rainfall-runoff parameters were derived for the Central Coast Council LGA through a calibration process to stream flow information for Jilliby - Jilliby Creek (upstream tributary of Wyong River). Details of this calibration process are provided in the *DRAFT Discussion Paper Modelling Rationale for the Porters Creek Stormwater Harvesting Strategy (Ecological Engineering 2006)*.

Based on the calibration to stream flow data at Jilliby - Jilliby Creek two general pervious source nodes were developed, an '**upland**' and '**lowland**' node, based on the following catchment geography:

- Upland nodes are areas within the catchment where slopes are generally **greater than 5%** and are typically found in the headwaters of the catchments.
- Lowland nodes are areas with slopes generally **less than 5%** and are typically found in the floodplain zone of unconfined valleys of a higher order creek.

Pervious areas must be modelled as upland or lowland area depending on the location of the development within the Central Coast LGA.

11.4.2.6 Defining Upland and Lowland Areas

To delineate between **upland** and **lowland** areas, the following steps should be undertaken:

- Obtain the best available contour data for the catchments of interest.
- Make an initial visual assessment of the contour information based on obvious changes in slope and topography for a rough estimation of upland and lowland areas.
- Calculate ground slopes (%) for the area of interest. A Digital Elevation Model may be of assistance in delineating upland and lowland areas for larger catchments.
- Analyse slope data to identify areas greater than and less than approximately 5% slope. **Slopes <5% are considered lowland and slopes >5% are considered upland.** Note: It

may be necessary to repeat this step with slopes of 2-6% to achieve a reasonable delineation between upland and lowland areas.

- Perform a manual check and edit anomalies. Common anomalies include relatively flat areas in the upper part of the catchment (e.g. gently sloping hill tops). These areas should be modelled as upland to reflect the likely soil properties.

A site-specific assessment should be performed for most developments, to generate more detailed information at a scale appropriate to the individual development.

11.4.2.7 Rainfall – Runoff Parameters for Upland and Lowland Areas

The following soil characteristics are to be used in the rainfall-runoff parameters of **upland** and **lowland** areas:

Table 11.6 Soil Characteristics

Parameter	Upland (>5% slope)	Lowland (<5% slope)
Impervious area parameters		
Rainfall Threshold (mm)	1	1
Pervious area parameters		
Soil Capacity (mm)	200	250
Initial Storage (%)	30	30
Field Capacity	80	100
Infiltration Capacity Coefficient a	200	200
Infiltration Capacity Coefficient b	1	1
Groundwater Properties		
Initial Depth (mm)	10	10
Daily Recharge Rate (%)	0.5	4
Daily Baseflow Rate (%)	0.16	2
Deep Seepage (%)	2	0.4

Note: The above rainfall threshold values are an average value for the various land-use types. Refer to the current version of the NSW MUSIC Modelling Guidelines (i.e. Table 5-4) for specific threshold values relating to roofs, roads/paths etc.

11.5 MUSIC Source Nodes

The source nodes must be defined to reflect the details of the contributing catchments of the development. Source Nodes for Central Coast Council catchments are defined below:

- The **Urban Source Node** is used to describe low to high density residential, commercial and industrial areas. These land uses include lots with all associated facilities, such as roads and parks.
- The **Agricultural Source Node** refers to areas of large-scale cropping or grazing. This node should only be used for low density rural areas situated in predominantly agricultural settings.
- The **Forested Source Node** is to be used for natural bushland areas. This node is to be utilised in areas where canopy densities are greater than 50%.
- The **Imported Data Source Node** is to be utilised in the regional storage and harvesting scenario modelling.



Each individual Source Node, with the exception of the Imported Data Node, requires the total area and effective impervious area (EIA) percentage of the site to be defined.

An initial estimate of percentage impervious for each particular land use should be based on the ultimate zoning of the area, reflecting the ultimate land use of the catchment. Building density controls for urban areas must also be considered, including elements such as minimum soft landscaping area, maximum building envelopes, floor space ratios and road design guidelines. These estimates should also be compared to aerial photos of similar recent housing developments in the vicinity of the proposed development. Where differences between the estimates and the on ground impervious area are significant then estimates should be revised or the differences justified. Section 10 - Stormwater Drainage Design of this document provides information on determining appropriate development impervious areas.

11.5.1 Urban Land Use Split

The urban node must be split into the various land use types (i.e. road reserve, roof, ground level pervious and impervious) when the following proposed developments are modelled:

- A single lot (including commercial and industrial).
- A single street (including multiple lots).
- The influence of rainwater tanks within a development (regardless of the size of development).

When utilising this approach:

- Roof areas are to be modelled as **100%** impervious.
- Road reserve areas include the road and adjacent landscaping and paths contained within the road reserve. Imperviousness of this node should be approximately 70%.

- Remaining ground areas can be further split into pervious and impervious areas when required.

An example of an urban land-use split in MUSIC is shown below:

Figure 11.7 Example MUSIC Model Setup for a Typical Single Low-Density Residential Lot Including a Rainwater Tank

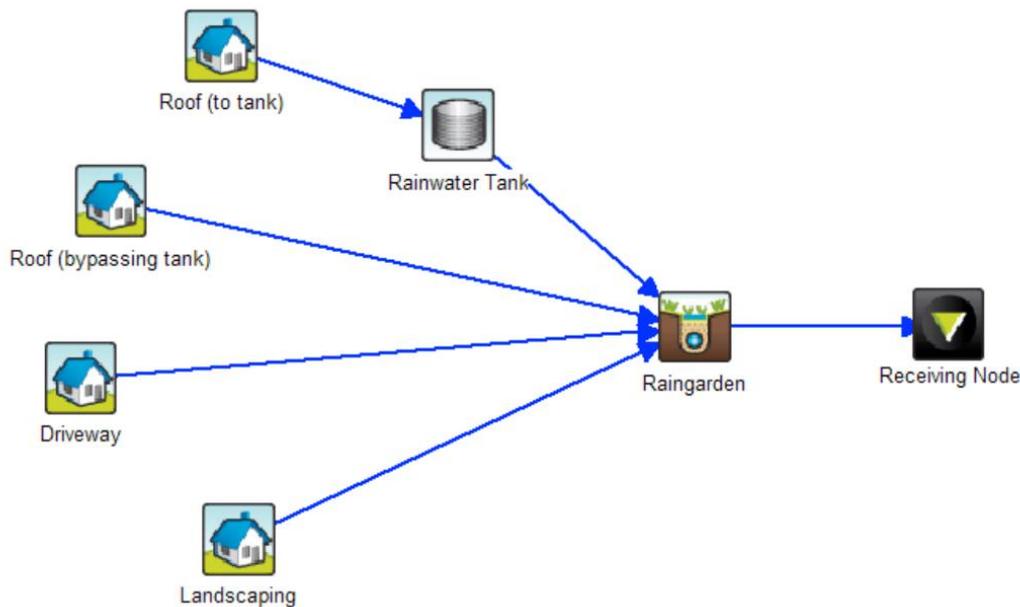
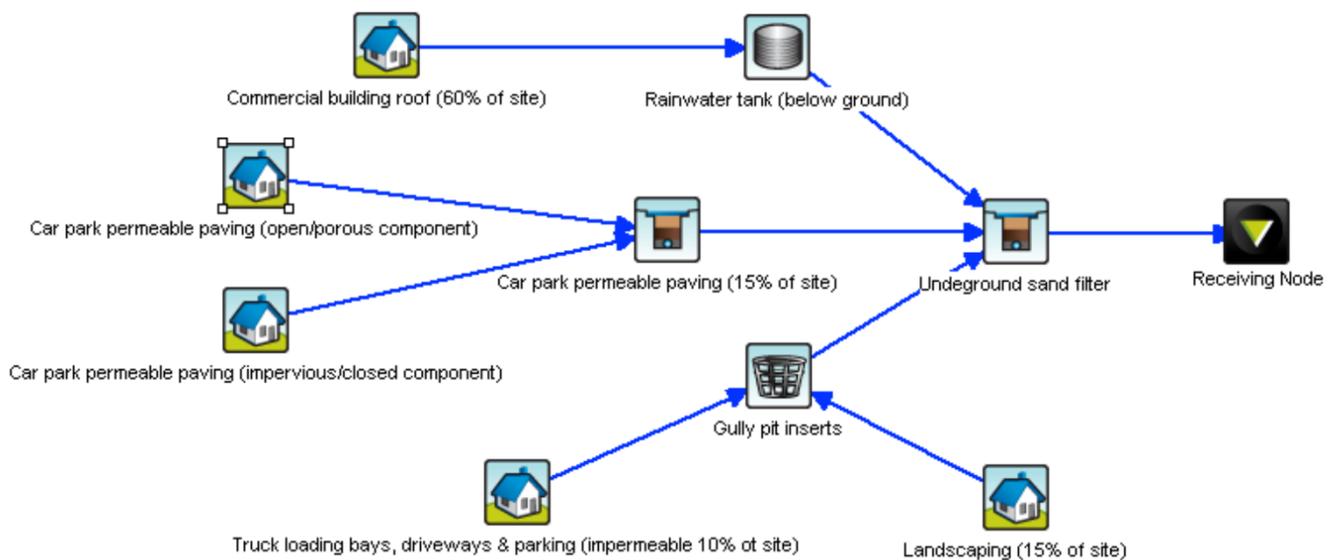


