GOVERNMENT OF WESTERN AUSTRALIA

Department of **Planning, Lands and Heritage**

Western Australian Planning Commission

Local Government Guidelines for Subdivisional Development

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Institute of Public Works Engineering Australasia
Western Australia Incorporated
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Western Australia 6005

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The version of referenced publications may have been superseded since this document was published consequently care should be taken to ensure that only the latest version of any referenced publication or standard is applied.

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Foreword

The ability of State and Local Government and the development industry to provide an affordable, sustainable and timely supply of urban land is a key planning priority. The specific requirements necessary to achieve planning and engineering approval for the subdivision of residential, industrial and commercial lots should be clear, transparent, and consistently applied.

To provide greater clarity and certainty of subdivisional engineering requirements, the Department of Planning, Lands and Heritage has partnered with the Institute of Public Works Engineering Australasia Western Australia Incorporated (IPWEA) to produce Edition No. 2.1 of the *Local Government Guidelines for Subdivisional Development, 2011*.

These Guidelines are intended to underlie and support subdivision conditions applied by the Western Australian Planning Commission pursuant to the *Planning and Development Act 2005.* The Guidelines encompass current legislation and best practice minimum engineering standards. They are intended to guide Local Government and the development industry through engineering specification, construction and post-construction subdivision approval. IPWEA has committed to update the Guidelines on a regular basis every two years.

The Department of Planning, Lands and Heritage and IPWEA urge developers, designers and approval authorities to employ this document as their basis for subdivision engineering design and construction. Local authorities are also strongly encouraged to formally adopt these Edition 2.3 Guidelines as the basis for subdivisional engineering approval within their municipality.

ACKNOWLEDGEMENTS

This production of Edition No.2.3 of the Local Government Subdivisional Guidelines was overseen by a Steering Committee on behalf of the Department of Planning, Lands and Heritage and the Institute of Public Works Engineers Australasia Western Australia Incorporated (IPWEA).

The Department of Planning, Lands and Heritage funded the project on behalf of the IPWEA to ensure that the Guidelines contain best practice and the latest statutory regulations for the development of land within Western Australia.

During the course of the review the Steering Committee consisted of the following Members:

Mr Martyn Glover	Chair, Executive Director, City of Busselton
Mr Gordon Allan	Director Engineering, Shire of Serpentine Jarrahdale
Mr Aaron Baxter	Engineering Services Project Coordinator, City of Rockingham
Mr Mark Bondietti	Policy Manager Transport and Roads, Western Australian Local Government Association (WALGA)
Mr Markus Botte	Manager Technical Services, City of Gosnells
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Mr Anthony Vuleta	CEO, Town of Victoria Park
Mr Robert Willis	Consultant

The contributions of the individuals above and their organisation is recognised and acknowledged for the cooperation and supply of technical data and support for the project.

The review of the Department of Water and Environment Regulation contribution was reviewed by Cardno (WA) Proprietary Limited under the direction of Mr Marino Evangelisti.

Updates

The original Local Government Guidelines for Subdivisional Development Edition 1 was published in October 1998. The document has been updated since and the history is included in the table below:

Date	Updates	Contents and purpose	Edition No.	Amended Modules
July 2009	01	Revision of Edition 1	2.0	All
Jan 2011	02	Revision of Edition 2.0	2.1	All
Aug 2012	03	Revision of Edition 2.1	2.2	All
June 2016	04	Revision of Edition 2.2	2.3	All
Nov 2017	05	Minor revision required by WAPC		All

Each update will be listed above with the Guidelines, as amended, available on the IPWEA web site http://www.ipwea.asn.au/ and
DPLH website: https://www.planning.wa.gov.au/publications/6439.aspx

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Module No. 1

Legal Framework and Contract Administration

1 Module No. 1 – Legal Framework and Contract Administration

1.1 General requirements

These subdivisional development guidelines have been developed as a reference guide for developers, planners, engineers, technical consultants and contractors involved in subdivisional design and construction. They can be interpreted as setting out the minimum requirements that should be accepted by a Local Government in granting clearance of the engineering conditions imposed on a subdivision by the Western Australian Planning Commission (WAPC). The Commission is the subdivision approval authority in Western Australia, acting under the *Planning and Development Act 2005*.

The guidelines are intended to balance specifications for land affordability whilst maintaining life expectancies for major infrastructure, and they shall not form the basis of a construction contract. The developer is to provide adequate and sound infrastructure to the benefit of the local community or government.

The guidelines prescribe the use of best practice to set minimum standards applicable to the design and construction of roads, drainage, pathways, earthworks and public open space. Developers are encouraged to discuss their proposals with the WAPC and the Local Government at an early stage. These guidelines are intended to promote innovative solutions or improvements in best practice.

It is acknowledged that accepted industry standards change over time. In order to accommodate such changes, periodic revisions will be made to these guidelines on an as needs basis. The guidelines also prescribe the latest legislative requirements at the time of drafting.

This Edition No. 2.2 – 2012 also attempts to highlight many agency policies which have been formulated under jurisdiction of the legal framework in place at the time of drafting. These policies serve as a description or clarification of individual agency interpretations of legislation and how that legislation is to be put into practice in planning, designing and constructing subdivisions.

Local Governments are encouraged to adopt these guidelines as the minimum standard for subdivisional development and they are to be read in conjunction with other policies and legislation relevant to agencies associated with subdivisional approvals.