Figure 11.8 Example MUSIC Model Setup for Catchment Areas for a Typical Commercial Lot

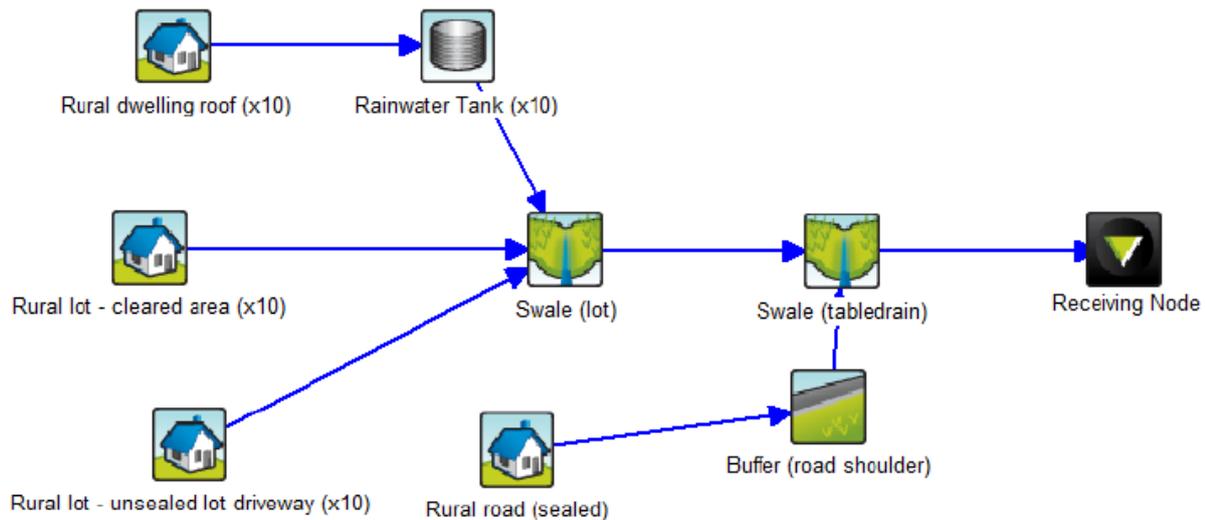


11.5.2 Multiple Lots

To simplify the model, the modeller should look to combine areas with similar characteristics, such as where a subdivision is proposed of similar lots. The individual lots do not need to be modelled

separately, but can be aggregated, or “lumped” such that the source node used represents several lots of similar characteristics. The imperviousness used in this case should reflect the aggregated lots. The size of the treatment measures estimated using this modelling approach can also be aggregated and proportioned within the site based upon the actual size any individual treatments on each individual lot. The example in Figure 11.9 below shows an area being modelled where 10 lots are lumped into a single source node for each of surface types required. The rainwater tank node is also used to lump 10 rainwater tanks into a single treatment node.

Figure 11.9 Combining Areas to Simplify MUSIC Modelling



11.5.3 Pollutant Generation

The recommended model defaults for various land use categories is based on research by Fletcher et al. (2004). These are adopted from the current version of *NSW MUSIC Modelling Guidelines*.

Note: For all simulations the MUSIC model must be run with pollutant export estimation method set to “stochastic generated” as opposed to the “mean” estimation method.

Table 11.7 Stormwater Quality Parameters for MUSIC Source Nodes (BMT WBM)

Land-use Category	Log10 TSS (mg/L)		Log10 TP (mg/L)		Log10 TN (mg/L)		
	Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow	
Large Areas of Interest							
General Urban (including public open space)	Mean Standard Deviation						
Residential		2.15	1.20	-0.60	-0.85	0.30	0.11
Industrial		0.32	0.17	0.25	0.19	0.19	0.12
Commercial/Business							
Rural	Mean Standard Deviation	1.95	1.15	-0.66	-1.22	0.30	-0.05
		0.32	0.17	0.25	0.19	0.19	0.12
Small Areas of Interest							
Sealed Road Areas	Mean Standard Deviation	2.43	---*	-0.30	---*	0.34	---*
		0.32	---*	0.25	---*	0.19	---*
Roof Areas	Mean Standard Deviation	1.30	---*	-0.89	---*	0.30	---*
		0.32	---*	0.25	---*	0.19	---*

* Base flows are only generated from pervious areas; therefore, these parameters are not relevant to impervious areas. Refer to NSW MUSIC Modelling guidelines for other land uses (e.g. Forest, Agricultural, Quarries, etc).

11.5.4 Link Routing

Routing may be used to reflect the travel time for flood wave propagation through the catchment. For all MUSIC model simulations, it is recommended that the channel routing option in MUSIC be set to "No Routing" as this is the most conservative modelling scenario.

If the routing option is used in the model, suitable justification is required to be submitted with the concept design. *Translation only* method or *Muskingum-Cunge* method are to be used if the routing option is chosen. The user is referred to the *MUSIC User Manual* for further details.

11.6 Stormwater Quality Treatment Nodes

To meet the site's stormwater quality objectives, the development will need to incorporate an appropriate stormwater treatment process for the development, dependent on-site constraints and opportunities.

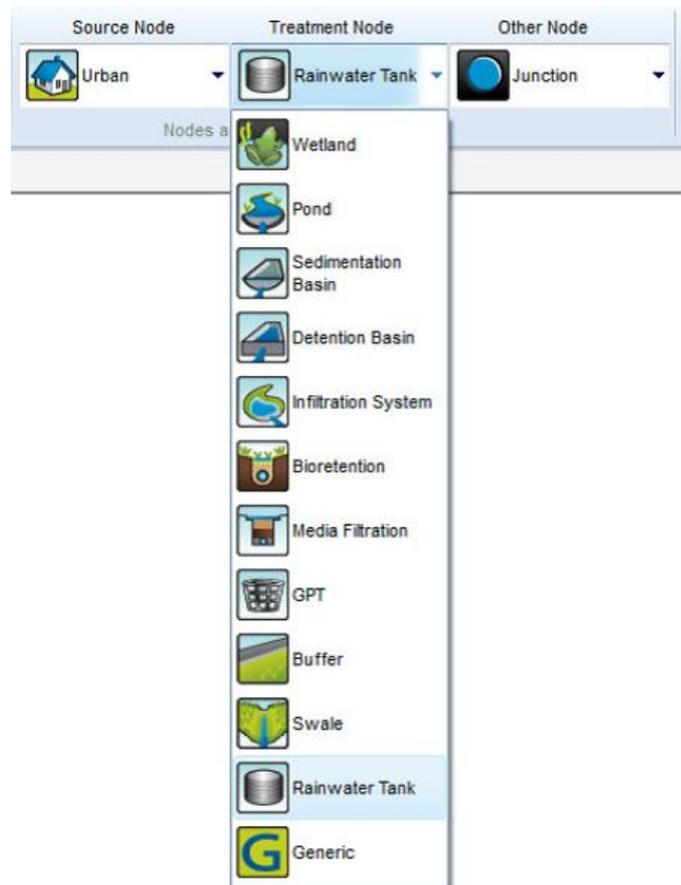
The default parameters in MUSIC for the first order decay $k-C^*$ model used to define the treatment efficiency of each treatment device should be used unless local relevant treatment performance monitoring can be used as reasonable justification for modification of the default parameters. Reference should be made to the *MUSIC User Manual*.