Module No. 1 addresses the legislative framework that both Local Government and the development industry are bound to abide by to plan, design, construct and approve land development within Western Australia. This module also sets out several contractual issues which should be addressed when considering and planning subdivisions. These items need to be considered by both developers and Local Government when signing contracts and seeking approvals for those contracts.

Legislation that sets the legal framework which governs subdivisional development throughout the State includes:

- *Planning and Development Act 2005*;
- *Environmental Protection Act 1986 and Environment Protection Regulations 1987*;
- *Contaminated Sites Act 2003*;
- *Disability Services Act 1993*;
- *Health Act 1911;*

- *Bush Fires Act 1954;*
- *Conservation and Land Management Act 1945*;
- *Native Title Act 1993 and Amendments 1998 (Federal)*;
- *Aboriginal Heritage Act 1972*;
- *Local Government Act 1995*;
- *Fire and Emergency Services Authority WA Act 1998*;
- *Swan and canning Rivers management Act 2005*
- *Occupational Safety and Health Act 1984*; and
- *Environmental Protection and Biodiversity Conservation Act 1999 as amended (Federal).*

There are also Acts of Parliament that have relevance but do not necessarily have a direct effect on subdivisional construction. These include:

- *Main Roads Act 1930*;
- *Transport Coordination Act 1966*;
- *Soil and Land Conservation Act 1945;*
- *Land Administration Act 1997; and*
- *Transfer and Land Act 1893.*

Contract documents address many of the following items so that developers in particular, understand their obligations prior to proceeding to conditional planning approval stage. These guidelines will give developers the opportunity, prior to seeking any approvals, to discuss and understand what legislation governs their development and what issues can arise during that approval process. Some of these contractual issues include:

- statutory requirements
- developer responsibilities
- occupational health and safety
- road upgrading for subdivisions
- street lighting
- dust control
- control and supervision of works
- practical completion
- survey release
- bonding outstanding works
- defects liability.

Many of these topics are discussed in further detail in the following sections.

1.1.1 Objectives of the Guidelines

These guidelines are for use by both statutory organisations and the development industry. They aim to ensure that subdivisional development:

- meets relevant design and construction standards to ensure safety and longevity;
- produces a beneficial asset for the community;
- being effective (achieves its intention);
- occurs in an efficient manner;
- minimises adverse effects on the local environment;
- produces suitable lots and facilities at a reasonable cost to the community;
- minimises future maintenance liability; and
- considers and allows for future development and maintenance.

1.2 Planning and Development Act 2005

Subdivision in Western Australia is administered by the WAPC. The statutory basis for broad acre subdivision is established primarily by the *Planning and Development Act 2005*.

The guidelines set out in this document become applicable *only* after the planning conditions for subdivision have been set by the WAPC.

1.2.1 Subdivision and clearance process

Subdivision generally occurs after the planning context for a landholding has been established by zoning under the Metropolitan Regional Scheme (MRS) or other region scheme and the local planning scheme; and by the preparation of structure plans or outline development plans under the Local Government's local planning scheme.

Structure plans and/or outline development plans should occur in advance of subdivision and broadly outline the distribution and type of land uses proposed and the indicative site layout including streets, retail and commercial facilities, employment areas, open space, schools, community facilities and infrastructure provision. Initiation and preparation of structure plans and outline development plans generally rests with the landowner, although the WAPC and Local Governments may prepare these documents to guide development, particularly where land ownership is fragmented or has complex development constraints.

Local Government engineering involvement is critical at structure planning stage to address general design issues. The WAPC has operational policies that guide the design of urban areas and the assessment of proposals. The current subdivision design and assessment policy is the WAPC's *Liveable Neighbourhoods* (and supporting) operational policies, which is available online at www.wapc.wa.gov.au. The Commission also has power under the *Planning and Development Act 2005* to set minimum standards of construction for roads (s169).

There may be situations where the developer may enter into a cost sharing arrangement with the Local Government for common infrastructure and this could be set out under a Development Contribution Plan.

IT IS IMPERATIVE THAT ALL LOCAL GOVERNMENT DISCIPLINES HAVE INPUT AT THE DISTRICT AND LOCAL STRUCTURE PLAN STAGES. IF THIS OCCURS AND THE DESIGNS CONFORM TO 'LIVEABLE NEIGHBOURHOODS POLICIES', THEN MOST OF THE DESIGN ISSUES SHOULD BE SOLVED WITHOUT CONDITIONS BEING COMPROMISED.

1.2.1.1. Subdivision process

The WAPC determines all green title, built, vacant and survey strata subdivision (except built strata subdivision applications of five lots and under which are determined by Local Government).

Application to the WAPC for subdivision approval is initiated by the landowner/developer. Subdivision applications are lodged with supporting information, including a plan, and are processed by the Department of Planning, Lands and Heritage on behalf of the WAPC.

Subdivision applications are registered by the Department of Planning, Lands and Heritage then referred to relevant State government agencies and the Local Government for comment on whether to grant conditional or unconditional approval, or refusal. All applications are referred to the relevant Local Government, Western Power and the Water Corporation. Other possible referral agencies include the Department of Biodiversity, Conservation and

Attractions, Department of Water and Environment Regulation, Main Roads Western Australia (MRWA), Swan River Trust, Fire and Emergency Services, Department of Health, Department of Agriculture and Department of Education.