Several stormwater treatment elements are available in MUSIC as shown adjacent. Once the WSUD objectives have been determined for a site, an appropriate treatment train can be modelled in MUSIC.

In order to avoid any confusion relating to treatment node implementation Council provides the following advice for modelling stormwater quality treatment systems within the Central Coast Council LGA.

The following devices are not to be modelled within the MUSIC program:

- Natural waterways.
- Natural wetlands.
- Naturalised channel systems.



- Environmental buffers.
- Natural lake/pond systems.

Table 11.8 below briefly outlines each treatment element available in MUSIC, and parameters to be used, if applicable. Reference should be made to the current version of MUSIC user manual for further details and modelling requirements for rainwater reuse, pervious pavements and other treatment measures

Please note that MUSIC is a conceptual comparison tool only, not a design tool. It is essential that devices included in a model are achievable within the modelled catchment. The designer should carry out preliminary calculations to ensure that devices included can be drained and adequate allowance has been made for batters in restricted areas.

Table 11.8 Stormwater Treatment Parameters

Stormwater Treatment Measures	Selected Key Parameter Values and Design Guidance
 <p>Bioretention systems are a combination of vegetation and filter substrate that provides treatment of stormwater through filtration, extended detention and some biological uptake</p>	<p>High flow bypass = generally 3-month ARI flow (to be calculated by consultant)</p> <ul style="list-style-type: none"> • Extended detention (i.e. ponding) depth = 100 - 300mm (for basins) • Saturated hydraulic conductivity = 125mm/hr (maximum) • Filter depth = 500 - 800mm • TN content of filter media = 400mg/kg (where unknown) • Orthophosphate content of filter media = 40mg/kg • Exfiltration (seepage) rate = 0mm/hr <p>Note that a submerged (saturated) zone requires a specially designed outlet pit configuration.</p>

Stormwater Treatment Measures	Selected Key Parameter Values and Design Guidance
 GPT <p>Gross Pollutant Traps (GPTs) typically remove rubbish, sediment and hydrocarbons from stormwater runoff</p>	<p>There are no specific input parameters for GPTs</p> <p>High flow bypass for the device = 3-month ARI peak flow (50% 1 yr ARI).</p> <p>It is suggested that the default treatment performance values shown below be adopted where no data is provided.</p> <ul style="list-style-type: none"> • Total Suspended Solids (TSS) removal = 65% (unless CDS-type system, when TSS removal can be up to 70% for inflow concentrations greater than 75mg/L). • Total Phosphorus (TP) removal = 15% (unless a CDS-type system, when TP removal can be up to 30% for inflow concentrations greater than 0.5mg/L). • Total Nitrogen (TN) removal = 14% <p>If alternative performance values are adopted, independent testing data shall be provided with the report to support their use.</p> <p><i>* Central Coast Council can provide acceptable GPT nodes. Generally, the Rocla CDS and HumeGard units are preferred due to their extensive performance testing and monitoring. Refer to <u>Gross Pollutant Removal From Urban Waterways and Field evaluation of the Nutrient Removal Performance of a Gross Pollutant Trap (GPT) in Australia</u></i></p>

Stormwater Treatment Measures	Selected Key Parameter Values and Design Guidance
 <p>Wetland</p> <p>Constructed wetland systems use enhanced sedimentation, fine filtration and pollutant uptake processes to remove pollutants from stormwater</p>	<p>High Flow bypass = 1-year ARI flow (to be calculated by consultant)</p> <p>Inlet pond volume calculated using:</p> <ul style="list-style-type: none"> • Inlet pond surface area = 10% of macrophyte zone (storage surface) area • Inlet pond depth = 2.0m recommended • Extended detention depth = 0.25 - 0.75m based on outlet design • Notional detention time target = 48 - 72 hours for optimal treatment and to allow nutrient uptake. • Evaporative loss shall be left as default at 125% of PET • Seepage loss should be modelled as 0mm/hr (i.e. 300mm impermeable clay liner) unless it can be shown that infiltrated flows with re-contribute to observable downstream flows (i.e. secondary flow link) <p><i>Adjust the pipe diameter or orifice size to ensure the device has adequate residence time. Sizes less than 100mm diameter are to consider appropriate screening to prevent blockage.</i></p> <p><i>* A fixed default of 50% coverage of vegetation applies to the constructed wetland node. If less vegetation is proposed, the constructed wetland node k and C* values should be modified to the pond node values to represent a lower level of treatment.</i></p>

Stormwater Treatment Measures	Selected Key Parameter Values and Design Guidance
<div data-bbox="177 573 328 651" data-label="Image"> </div> <p data-bbox="167 752 609 981">Vegetated swales are open vegetated channels that can be used as an alternative stormwater conveyance system to pipes or can be used in conjunction with a pipe system</p>	<ul data-bbox="715 322 1469 857" style="list-style-type: none"> • The longitudinal bed slope between 1 - 4% grade • Swales with bed slopes between 1 - 2% must incorporate a low-flow subsoil drainage line. • Vegetation heights of 50 - 500mm are acceptable; however, MUSIC assumes that swales are heavily vegetated when modelling their treatment performance. Mown grass swales should not be expected to provide significant stormwater treatment and should not be modelled in MUSIC. • Set low flow bypass to 0m³/s unless low flows draining to the swale would bypass in low flow events (i.e. low flow pipe under the swale). • Ensure side batters are a minimum of 1 (vertical): 4 (horizontal). <p data-bbox="639 922 1469 1032">Swale depths should be between 150 and 300mm in road reserves and can be deeper in other areas (e.g. open space areas).</p> <p data-bbox="639 1117 1469 1227">Model seepage loss as 0mm/hr unless it can be proven that infiltrated runoff would not contribute to observed flows downstream.</p>

Stormwater Treatment Measures	Selected Key Parameter Values and Design Guidance
<div data-bbox="181 936 258 1010" data-label="Image"> </div> <div data-bbox="258 958 438 987" data-label="Caption"> <p>Rainwater Tank</p> </div> <p data-bbox="167 1126 603 1391">In order to appropriately model the treatment efficiency of a rainwater tank within an urban development, the rainwater tank that is entered into MUSIC must comply with any BASIX certificate for that residential site</p>	<p data-bbox="639 322 1313 353">Only roofs should be connected (100% impervious).</p> <p data-bbox="639 439 1453 584">Given constraints due to gutter and downpipe arrangement, typically a maximum of 50% of the total roof area can be connected to one tank for retrofits. An assumption of no more than 75% connection is feasible for greenfield developments.</p> <ul data-bbox="716 669 1461 857" style="list-style-type: none"> • High flow bypass = 0.005m³/s per dwelling • 80% of the physical rainwater tank volume should be adopted for modelling. This caters for 10% allocated for sediment storage and 10% allowance for an air gap above the overflow pipe. <p data-bbox="639 922 1453 1149">If using stored water for irrigation, insert annual irrigation demand (kL/yr) and provide other irrigation estimation details. For a daily demand (kL/day), make estimation based on proposed building design with calculations of proposed demands to be connected (e.g. toilet flushing and/or washing machines). Water demand must be justifiable.</p> <p data-bbox="639 1234 1461 1379">* If rainwater tanks are used for on-site detention (OSD) storage, the proportion of the tank available for harvesting below the OSD outlet may be significantly lower than 80% and this should be allowed for in the model.</p> <p data-bbox="639 1464 1445 1496">Modelling on-site detention (OSD) with rainwater reuse tanks.</p> <ul data-bbox="716 1525 1461 2018" style="list-style-type: none"> • The rainwater tank should have the depth above the overflow pipe set to the storage depth of the tank above the OSD outlet, and the volume below the overflow set 0. No reuse should be specified from the tank. • In some circumstances a BASIX rainwater tank may be required in addition to an OSD tank. For this situation, two rainwater tanks in series can be configured. The first rainwater tank would be modelled with water demands and a storage volume below the overflow to suit BASIX requirements. The second tank in the series would be simulated as an OSD tank as above.