Referral agencies have 42 days to respond. If conditional approval is recommended, conditions are normally derived from a set of conditions developed and adopted by the WAPC and based on advice from referral authorities; however, non-generic conditions may be imposed. This is the critical point for detailed Local Government engineering involvement and dialogue between the Local Government and the developer should take place as early in the process as possible. The *Planning and Development Act* now provides that if referral advice is not received within 42 days, there is deemed to be no objection to approval and no requirement for conditions from that agency.

Once referrals are received, the planning officer generates a report and recommendation. A set of 'model' conditions, adopted by the WAPC, is used as the basis for condition setting.

The decision of the WAPC is forwarded to the applicant with copies to referral agencies. Generic conditions that apply to most major subdivisions include site contouring and provision of power, sewer, potable water, drainage, streets and open space. In general, more than half of the approval conditions relate to the Local Government requirements.

A responsible State or Local Government agency is identified for each condition to ensure compliance by the developer. These agencies specify the requirements necessary to meet generically worded conditions and they are responsible for confirming that the works or tasks have been completed satisfactorily during the development. In addition to conditions, approvals often contain advice notes that provide more detailed information on what may be required to satisfy certain conditions. Engineering conditions may be generic and the lack of certainty and specificity on engineering conditions has warranted the Department of Planning, Lands and Heritage's funding of this current review. The clearance process is outlined in section 1.2.1.2.

An applicant receives either a refusal, or an approval with conditions. If the applicant considers the decision (refusal or conditions) unacceptable, they have a right of review to the State Administrative Tribunal (SAT). There is also a right of appeal if the subdivision application is not determined within 90 days.

Most conditional approvals are valid for four years.

1.2.1.2. Design, construction and the clearance process

A landowner/developer with a conditional subdivision approval initiates the clearance process. After construction of the subdivision and certification that relevant standards and conditions have been met, an application is made for final approval and issue of title. Not all conditional approvals progress to final approval. For large subdivision approvals, clearances are sought for stages (usually of 40–80 lots) rather than the entire subdivision.

The WAPC remains the statutory approval authority for clearances but conditions are worded such that works are to the specification and/or satisfaction of the clearing authority. The landowner/developer or their representative(s) approaches each individual clearing agency to receive advice on the specific works or tasks necessary to satisfy the condition(s) for the lots for which clearance is sought.

The landowner/developer then proceeds to prepare plans, undertake the specified works, and seek clearance at or near the end of the site construction process. The *Planning and Development Act* at section 170 requires that a proponent (subdivider) is to provide to the

Local Government drawings and specifications for roads, artificial waterways and any such other information relating to levels, drainage, nature of soil and physical features as the Local Government requires. The Act specifies the process that is to be followed by the Local Government and the proponent in dealing with drawings and specifications. There is a right of review to the SAT if a proponent does not agree with the requirements specified by the Local Government.

Once all works are completed or near completion, application is made for clearance of the stage. A diagram of survey outlining the surveyed public and private lot configurations and dimensions is submitted to each clearance agency and the agency advises the WAPC or proponent in writing that the condition has been satisfied. The proponent lodges application with the WAPC together with clearance letters from all relevant agencies and the diagram of survey. Once compliant, these are forwarded to Landgate for the issue of title.

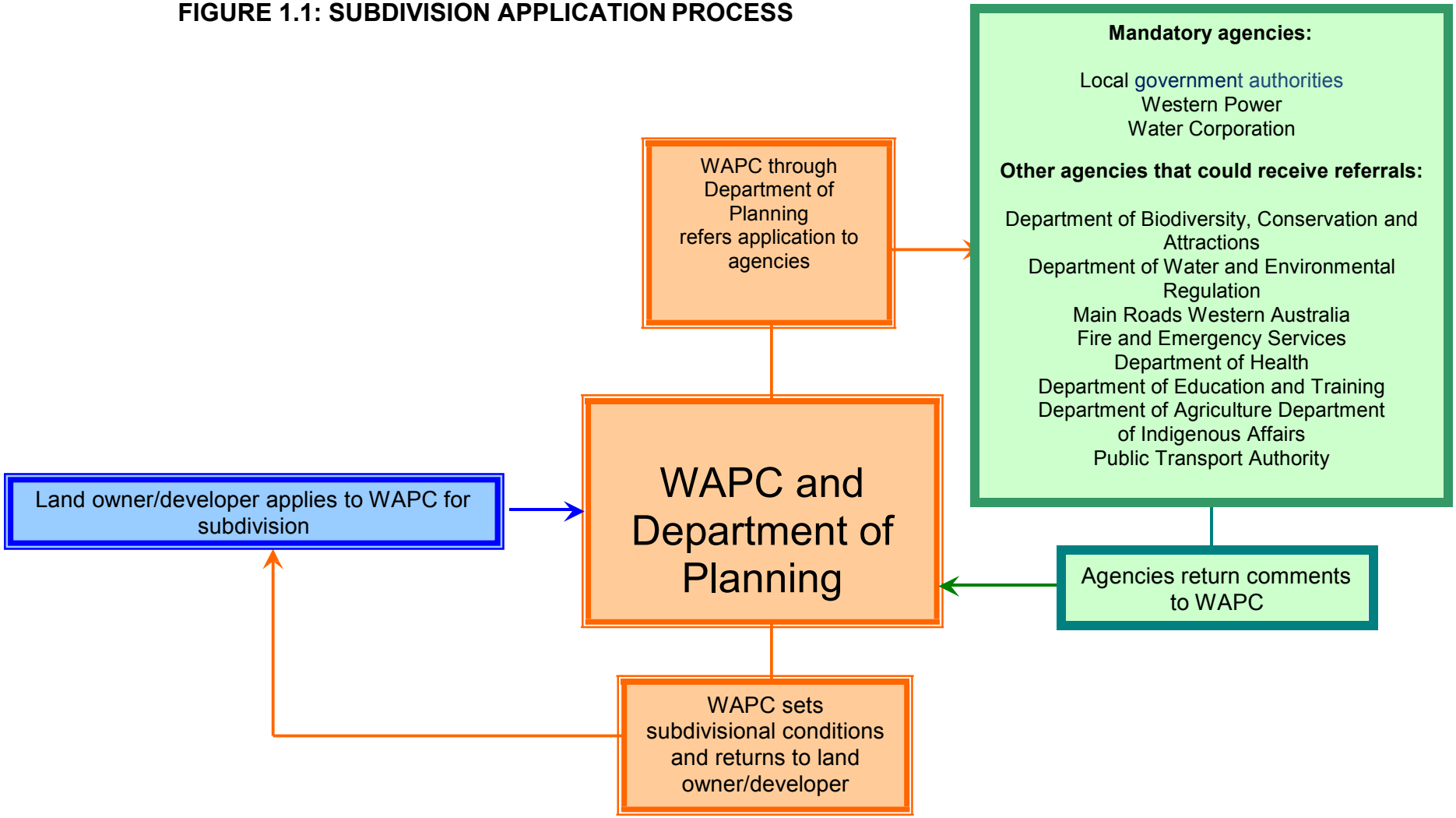
If a clearance agency refuses to clear a condition, a proponent may request the WAPC to clear the condition and endorse the diagram of survey pursuant to section 145 of the Act. The WAPC is likely to use these guidelines as minimum standards in determining requests for endorsement of diagram where a Local Government will not. The WAPC is to try to deal with an endorsement request within 30 days. A proponent has a right of review to SAT if the Commission refuses to endorse the diagram, or does not make a decision within 30 days.

A sample condition from the WAPC's Model Conditions is:

Those lots not fronting an existing road being provided with frontage to a constructed road(s) connected by a constructed road(s) to the local road system and such road(s) being constructed and drained at the applicant/owner's cost. As an alternative the WAPC is prepared to accept the applicant/owner paying to the Local Government the cost of such road works as estimated by the Local Government subject to the Local Government providing formal assurance to the WAPC confirming that the works will be completed within a reasonable period as agreed by the WAPC. (Local Government)

The following diagram shows the subdivisional process as described previously.

FIGURE 1.1: SUBDIVISION APPLICATION PROCESS



1.2.1.3. Road safety audits

Most traffic and road safety issues should be resolved through the road network design at structure planning stage. Road safety audits may be further required by the Local Government in specific situations. These may include but are not limited to:

- main streets and other streets and intersections in town and neighbourhood centres;
- rail station precincts;
- special streets with cross-sections different from those included in the WAPC's *Liveable Neighbourhoods* policy;
- intersections that do not meet the requirements of *Liveable Neighbourhoods*;
- where traffic volumes are high and risk warrants an audit;
- new schools; and
- other areas where there is potential for significant conflict between cyclists, pedestrians and vehicles.

In addition to vehicle safety an audit must make balanced consideration of the safety of all road users. The road safety audit team should have expertise in pedestrian, cycle and public transport safety matters. Audits must be conducted in accordance with AUSTROADS Guide to Road Safety Part 6: Road Safety Audit (2009).

1.2.1.3.1. Road safety auditor

Where a road safety audit is required, it is to be undertaken by an Accredited Senior Road Safety Auditor and supported by at least one independent team member.

1.2.1.4. Traffic impact study

Where a traffic impact study is required it is to identify:

- current traffic conditions on relevant external roads;
- predicted traffic volumes (internal roads and relevant external roads).
- current and future road hierarchy;
- road upgrade requirements (including intersection requirements);
- intersection treatments; and
- recommended design solutions.

It is recommended that when considering traffic impact studies, the developer should be aware of the requirements and conditions within the WAPC Transport Impact Assessment Guidelines (2016) developed by the Department of Planning, Lands and Heritage. These guidelines may give rise to a full transport assessment for the development.

1.2.1.5. Cash in lieu of public open space

Where the WAPC, the Local Government and the developer agree, a condition may be imposed that relieves the developer from setting aside land for public open space if payment occurs to the Local Government to the value of the land. This is governed by section 153 of the *Planning and Development Act*.

1.2.1.6. Monies paid to Local Government in lieu of public open space

Section 154 of the *Planning and Development Act* outlines that cash in lieu of public open space must be placed in a dedicated trust account with use to be on public open space within the locality.

1.2.2 Subdivision costs

Subdivision costs to the Local Government are covered under Division 4 of the *Planning and Development Act 2005,* however, some definition will be supplied as to certain calculations and the areas of subdivisions to which they should apply.

1.2.2.1. Expenses of road or waterway construction and road drainage

Section 158 of the *Planning and Development Act* addresses the supervision fees for Local Governments which were originally within the *Local Government Act*. The section not only gives legal jurisdiction for Local Governments to collect these funds but it sets down how these fees should be calculated.