Stormwater Treatment Measures	Selected Key Parameter Values and Design Guidance
 Infiltration System Infiltration measures encourage stormwater to infiltrate into surrounding soils	<p>Infiltration measures are highly dependent on local soil characteristics and are best suited to sandy soils with deep groundwater. Generally geotechnical assessment is to be undertaken before infiltration is considered at a particular site.</p> <p>Establish the infiltration rate based on findings from a geotechnical engineering report or soil percolation test to determine the likely infiltration rate from the device to the surrounding soils.</p> <p>Infiltration is not a stormwater treatment measure and stormwater treatment should be provided upstream of infiltration basins.</p> <p>MUSIC pollutant removal parameters assume that the basin is vegetated and that stormwater is pre-treated to remove coarse sediment upstream of the retention/infiltration basin. If these assumptions are not true, then the basin should not be expected to meet the pollutant removal performance estimated in MUSIC.</p>
 Pond Water quality ponds (note there are separate procedures for modelling water storage ponds)	<ul style="list-style-type: none"> • Permanent pool = 1.0 - 2.0m • Extended detention depth = 0.25 - 1.0m <p>Parameters within the MUSIC model assume that stormwater is pre-treated to remove coarse sediment upstream of the pond, therefore ponds should never be designed without pre-treatment (such as a swale or sedimentation basin)</p>
 Sedimentation Basin Sediment basins are used to retain coarse sediments from runoff. They operate by reducing flow velocities and encouraging sediments to settle out of the water column	<p>Permanent pool volume based on 2m depth (e.g. with a surface area 50m² the permanent pool volume would be 100m³)</p> <p>Extended detention depth = 0.25 - 1.0m</p> <p>Exfiltration (Seepage loss) = 0mm/hr unless soil tests indicate otherwise</p>

Stormwater Treatment Measures	Selected Key Parameter Values and Design Guidance
 Detention Basin A detention basin is assumed to be a dry detention basin	Whilst MUSIC is not an appropriate model for the sizing and concept design of on-site detention storages, MUSIC can be used to estimate the impacts of on-site detention on runoff quality and frequent flows resulting from temporary detention of stormwater in these tanks. <i>* For locations where dedicated on-site stormwater detention is required, the rainwater tank node in MUSIC can be used to simulate this situation.</i>
 Buffer Buffer or filter strips, in the context of urban stormwater, are grassed or vegetated areas over which stormwater runoff from adjoining impervious catchments traverses en route to the stormwater drainage system or receiving environment	Buffer strips are only applicable where runoff is distributed across the whole buffer strip and the buffer strip slope is $\leq 5\%$
 Media Filtration Media filtration systems (e.g. sand filters, permeable paving)	As per bioretention systems (i.e. without vegetation)

Stormwater Treatment Measures	Selected Key Parameter Values and Design Guidance
 <p>Generic (i.e. user defined)</p>	<p>For modelling a treatment device that is not a specific node within the program. Examples of applications include proprietary treatment devices, flow diversions, or sewer overflows.</p> <p>This option should only be used if the user has sufficient data to model it effectively.</p> <p>For proprietary SQIDs verified water quality performance reports must be appended to the stormwater report clearly demonstrating that the proposed SQID achieves the pollutant reductions adopted in the MUSIC node.</p>
<p>ALL TREATMENT NODES</p>	<p>Seepage loss (exfiltration rate) should normally be zero in most cases.</p> <p>If site specific geotechnical investigations and hydraulic conductivity tests are carried out these can be used to set alternative exfiltration rates.</p> <p>Evaporative loss should normally range from 75% of PET for completely open water to 125% of PET for heavily vegetated water bodies.</p>
<p>ALL "ADVANCED PROPERTIES"</p> <p>(k-C* values, orifice discharge and weir coefficients, void ratio, number of CSTR cells)</p>	<p>As per MUSIC default values. Appropriate justification is required to change the advanced properties</p>

11.6.1 Modelling of Treatment Systems with Infiltration

MUSIC v4 did not contain the necessary functionality to model treatment systems with infiltration for compliance with pollutant load reduction targets. MUSIC v6 allows for the use of secondary drainage links. This new link allows infiltration systems to be appropriately modelled by introducing a secondary node and link to capture the infiltration and pollution that would normally be lost from the model by seeping into the surrounding soils and bring it back in. For more information refer to Healthy Land and Water's *MUSIC Modelling Guidelines*.

11.7 References

MUSIC Modelling Guidelines 2010 - Water by Design

Northern Beaches Council - WSUD and MUSIC Modelling Guidelines - June 2016

Using MUSIC in Sydney's Drinking Water Catchment December 2012

Developer Handbook for Water Sensitive Urban Design - Blacktown City Council 2013

Penrith City Council - WSUD Technical Guidelines 2015

Hornsby Shire Council - WSUD Reference Guidelines 2015

Section 12 - Street and Public Place Lighting General Requirements

Lighting shall be designed and constructed for:

- Subdivision or development roads.
- Intersections, roundabouts and mid-block traffic calming devices.
- Public areas where nominated in the Development Consent.
- Pedestrian underpasses, overpasses, bridges, ramps and paths.
- Bicycle parking facilities.
- Car parks.
- Cul-de-sacs, permanent turning heads and temporary turning facilities.
- Potential vehicle conflict area and pedestrian and cyclist road crossing locations.

Lighting shall be designed in accordance with AS/NZS 1158 *Lighting for roads and public spaces* and AS 4282 *Control of the obtrusive effects of outdoor lighting*, allowing for the following:

- Lighting design generally shall be sub-category P4 or P5. An alternative sub-category may be recommended by the Service Provider for Council Representative's approval.
- Outdoor off-street car park designs shall be based on lighting sub-category P11/P12.
- A minimum of 20-year design life for all lighting components, except supporting structures where a 40-year design life shall be provided.
- Best practice energy efficient lighting.
- Minimal impact of glare and light spill into adjacent properties.
- Consideration for cost, while endeavouring to meet the set lighting standards.
- Solar lights may be considered for installation in car park areas, alongside pathways and at specific roadside facilities, especially at locations where there is no suitable nearby connection to a low-voltage power supply and where it is considered the most economical way to provide lighting. All new solar light poles shall have a preferred pole height of 6m unless otherwise approved by Council's Representative.

Only galvanised finished light poles and associated fittings will be accepted by Council unless otherwise negotiated with Council's Representative.

Street lighting requirements on rural roads shall be discussed with Council's Representative.

Best practice energy efficient lighting must be specified in the design and the use of LED as the lighting technology is preferred.

It is the Service Provider's responsibility to meet all costs associated with the design, supply and installation of street lighting where required by a Development Consent.

Section 13 - Utility Services Design and Installation

13.1 Design of Services

It is essential to obtain approval from the relevant Roads Authority (Council or in the case of State Roads, TfNSW), before excavating any street or verge. Some Utility/Service Providers may not be required to obtain approval, as a result of legislation or established agreements. Where exemptions apply, Central Coast Council must be notified of the works.