Section 158 of the *Planning and Development Act 2005* requires the involvement of a consulting engineer and clerk of works. The current practice is that subject to the agreement of the developer and the Local Government, another person may be appointed in lieu of the clerk of works. A suitable inspection and quality assurance process can be implemented in lieu of the clerk of works.

The latest water designs include overland flow across future private property and therefore, any artificial waterways must include run-off from those areas and the subsequent works be subject to the fees for supervision.

Where public open space development is not a condition of subdivision but where the developer wishes to upgrade these areas, then they are subject to negotiation and costs of such works may be included in the calculations for fees.

In addition, where drainage is placed in public open space and the stormwater is to flow across such public open space the supervision fee is to apply to both the public open space and the actual area of the drainage.

In general, roads contribute approximately 15 per cent of the total area, including earthworks on private lots. This area then (15 per cent of total area of earthworks) should be subject to supervision fees as required under section 158 of the *Planning and Development Act*.

Where practical, retaining walls within subdivisions should be wholly contained within private title and are subsequently subject to building permits, so do not form part of the subdivision calculations for supervision fees. As such, they would normally attract a Building Permit application fee.

1.2.2.2. Initial subdivider may recover road costs from subsequent subdivider

In some instances subdivision requires road and drainage to be constructed on a boundary with vacant land and the initial subdivider is required to construct the full pavement at subdivision stage. Section 159 of the Act includes a mechanism for the initial subdivider to claim a portion of the initial road costs from the subsequent subdivider.

1.3 Environmental Protection Act 1986

Environmental conditions may be applied to schemes and specific development or subdivision proposals under the *Environmental Protection Act*. These must be complied with.

In other cases, requests may be made by the Department of the Environment and Conservation to the WAPC for the imposition of environmental conditions on subdivisions. There may need to be liaison between the Local Government and the Department of the Environment and Conservation if such conditions are set by the WAPC.

1.4 Contaminated Sites Act 2003

The *Contaminated Sites Act* applies separately to the *Planning* and Development Act. Responsibilities in relation to contaminated sites rest with proponents, landowners, the polluter and auditors. The Department of Biodiversity, Conservation and Attractions is the responsible agency for this Act and more information is available online at www.dec.wa.gov.au/pollution-prevention/contaminated-sites.

1.4.1 Accredited auditors

Part 7 of the *Contaminated Sites Act* refers to independent auditors who act on behalf of the client under the authorisation of the Department of Biodiversity, Conservation and Attractions. These auditors are paid by the proponent but carry out the overseeing role on consultants that work on and report on the remediation of contaminated sites. The auditors carry out a role to ensure that remedial reports cover the requirements of the Department of the Environment and Conservation so approval by that department is easier and the process is quicker for the developer.

1.5 Acid sulfate soils

An acid sulfate soil is the common name given to naturally occurring soil and sediment containing iron sulphides. These naturally occurring iron sulphides are generally found in a layer of waterlogged soil or sediment, and are benign in their natural state. When disturbed and exposed to air however, they oxidise and produce sulphuric acid, iron precipitates and concentrations of dissolved heavy metals such as aluminium, iron and arsenic. If acid sulfate soils are not managed there are potential adverse impacts on the natural and built environment.

Subdivision proposals on sites of medium to high risk of acid sulfate soils are automatically referred to the Department of the Environment and Conservation by the WAPC. Standard conditions are applied including acid sulfate soil self-assessment and preparation of reports and management plans for Department of Biodiversity, Conservation and Attractions clearance.

1.5.1 Technical advice

The WAPC's website contains *Acid Sulfate Soil Planning Guidelines* (January 2009) and a related Planning Bulletin 64/2009. The Department of Biodiversity, Conservation and Attractions has also prepared the *Acid Sulfate Soils Guidelines* series to assist agencies, developers and individuals to manage development in areas where acid sulfate soils will or may be impacted upon.

Further technical advice and information can be obtained online at the Contaminated Sites page on the Department of Biodiversity, Conservation and Attractions's website at

http://www.environ.wa.gov.au/contaminatedsites.

1.6 Disabilities Services Act 1993

The *Disabilities Services Act* has a direct effect on construction of subdivisions and sets out the frameworks and requirements to allow the disabled to use and enjoy the facilities provided in a new development. It attempts to provide guidance to the issues that must be considered when providing infrastructure within a subdivision so that all members of the community receive the same benefits.

1.7 Aboriginal Heritage Act 1972

This *Aboriginal Heritage Act* is in place to provide protection for places and objects which are considered of significance to the aboriginal heritage. It protects the traditional use of such land or objects that have been or are in use by aboriginal people and is part of tradition in those places or in use of those objects.

The Act sets up the Aboriginal Cultural Materials Committee which oversees the functions of the Act and makes determinations in relation to issues raised under the Act.

Traditional Custodians (aboriginals) who, in the opinion of the Committee, have an interest in the place or object, are gazetted by the Minister.

1.7.1 Consent to certain uses

Under section 18 of the *Aboriginal Heritage Act* the owner of any land which has an aboriginal interest must seek approval from the aboriginal elders of the land and subsequently an approval from the Aboriginal Cultural Materials Committee to develop the land in question.

Requirements for such approvals are no longer set as a condition by the WAPC as they occur under separate legislation. There may, however, be an advice note alerting proponents to the need to seek separate approval. Section 18 approval under the *Aboriginal Heritage Act* will be required before clearance and approval of the condition is granted.