The Designer is to include measures to minimise the risk of any adverse effects of earthworks on existing services including but not limited to:

- Obtaining Dial Before You Dig utility services plans, survey marks and other services information including Council's stormwater, water and sewer information.
- Showing services locations and descriptions on all Engineering Drawings.
- Using specialist Services Locators to confirm locations and depths within the vicinity of the proposed work of all services and noting existing and proposed cover or clearances on Engineering Drawings.
- Providing details of arrangements and contacts for timely adjustments/relocations by services authorities.
- Noting on Engineering Drawings any restrictions on activities near services for the purpose of asset protection.
- Noting on Engineering Drawings the responsibilities and obligations attaching to individuals concerning Services matters.
- Detailing the design of protection works whether temporary or permanent.
- The installation of services in Acid Sulphate Soil (ASS) and Potential Acid Sulphate Soil (PASS) material must be avoided. Where unavoidable ASS and PASS management plans in accordance with the current NSW Acid Sulphate Soil Manuals and Guidelines are required.
- NSW Streets Opening Conference 2009 Edition of *Guide to Codes and Practices for Streets Opening*.
- Service trenches must be placed in the cut side unless approved by Council's Representative as service trenches in the fill side can create a potential slip plane.
- Particular attention is drawn to the importance of protecting any survey marks which may be affected by the proposed work. Showing survey marks on all Engineering Drawings and noting plans to protect survey marks.
- Detailing temporary and permanent road reserve reinstatement plans.

It is advisable that the Service Provider liaise with Service Authorities at an early stage of the development process to resolve servicing issues such as proposed services layouts, future services, the locations of substations and telecommunications installations and planning regarding existing services alterations or amplifications.

It is advisable that the Designer liaise with Service Authorities at an early stage of the design process to prepare engineering designs which are compatible with the requirements of Council and Service Authorities.

The Service Provider must provide all Service Authorities with finished surface levels and/or up and down measurements from the top of kerb at the proposed property boundary and/or the proposed location of the Service Authorities pit, marker, etc to ensure that:

- All Service Authority conduits, etc have correct cover.
- All Service Authority pits, markers, etc do not require future adjustments to suit driveways, footpaths or similar.

The arrangement of services within verges shall be in accordance with the Central Coast Region allocations within the NSW Streets Opening Conference 2009 Edition of *Guide to Codes and Practices for Streets Opening* and any specific site requirements imposed by Council.

Any area to be disturbed by the provision of services shall be restored to design levels either to new surface treatments when within the site or by reinstatement of existing surface treatments within existing roads and properties.

Refer to Council's *Civil Works Specification - Construction Specification* Section 7 - Utility Services Installation, Road Opening and Utility Restorations for requirements regarding utility trench installation within road reserves and road reserve reinstatement. Engineering drawings shall be notated accordingly with details to specify remedial works where not adequately covered by Council's *Civil Works Specification - Construction Specification*.

Where the utility work has significant impact on road pavements the Designer shall consider a full pavement redesign (in accordance with Section 7 - Design of Pavements of this *Design Guideline*) in lieu of the required trench restoration (as per *Civil Works Specification - Construction Specification* Section 7 - Utility Services Installation, Road Opening and Utility Restorations).

13.2 Effects on Services

Major public utility adjustments often prevent the proposed works from proceeding because of the costs of relocation. The Service Provider therefore must accurately locate surface and underground utilities in critical locations in respect of type, size, horizontal and vertical placement. This can mean removal of pit lids for inspection, electronic detection and trench excavation for physical exposure of the utilities where site conditions dictate.

Where a utility is unable to be located and/or an assumed depth is adopted than a clear highlighted note is to be provided on the plan view and associated longitudinal section indicating assumed location and depth unknown.

The Service Provider is to include measures to minimise the risk of any adverse effects of earthworks on existing services including but not limited to:

- Obtaining Dial Before You Dig plans, survey marks and other services information including Council's stormwater, water and sewer information.
- Showing services locations and descriptions on all Engineering Drawings.
- Using specialist Services Locators to confirm locations and depths within the vicinity of the proposed work of all services and noting existing and proposed cover or clearances on Engineering Drawings.

- Providing details of arrangements and contacts for timely adjustments/relocations by services authorities.
- Noting on Engineering Drawings any restrictions on activities near services for the purpose of asset protection.
- Noting on Engineering Drawings the responsibilities and obligations attaching to individuals concerning Services matters.
- Detailing the design of protection works whether temporary or permanent.
- The installation of services in Acid Sulphate Soil (ASS) and Potential Acid Sulphate Soil (PASS) material must be avoided. Where unavoidable ASS and PASS management plans in accordance with the current NSW Acid Sulphate Soil Manuals and Guidelines are required.
- NSW Streets Opening Conference 2009 Edition of *Guide to Codes and Practices for Streets Opening*.
- Service trenches must be placed in the cut side unless approved by Council's Representative as service trenches in the fill side can create a potential slip plane.
- Particular attention is drawn to the importance of protecting any survey marks which may be affected by the proposed work. Showing survey marks on all Engineering Drawings and noting plans to protect survey marks.
- Detailing temporary and permanent road reserve reinstatement plans.

Section 14 - Landscaping and Street Tree Planting

14.1 Landscaping

Landscaping may be required by conditions of Development Consent approvals and restoration of civil works. Landscaping, including estate entry features, fencing, mounding or site regrading not shown on the approved Landscaping Plans shall not be undertaken without prior approval by Council's Representative.

Landscaping plans shall be prepared in conjunction with Civil Works Design Drawings and Environmental Assessment and shall be approved by Council prior to the release of a Subdivision Works Construction Certificate or Civil Works Approval.

14.1.1 Landscape Design Objectives

Landscaping designs shall be carried out by appropriately qualified persons. Vegetation and hard landscaping shall:

- Be ecologically sound and sustainable.
- Add value and character to the surrounding environment.
- Integrated with the built and natural environment.
- Avoid root intrusion into road pavements, drainage, sewer and other utilities.
- Avoid uplifting of paving, damage to structures or creating of hazards to pedestrians by tree roots.
- Not restrict access or alter cover to buried services and stormwater lines particularly at fittings, connections and inspection points.
- Not create unacceptable maintenance practices.
- Minimise disruptions to traffic due to maintenance activities.
- Not create unsound or hazardous structures.

Vegetation and hard landscaping must not:

- Create unsafe or nuisance surface flooding or pavement damaging subsurface flooding by irrigation systems or associated water quality measures.
- Restrict view and sight lines which have implications for public safety and crime prevention.
- Result in excessive implementation and maintenance costs.
- Result in any adverse environmental or ecological impacts.

14.1.2 Landscape Design Guideline

Refer to Central Coast Council's *Green Grid Policy*, *Greener Places Strategy* and *Landscape Design Guideline* and Council's *Civil Works Specification - Standard Drawings* for further information on landscaping requirements.

Enquiries regarding landscape design and approval shall be directed to Council's Representative.

14.2 Street Tree Planting

Street tree planting will be dependent on the individual street width, traffic speed and volume, road user safety and public utility services and will therefore require site specific designs to be employed.

14.2.1 Street Tree Planting Objectives

The primary objective of street tree planting is to provide a healthy tree canopy within the urban and suburban environments that is safe, robust, provides good amenity and retains biodiversity.

Landscape designs shall be fit for purpose and lead to cost effective landscaping schemes, requiring careful examination of cost estimates for implementation of landscaping works and for the ongoing maintenance of landscaped areas within road reserves.

14.2.2 Safety in Design

Safe System principles shall form part of the decision-making process when preparing landscape designs within road reserves regarding sight lines at intersections and property accesses, roadside hazards and the potential obstruction of road traffic signs.

Safety in Design principles shall also form an integral part of the landscape design process to ensure work health and safety requirements are properly considered for persons implementing landscaping proposals and for future maintenance activities.