1.8 Heritage of Western Australia Act 1990

Where development or subdivision of any land entered in the Heritage Register is requested, the matter must be referred to the Heritage Council prior to any decision being made in relation to the development. Part 8 of the *Heritage of Western Australia Act* refers to effects on development proposals and would form part of the consultation process by the WAPC, prior to subdivision conditions being set and sent out to developing parties and relevant authorities.

1.9 Fire and Emergency Services Authority WA Act 1998

The Fire and Emergency Services Authority (FESA) is a referral agency for many subdivisions in accordance with WAPC Policy DC 3.7 and by means of mutually agreed referral criteria. It also has direct responsibility for fire protection matters in defined areas of the State (Emergency State Locations 1, 2 and 4) (ESL) and has a direct interest in ensuring that land development considers the safety of the community.

Local Government has responsibility for fire protection matters in defined areas of the State (ESL 3 and 5) and therefore has responsibility for ensuring land development has adequately

considered fire risks. WAPC Policy DC 3.7 (and associated documents such as *Planning for Bush Fire Protection*) apply.

The WAPC applies appropriate conditions on the advice of FESA.

Where fire-fighting services are required verification of the water supply will be required to provide flow rates and pressures to protect the potential fire loads (industrial) to suit Australian Standard 2419.

It should be noted that the water utility (Water Corporation, Aqwest, Busselton Water) will apply and clear conditions relating to hydrants as part of their condition relating to water supply infrastructure, utilising FESA standards for hydrant spacing, flow and marking. However, FESA can assess subdivisions and advise on the processes by which water should be stored or made available in times of fires.

1.10 Environmental Protection and Biodiversity Conservation Act 1999 as amended (Federal)

Developers and Local Government should be aware that section 266B of the *Environmental Protection and Biodiversity Conservation Act* refers to a list of threatened species, which must be considered as part of any development proposals.

While there is a list of threatened species it is also relevant to understand that there are matters of national significance covered by both the State and federal acts in relation to the environment.

1.11 Statutory requirements

The preceding section shows the relevant Acts of Parliament that need to be taken into account when development is taking place within an area. However, there are policies and guidelines which are updated and need reference checks to assess appropriate changes as they occur.

The draft policies are sometimes given a period of testing and developers and local authorities are requested to partially implement and comment on the success or otherwise of these documents.

There are also documents and technical papers developed but these are for reference only. Until formally adopted by the government agencies the information held within those guides can be negotiated between parties but do not have the legislative or departmental backing.

Local Government officers should make themselves fully conversant with the relationship between the developer and the consultants prior to calculating the fees as set down in S158 of the *Planning and Development Act.* The setup of the inspection and supervision structures for the subdivision will determine the level of fees that the developer is to pay to the Local Government.

Where the developer wishes to carry out work outside the conditions of development then these fees are to be negotiated and agreed upon by both parties. This document sets basic or minimum fees applicable but where extra works are done then these fees will need to be negotiated at the time of both parties agreeing to the extra works.

1.12 Local Government responsibilities

1.12.1 Approval period for designs and documentation

It is incumbent on local authorities to expedite the processing of approvals, particularly approval of designs for subdivision. If these guidelines are adopted by local authorities the requirements for documents to be submitted for approval are clearly known by the developer and the Local Government, and the approval process should follow in due course.

Approvals should be given as soon as possible but in a period no longer than six (6) weeks. Despite the resources available to a Local Government contact with the various consultants should be feasible within that period. Consultants require some form of consultation and feedback on documents within the six-week period so amendments can be made or arrangements to move the project forward after the documents have been approved. This feedback is essential and must be done as soon as possible as in many cases, developers have interim finance on projects and any major delays can create a flow-on effect of costs to the ultimate purchaser of the land.

1.13 Developer responsibilities

Once the WAPC has set down subdivision conditions it becomes the responsibility of the developer to engage appropriate expertise either from his or her own qualified staff or by engaging qualified consultants, or by engaging the Local Government to carry out the specific tasks of design and documentation of the development.

1.13.1 Engaging consultants

Subdivisional conditions can involve several areas of expertise including but not limited to engineering, environmental, hydrology, horticulture, landscaping and aboriculture.

1.13.1.1. Engineering consultants

The developer shall engage a consulting engineer to design and inspect the engineering works associated with the subdivision. As an alternative the developer may engage Local Government to design and inspect works under section 158 of the *Planning and Development Act.*

The consulting engineer shall prepare designs and specifications for the engineering works listed in the WAPC's conditional approval of subdivision in accordance with these guidelines. Before any work commences on the construction of the subdivision, the drawings and specifications shall be approved by the Local Government.

By way of definition the consulting engineer shall be a professional eligible for membership of the Institution of Engineers Australia or registration in the National Professional Engineers Register.

1.13.1.2. Environmental consultants

Where conditions of subdivision highlight environmental issues that must be addressed for subdivisional clearance, the developer shall engage appropriately qualified environmental consultants in line with current practices of the Department of Biodiversity, Conservation and Attractions and the Department of Health. This may include such consultants as environmental auditors to assess environmental consultants reports on behalf of the State authorities.

1.13.1.3. Dilapidation survey or service reinstatements

Where applicable and where developments are directly adjacent to old, heritage and other structures, it may be prudent for the developer to carry out a dilapidation survey on the existing infrastructure. This may reduce damage claims during the construction and at the end of works on the development.

There will be a need to assess the location of existing services prior to works commencing to ensure the viability of those services not being damaged during construction.

1.13.1.4. Hydrological consultants

Water and its treatment has become a major issue for land developers and in many cases there may be a need to engage hydrological consultants to model and determine the effect of the development on surface and groundwater resources to satisfy the requirements of the Department of Water and Environment Regulation. The outcomes of these investigations, which should be prepared by suitably qualified consultants, will usually require endorsement by the Department of Water and Environment Regulation.

1.13.1.5. Indigenous heritage consultants

Where land is affected by indigenous heritage laws and will require a section 18 clearance under the *Aboriginal Heritage Act 1972*, the developer can be required to engage specialist consultants to deal with the issues in gaining clearances under section 18.

1.13.1.6. Horticultural/Aboricultural consultants

Where the requirements of *Liveable Neighbourhoods* or a negotiated development of public open space is to be part of the overall development there may be a need to engage consultants with horticultural and/or aboricultural expertise which may even require the advice and involvement of a qualified landscape architect and in some instances an environmental consultant.

Negotiations may also result in the requirement for a landscaping plan to be provided to the Local Government.

1.13.1.7. Geotechnical investigations

Prior to the consulting engineer undertaking the design of the subdivision, the developer shall carry out a site inspection and investigation by a geotechnical engineer to determine the geotechnical properties of the soils. The level of investigation shall be determined by the particular site characteristics required for the development and in some cases there may be specific requirements detailed by the Local Government. Such information shall form the basis of the design of the subdivisional infrastructure. A copy of the report on the site investigation shall be lodged with the appropriate authorities for approval of relevant subdivisional conditions prior to, or at the same time as, the design drawings and specifications are also lodged for approval.

Upon completion of the earthworks for the development, the consulting engineer shall submit copies of all soil tests undertaken, and assess and classify the site in accordance with AS1726-1993: Geotechnical Site Investigations.

All geotechnical reports are to be prepared by a geotechnical engineer with testing and analysis of soil samples to be undertaken at a NATA registered laboratory.

1.13.2 Liabilities and insurances

For the duration of the subdivision process (through to the issuing of titles) the developer shall be responsible for all damage caused by or contributed to by it (or its contractors, servants or agents) to existing facilities, including retained vegetation, services and structures in both public and private ownership, sustained as a result of the development of the subdivision.

Any damage shall be reinstated to a similar standard acceptable to the relevant owner without delay.

The developer shall obtain insurance cover, on standard terms with a reputable insurer, for public liability, professional indemnity, contractors' works and workers compensation risks, to a level of liability required by the Local Government, and thereafter provide copies of all current certificates of insurance to the Local Government.

1.13.3 Occupational safety and health

All phases of the construction works associated with the proposed subdivision shall be carried out in compliance with all Acts and Regulations administered by the relevant government authorities. The developer's attention is specifically drawn to the requirements of the *Occupational Safety and Health Act 1984, Clean Air Regulations 1967 and Environmental Protection Act 1986*.

The safety of the general public, contractor's employees and road users on adjacent streets during the construction of the subdivision is paramount and details of how this is to be achieved shall be included in the project specification.

Where subdivisional works interface with existing infrastructure and traffic the developers shall be responsible for producing and having approved by the Local Government traffic management plans prior to any works commencing. These plans will be accordance with the relevant Australian Standard AS1742.3–2002 and MRWA's code of practice *Traffic Management for Works on Roads – Total Practice*.

1.13.4 Road upgrading for subdivisions

Where a planned subdivision shows the joining of a subdivisional road with an existing public road, then the subdivisional road is generally required by condition to be constructed to connect to the existing public road.

Where a subdivision is constructed adjacent to a future primary or district distributor the Local Government requires the ceding of the land free of cost and the construction of earthworks for the whole of the road reserve, the construction of one carriageway (two lanes) and associated drainage facilities. In addition, grade separated pedestrian crossings and a dual use path along one side of the road may be required where these facilities accord with proposals for the overall structure planning for the area. Where junctions, through the subdivisional process, are upgraded the developer shall also upgrade the street lighting to Australian standards.

A landowner's agreement may be negotiated between the Local Government and the developer for the contributory arrangements for provision of the primary and distributor road networks.

Where it is considered that existing roads, whether directly abutting the subdivision or not, are substandard or inadequate to accommodate the expected additional traffic generated by the subdivision, the Local Government may request, as a subdivision condition, the upgrading of that existing road.

Generally, where a proposed subdivision abuts an existing road reserve containing a substandard road, the Local Government will request a condition be imposed requiring that section of the road contained within the one-half of the road reserve fronting the subdivision to be upgraded to the standard for that class of road, with the upgrading works required to be carried out prior to the clearance of the subdivision.

In cases where the whole road requires upgrading as a condition of subdivision and the development is located on one side of the road only (eg. in situations where there is no existing road and it would be impractical to build one-half of the proposed road), the cost of this work will generally be shared in accordance with a negotiated cost share agreement between the Local Government and the developer of the land. The Local Government's portion shall be funded in accordance with the repayment terms of the agreement.

Every attempt shall be made to partially or wholly upgrade substandard roads fronting new subdivisions. Where it is impractical to physically construct the road or part thereof, the developer shall lodge a non-refundable cash contribution equal to the estimated cost of the proposed roadworks with the Local Government prior to the clearance of the subdivision.