Road clear zones (typically 3m from the traffic lane or edge line in an urban residential area) shall be kept clear of trees and shrubs greater than 100mm in diameter at a height of 500mm from the surrounding ground level. Where tree planting is proposed within the road reserve and it is impractical to achieve the required clear zone widths, a road safety barrier system shall be considered for road user safety reasons, where practicable, following a thorough risk assessment process.

14.2.3 Design Life and Location

The design life for plants selected for use in urban residential areas shall be 40 years minimum.

Desirably, street trees in urban areas should be planted so that there is no more than 1 street tree placed outside each property frontage, with an approximate spacing of 10 to 15m, where practicable, and subject to the specific location and tree species.

Trees should be planted in grass surrounds within a tree pit and with a tree grate, where applicable, with a root barrier system where trees are planted near concrete kerb and/or concrete paths.

The location of street trees near underground and overhead public utility services shall require careful consideration to ensure that tree health and stability is not compromised, and public or domestic utility services are not damaged because of tree growth.

14.2.4 Permeable Pavement Systems

Street tree planting may be permitted in permeable pavement surrounds by utilising permeable block pavers and a 300mm minimum free-draining gravel base course to reduce pavement damage and

costly remedial work within the road reserve, subject to specific geotechnical engineering investigation and pavement design and the approval of Council's Representative. Refer to the article published in Science of the Total Environment 671, 23 March 2019: *An infiltration approach to reducing pavement damage by street trees* by T Lucke and S Beecham.

14.2.5 Landscape Design Guideline

Technical details have been developed to ensure Service Providers provide appropriate and consistent treatment for street tree planting.

Refer to Central Coast Council's *Green Grid Policy*, *Greener Places Strategy*, *Landscape Design Guideline* and Council's *Civil Works Specification - Standard Drawings* for further information on street tree planting requirements.

Street tree planting design plans or landscape design plans shall be submitted to Central Coast Council for consideration and approval prior to any installation within road reserves.

14.2.6 State Roads

Street tree planting proposals on state roads shall be planned in consultation with the appropriate TfNSW representative and in accordance with the TfNSW *Landscape Design Guideline* and *Biodiversity Guidelines*.

Appendix A - Preparation and Presentation of Design

A.1 General

All drawings prepared and submitted to Council shall comply with the relevant Council standards to ensure that the drawings are suitably legible for review by Council's Representative.

A.2 Data Ownership

All data associated with projects undertaken on behalf of Council becomes the property of Central Coast Council. This includes data provided during and upon completion of the project. No data or information that is considered the property of Central Coast Council may be given to a third party without the formal written consent of Central Coast Council.

A.3 Design Drawings

A.3.1 General

All engineering drawings shall comply with the following in order to standardise the presentation of drawings to facilitate the approval and construction processes.

Engineering drawings shall be uncluttered and information clearly readable.

A.3.2 Size

Engineering drawings shall be supplied on A series ISO standard sheet sizes (A0, A1, A3, A4, etc).

Engineering drawings submitted for Development Consent shall be submitted as three sets at A3 size and a PDF file.

A.3.3 Colour

When colour is used in a drawing and it is to be printed in colour, a note must appear on the title block stating that the drawing was created using colour and may appear incorrect if reproduced in greyscale or black and white. Colours used in drawings shall be visible and easily distinguishable and remain clear when the drawings are copied.

A.3.4 Text

The size of construction notes on the plans and drawings shall be minimum 2mm on A3 sheets. The size of other lettering or numbering, including text within line types, shall be minimum 1.5mm on A3 sheets. The minimum text size on A1 sheets shall be 2.5mm.

All annotation shall be carried out using CAD systems unless otherwise approved.

A.3.5 Line work

All line work shall have a minimum line weight/thickness of 0.15mm.

A.3.6 Hatching

Hatch patterns and the scale of the hatch shall be easily identifiable and distinguishable. The appearance of the hatching shall match that shown in the legend. Hatch patterns must be consistent across all drawings.

A.3.7 Scales

Plan

- Road and Drainage: 1:400 minimum or as required for clarity. 1:100 or 1:200 for detailed road intersection plans.
- Water and Sewer: Refer to Water Authority Requirements and adopted WSAA Code.

Detail

- As required for clarity.

Longitudinal Sections

- Generally, 1:400 Horizontal, 1:100 Vertical.
- Vertical scale may vary in very flat or steep grades.

Cross Sections

- 1:200 Natural.

Kerb Returns

- As required for clarity, see A.3.11.5 Kerb Return Profiles.

Catchment Areas

- As required for clarity to suitably denote new and existing contributing catchments.

A.3.8 Drawing Title

All sheets must show the following information in the title block:

- Project/Property description.
- Service Provider/consultant/owner.
- Surveyor/Engineer.
- Scale, bar scale and survey datum.
- Project/Development Consent number.
- Sheet number and amendment number/letter.
- Description of work.

A.3.9 General Notes to be Shown on Development-Related Design Drawings

The following general notes shall be shown on the first or cover sheet of all Design Drawings:

1. All work is to be carried out in accordance with Central Coast Council's *Civil Works Specification* and to the satisfaction of Council's Representative.
2. The Service Provider is responsible for ongoing maintenance of erosion and siltation control measures.
3. All public utilities shall be clearly identified in the field prior to any civil works. Council does not accept any responsibility for damage or relocation costs to public utilities during construction of the development.
4. Prior to commencement of any work, a **Notice of Intention to Commence - "Subdivision Works, Roads Act Approval Works and/or Approved Stormwater Drainage Works"** must be lodged with Council. This form is available from Council's website.

5. It is the Service Provider's responsibility to ensure that all works shall be carried out in accordance with the *Work Health and Safety Act 2011*.
6. Permission to Enter, construct works and discharge stormwater onto adjoining properties shall be obtained and submitted to Council prior to the commencement of any works.
7. Pavement to be designed and certified by a practising consultant geotechnical engineer and submitted to Council for approval prior to the commencement of any works.
Approved pavement design reports shall prevail over any design requirements or pavement details shown on the approved drawings.
8. These drawings shall be read in conjunction with the conditions stated in Central Coast Council's engineering plan approval correspondence and the conditions of the Development Consent.
9. **If the standard or requirements for works shown on the approved drawings differ from that required by Council's *Civil Works Specification*, then the requirements of the *Civil Works Specification* generally will prevail.** Clarification shall be obtained from Council's Representative if there is concern that the requirements of Council's *Civil Works Specification* may not be appropriate for a specific circumstance.
10. The Service Provider shall address all preconstruction requirements of Council's *Civil Works Specification* prior to commencement of any works.

A.3.10 Drawing List

The following is a list of the sheet types which may be applied for detailed Design Drawings:

- Cover and index.
- Typical cross sections.
- Survey control plan and co-ordinates.
- Alignment control and detailed setting out.
- General plans and longitudinal sections.
- Pavement composition - build-up, jointing, subsurface drainage, etc.
- Cross sections.
- Kerb return profiles.
- Property adjustments and/or driveway adjustments and longitudinal sections.
- Pavement marking, signposting and safety barriers.
- Drainage and subsurface drainage plans.
- Drainage longitudinal sections.
- Drainage calculation tables.
- Drainage catchment plan.
- Detailed drainage structures.
- Public utility services and proposed relocations.
- Erosion and sediment control plan.

A.3.11 Design Drawings

The following details shall be provided as a minimum set of Design Drawings.

A.3.11.1 Typical cross section details, with pavement details and subsurface drainage.

Typical cross sections as a minimum shall detail:

- Lane configuration and typical crossfalls.
- Typical location of road furniture (including streetlight poles and road safety barriers).

- Typical location of existing and proposed utilities.
- Pavement profile and reference to edge details.
- Subsurface drainage location.

A.3.11.2 Road and Stormwater Drainage Design Plans

Road and stormwater drainage design plans as a minimum shall detail:

- Site location plan.
- Centre line chainages.
- Chainages shall be aligned with the longitudinal section and generally run left to right across the plan, preferably readable in the direction of ascending chainages.
- North point to define orientation.
- Centre line bearing of straight sections and the radii of curves.
- Location, description and RL of bench marks, to AHD.
- Position of proposed subsurface drainage lines (may be covered by note or shown on typical cross sections).
- Existing road names and proposed road number/names, property boundaries (existing and proposed) and lot and house numbers.
- Proposed type and alignment of kerbs including road and lane widths.
- Proposed dimensions, locations, material and types of all pavement marking (including raised retroreflective pavement markers) and signs, including sign size code, mounting height and lateral clearance requirements.
- Location and level of all existing services with construction notes relating to any necessary alterations or protection treatments (any service impacted by the project shall also be provided with levels).
- Location of proposed drainage structures with pits and headwalls numbered to correspond with drainage calculations and longitudinal section. For clarity, drainage details may be shown on a separate drainage plan.
- Lip of kerb radius for all kerb returns.
- Existing drainage structures and conduits including size, type and invert levels.
- Existing road feature level and location each side of the new road location sufficient to determine design grades and crossfalls to the new work.
- Existing survey features.
- Show merged proposed and existing contours at 500mm intervals, together with any relevant topographical features over the whole site. In flat areas or in watercourses and flood plains, 100mm intervals shall be provided.
- Limits of cut and fill batters of significance.
- Existing and proposed cadastral boundaries, including existing and proposed road reserve boundaries.
- All trees (greater than 3m in height) and shrubs within the road reserve and those within 3m each side of a proposed drainage line together with any others likely to be affected by the works, must be located and shown on the plan.
- Set out co-ordinates for all design centre lines, stormwater structures and any other design features requiring accurate set out information.
- Details of intersections showing kerb return chainages, kerb radii, road design centre lines, finished surface contours at 100mm intervals, or 200mm intervals if required for clarity, and set out co-ordinates.
- Location and details of permanent and temporary survey marks required for set out purposes.

A.3.11.3 Longitudinal Sections for Roads

Longitudinal sections shall have chainages running left to right across the page. Other information to be shown shall include:

- Centre line chainages.
- Existing surface levels on the design control line.
- Design surface level on the design control line.
- Details of the vertical alignment, including crest and low points.
- Grades, size of vertical curves and chainage, and chainage and RL of intersection points.
- Datum RL of longitudinal section.
- Chainage, size and level of Public Utility mains and services (where information is available).

The longitudinal section shall extend for a minimum of 60m beyond the limits of pavement works, including along existing intersecting roads, to enable proper design tie-ins.

The longitudinal section of an offset cul-de-sac shall be curved to the centre of the turning circle and not in a straight line with an offset to the centre.

Hammerhead turning facilities shall have the long section continued along the main line of the facility. Where a cross section does not show the design centre line of the other turning arm, a long section shall be provided.

A.3.11.4 Cross Sections

- Cross sections must be shown at a maximum of 15m intervals and at key points for design purposes, e.g. where accesses require special design, where cover requirements over services are critical or where superelevation is required at the relevant transition chainages. Where appropriate for level control, designs may require cross sections at 5 or 10m intervals.
- Cross sections must be placed such that the lowest chainage occupies the bottom left corner of the sheet and run sequentially up the sheet in progressive columns towards the right.
- Cross sections must extend for the full road reserve width or for a sufficient distance to detail the proposed method of satisfactorily matching the design and existing surfaces.
- Additional cross sections shall be provided at each driveway access and be extended to detail transition to existing access or parking area.
- Provide sufficient existing cross section profiles and crossfalls to show transitions to proposed works where required.
- Details to be shown on cross sections shall include:
 - Road centre line chainage in bold print below each section.
 - Offset chainage from the pegged or design control line.
 - Existing surface RL.
 - Design surface RL.
 - Design crossfall (%).
 - Batter slopes (ratio Horizontal:Vertical).
 - Access grades (%).
 - Design centre line shift, offset crown or transitions where applicable.

- Existing and proposed road reserve boundaries and levels within properties or regrading levels where required.
- When instructed by Council's Representative, the position, size and level of any utilities in the vicinity of the work shall be included on the cross sections.

A.3.11.5 Kerb Return Profiles

- Each profile shall have a kerb return number (e.g. KR2) corresponding with a number shown on the plan view.
- Profiles shall represent lip line as viewed from the road in the direction of travel.
- Details to be shown shall include the following:
 - Horizontal and vertical scale. This scale must be selected to clearly show the convexity of the kerb profile.
 - Chainages. The running kerb lip chainage related to the profile together with the chainage related to the road centre lines. Chainages shall run left to right across the page.
 - Design level shall be lip of gutter.
 - Existing surface levels.
 - Applicable road/street names/numbers leading into the profile.
 - An extension of 15m minimum beyond the tangent points to ensure a smooth profile is achieved.
 - Show location and number of proposed drainage structures.
 - Datum RL of kerb return.

A.3.11.6 Stormwater Catchment Analysis

When the design is within an identified flood affected area (existing or a future), the Service Provider shall refer to Section 3.14 Design in Flood Affected Area for details of Council's flood data requirements. The following details shall be provided as a minimum:

- Full catchment plan including contours is to be provided with all stormwater drainage designs.
- Catchment calculations showing the extent of the catchment including contributing areas outside the proposed works must be shown and all areas accounted for in the calculations.
- Each pit sub-catchment shall have a reference number/letter which must be consistently used on the catchment plan, drainage calculations sheet, drainage longitudinal sections and kerb returns.

A.3.11.7 Stormwater Drainage Drawings

- The stormwater plan may be incorporated on the road plan if space permits otherwise it should be shown on a separate sheet orientated the same as the road plan sheet.
- Details to be shown on the plan shall include:
 - North point.
 - Proposed road alignment.
 - Pit/structure reference number/letter.
 - Location of any applicable drainage structure.
 - Pipe/box culvert sizes.
 - Location and width of existing or proposed drainage easements.

- Location of any utility services crossing the work.
- Typical sections and capacities.
- Location of any public utility service mains/services crossing influenced by the work
- Note referring to type of bedding/backfill condition required in accordance with AS/NZS 3725 *Design for installation of buried concrete pipes*.
- Details to be shown on the drainage profiles shall include:
 - Drainage longitudinal sections must have the downstream end of the system on the left-hand side of the sheet with chainages to run left to right unless otherwise agreed with Council's Representative.
 - Running chainage along the stormwater pipe at each pit structure and structures crossing the drainage line.
 - Pipe design invert level.
 - Pipe grade.
 - Existing surface level.
 - Existing invert of drainage where applicable (i.e. pipes, creeks, drains, etc).
 - Finished surface levels.
 - Pipe size, class and type.
 - Type of bedding/backfill condition required in accordance with AS/NZS 3725 *Design for installation of buried concrete pipes*.
 - Location, size and level of any public utility main or service that may be affected by the work and proposed treatment.
 - Pit/structure reference number and type (to be shown above the section together with details of kerb inlet extensions and pit k value).
 - Datum RL of the longitudinal section to AHD.
 - Hydraulic grade line and levels including the receiving waters design level.
 - Design flow and design storm Annual Exceedance Probability.
 - Partial and full pipe velocity.
 - Minimum friction grade of the design culvert.
 - Trenchstop or bulkhead locations and spacing required.

A.4 Water and Sewer Drawings

When additional water and/or sewer infrastructure is required, the Design Drawings shall comply with the applicable Water Services Association of Australia (WSAA) Codes and Council's *Water and Sewer Drawing Standards*, the latter of which can be obtained from Council's Representative.

A.5 Environmental Management Plan

A.5.1 Environment/Vegetation Protection Drawing

These drawings shall show kerb lines, drainage, sewer and any other civil infrastructure that will require disturbance to the natural environment. These drawings shall show "NO GO AREAS" and proposed fence lines and types to ensure there is no disturbance outside the construction corridors.

A.5.2 Erosion and Sediment Control Drawing/Soil and Water Management Drawing

These drawings shall show the location, type and specific details of all sediment and erosion control devices. Soil and Water Management Plans and/or Erosion and Sediment Control Plans shall be

prepared in accordance with *Managing Urban Stormwater: Soils and Construction*, 4th Edition, Landcom, 2004 (commonly known as "*The Blue Book*"). Refer to Council's *Civil Works Specification - Construction Specification* Section 5.1.2 Soil and Water Management, Erosion and Sediment Control.

Details of sediment basins shall show the capacity, batter slopes, maintenance access, fencing, spillway, pumping requirements, dosing/flocculation requirements and stabilisation of the basin as a minimum. Details shall also show proposed staging of works, requirements for revegetation or progressive revegetation. Stockpile sites and source control measures for the stockpiles shall also be detailed.

A.6 Retaining Walls

These drawings shall include as a minimum, the requirements listed in Section 8 - Design of Structures of this *Design Guideline* regardless of retaining type or height.

Further structural details for various types of retaining walls can also be found within Council's *Civil Works Specification - Standard Drawings*.

Appendix B - Engineering Survey

B.1 General

The engineering survey shall be carried out by a suitably qualified Engineering Surveyor and be referenced to the Geocentric Datum of Australia (GDA), using the Map Grid of Australia co-ordinate reference system, but with elevations established by reference to Australian Height Datum (AHD).

The survey is to accurately show the landform to facilitate the best possible design and construction of roadwork, drainage and other improvements upon the land consistent with minimum interference to the existing amenity of the area. The survey shall be approved/certified by a Registered Land Surveyor as defined by the *Surveying and Spatial Information Act 2002*, or approved equivalent. Internal Council surveys may be approved/certified by a Council Surveyor.

B.2 Work Methods

All surveys shall be carried out in accordance with the current *Surveying and Spatial Information Regulation 2017*. Work methods employed must be self-checking with redundant/check, observations/measurements made between set out points and adjacent/related structures to confirm the integrity of the set out and the drawing dimensions.

B.3 Permanent Marks, State Survey Marks and Cadastral Reference Marks

All information relating to Permanent Marks (PMs) and State Survey Marks (SSMs) and Cadastral Reference Marks shall be obtained by the Service Provider from the Survey Control Information Management System (SCIMS) and by a thorough search of plans on Public Record, prior to the commencement of the site survey. These PMs and SSMs shall have an accuracy of Class B, Order 2 as defined by SCIMS unless otherwise approved by Council's Representative.

The project Surveyor will conduct a thorough visual site inspection within the extent of survey, to locate existing or additional survey marks. Additional survey marks will include those not recorded in SCIMS, cadastral reference and boundary marks, survey monuments, bench marks, new marks on unregistered plans or marks of unknown origin that may be affected by the proposed works.

At the completion of the site inspection, the project Surveyor will prepare an audit schedule of all marks within the extent of proposed works and report their physical state, in other words, "found", "not found", or "destroyed".

The 'Audit Schedule of Survey Marks' will accompany the design plan for the project and will determine if a 'Plan of Survey Information Only' is required by the NSW Surveyor General.

The Permanent Mark(s) used to derive levels and the State Survey Mark(s) used to derive the co-ordinates for the project shall be noted on the applicable design plans.

B.4 Survey Control Stations

A minimum of three established Permanent Survey Marks shall be included in each project's survey control station network.

The Engineering Surveyor shall establish all survey control stations in the network as part of a closed traverse, within sight of each other, and at a maximum of 100m spacing on each project site.

All survey control stations shall be clear of any proposed works where practicable and be clearly shown on all working drawings.

Care must be exercised in placing the survey control stations so that they do not damage or affect underground utility services and ideally can be used during the whole period of construction and not, for example, on the high side of a road where there is likely to be a large cutting and the mark lost during construction.

The survey control stations shall be constructed according to good survey practice. The stations shall be of a conventional type and of a durable nature, such as a galvanised iron pipe (GIP) or truncated star picket, minimum 300mm long, a bolt or galvanised spike in the bitumen, a drill hole, or drill hole and wing, masonry nail or plug in concrete. Survey control stations placed in the ground shall be at least 50mm below the surface. All survey control stations shall be painted white and numbered in sequence for ease of location in the field by others.

Indicator stakes showing the location of 'in ground marks' will be placed clear of pedestrian traffic and where possible, near the edge of the road reserve and/or adjacent to the property line.

A Survey Control Station Schedule, showing the Station Number, Easting, Northing, RL and description, such as GIP, Plug, PM/SSM with reference number, shall be shown on the Design Drawings.

B.5 Datum

All levels must be related to Australian Height Datum (AHD).

The datum must be verified by closed height difference between a minimum of two benchmarks with known AHD levels. The benchmarks used to derive levels for the project shall be noted on the Design Drawings.

All height differences shall attain a precision of $0.012\sqrt{d}$ km metres or better (where d is the length of level run in km and the result is expressed in metres).

The Reduced Level (RL) of control stations shall be obtained by differential levelling.

Copies of closed level runs shall be kept by the Surveyor and made available to Council on request. Field notes may be called upon to check the difference between RLs and levels obtained by electronic means.

B.6 Extent of Survey

As a minimum, the extent of the survey shall cover the full width of the road reserve plus 6m each side.

The Surveyor shall supply detail survey information as required and where changes to existing surface features are encountered at a nominal maximum spacing of 15m to allow the development of an accurate digital terrain model (DTM) for the extraction of longitudinal and cross sections.

The DTM must be verified and for existing road pavements and associated structures shall be within $\pm 15\text{mm}$ of the actual RL at any point unless otherwise specified by Council's Representative.

All vehicle access crossings and driveways shall be surveyed in sufficient detail to identify the extent of property adjustments required. The Surveyor shall locate both edges of the vehicle access crossing and driveway and extend at least 6m into the property and locate and level any garage/carport floor.

The survey shall extend for at least 60m past the design area and alongside roads to enable longitudinal and cross sections to be developed. Where Council considers cross sections are unnecessary to determine tie-in works then only centre line levels for 60m past the design area shall be provided to enable a longitudinal section to be developed to define tie-in works.

The 15m spacing specified above shall be regarded as a maximum and where necessary, extra survey must be provided, for example, at sudden changes of grade to enable earthwork quantities to be calculated with reasonable accuracy.

B.7 Features to be Located

Prior to developing an engineering design, all relevant physical features and improvements shall be accurately located for plotting on the drawings.

Physical features shall include but shall not be limited to:

- Sufficient surface spot levels to enable creation of contours at 500mm intervals. In flat areas or in watercourses and flood plains, 100mm intervals shall be provided.
- Change of grade, top and bottom of banks.
- Rock outcrops (including cliffs, caves, etc).
- All trees (greater than 3m in height) and shrubs within the road reserve and those within 3m each side of a proposed drainage line together with any others likely to be affected by the works, must be located and shown on the plan. This includes the canopy spread of individual trees with a diameter of 300mm and larger when measured 1m above the ground unless the tree forms part of a group planting, in which case show the group canopy spread.
- Waterways, dams, ponds, springs, etc. Small watercourses that run only in times of rain may be shown as a single line, but streams and creeks must have a full cross section of the creek located at 10m intervals and at changes in direction and width.
- Artificial structures (for example; existing road formation, kerb and gutter, fences, buildings and vehicle entrances).
- Existing drainage structures.

- Existing utilities and services and their structures accurately located in the field and shown clearly on the plan.

It is the responsibility of the Service Provider to contact all relevant authorities to obtain current locality plans and to arrange location, excavation and levelling of all utilities which cross proposed drainage lines or could affect design levels.

Sewer main Work-as-Executed drawings initially may be used to identify sewer lines for the design, but potholing of these services shall be carried at critical locations, such as at drainage pipe road crossing locations, or where domestic sewer connection lines are located within the road.

A copy of all utility services diagrams collected shall be supplied to Council with the submission of the survey plan.