It should also be noted that WAPC policy 3.6 Development Contribution for Infrastructure allows for developer funded infrastructure improvement outside the immediate area of the development.

1.14 Street lighting

The developer may be required to provide street lighting, including the suitable illumination of traffic management treatments to the newly created subdivision, in accordance with Western Power Corporation specifications for illumination level, materials and installation and the Local Government’s specific requirements.

Alternatively, the provision of decorative street lighting may be negotiated between the Local Government, Western Power Corporation and the developer. Decorative lighting should generally be selected from Western Power’s Street Vision Decorative Lighting series.

Standard street lighting is designed and implemented in accordance with *Australian Standard 1158.1: Road Lighting – Vehicular Traffic Lighting – Performance and Installation Design Requirements*, based on the road hierarchy and the associated lighting category.

In some country areas local authorities may only require street lighting at intersections and where paths cross roadways. These situations should be done by negotiation with the Local Government and Western Power. The lighting standard should comply with the relevant Australian Standard.

When considering street lighting particular emphasis should be placed on facilities for pedestrians and cyclists.

1.15 Erosion control

Details of sediment and erosion control, dust and sand drift control measures to be adopted during the construction of the subdivision shall be included in the specification and shown on the drawings. The measures in relation to dust are to be in accordance with 'A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities (Department of Biodiversity, Conservation and Attractions, March, 2011). The WAPC does not normally require a dust management plan as a condition of subdivision, as developers are required to comply with separate health and environmental legislation, including the Department of Biodiversity, Conservation and Attractions Guidelines. Where dust control creates a problem for adjacent residents and developments the Local Government can implement Schedule 3.1 in reference to schedule 9.1 clause 12 (wind erosion and sand drift) of the *Local Government Act 1995*. Where required by the Local Government a Construction Management Plan shall be submitted prior to start of any subdivision work addressing, among other things dust control, control of export of eroded soil and nutrient from the site, dieback control, noise pollution and traffic management.

In those locations, where climatic conditions are such that wind borne dust and sand drift may cause significant problems the responsible Local Government may require a dust control and sand drift bond to be lodged as a condition of approval of the engineering drawings.

The measures in relation to vehicle or water caused transport of soils, sediments and dust are to be in accordance with Section 2.1.2.1.5.4 Soil Stabilisation Strategy.

1.16 Project signage

Where required by the Local Government, a project signboard shall be erected at a suitable location on the site to advise the public of the project details, including contact details for the consulting engineer and contractors, and the expected completion date of the project.

1.17 Control, inspection and supervision of works

The construction works shall be carried out in accordance with the approved drawings and specifications, and will be subject to stage inspections and approval by the Local Government. Final approval shall only be given when all works have been executed to the true intent and meaning of the approved drawings and specification.

Prior to commencing construction the Local Government shall be advised in writing of the:

- name and address of the contractor;
- name of the contractor's representative;
- name of the consulting engineer's representative or superintendent;
- timetable for construction in the form of a bar chart, indicating the starting and finishing dates for each stage of the works; and
- contract price of the works.

The Local Government may require the developer or consulting engineer to lodge documentary evidence as to the contract value of the works, including bulk earthworks as set out in section 1.2.2.1.

The payment of fees as set down in the section 158 of the *Planning and Development Act 2005* should be made just prior to seeking clearance of the subdivision.

Section 158 of the *Planning and Development Act* reads:

'158. Expenses of road or waterway construction and road drainage

(1) Where a person who is subdividing land is required under this Part to construct and drain roads or construct artificial waterways shown on the plan of subdivision that person may

(a) carry out or cause to be carried out the construction and drainage at his or her own expense; or

(b) arrange for the Local Government to carry out the work on behalf, and at the cost and expense, of that person.

(2) Where the person does not make the arrangement with the Local Government, that person is to pay to the Local Government, on demand, an amount (calculated under subsection (3)) to cover the reasonable costs of the Local Government in supervising the construction and drainage.

(3) For the purposes of subsection (2) the amount is to be calculated as follows —

(a) where the person has not engaged a consulting engineer and clerk of works to design and supervise the construction and drainage, the amount is to be three per cent of the cost of the construction and drainage as estimated by the Local Government;

(b) where the person has engaged a consulting engineer and clerk of works to design and supervise the construction and drainage, the amount is to be 1.5 per cent of the cost of the construction and drainage as estimated by the Local Government.'

(4) The Local Government may require the person to employ a consulting engineer and clerk of works to design and supervise the construction and drainage and that person, when required to do so by the Local Government, is to carry out the requirement.

1.17.1 Notification of commencement of works

The Local Government shall be advised five working days before the commencement of any works, and after a cessation of work, one day before recommencing any works. Residents who may be affected either directly or indirectly by the proposed subdivisional works may be required by the Local Government to be notified in writing of these works prior to the works commencing.

This notice may include:

- names of the developer and contractor;
- date of commencement of the works;
- expected completion date;
- details of measures proposed for the prevention of unacceptable levels of dust, noise and vibration;
- a statement regarding compliance with the Department of Biodiversity, Conservation andAttractions Protection publication: *A guideline for the prevention of dust and smokepollution from land development sites in Western Australia (1996*), and advice that a copy can be obtained from the engineering officer; and

- contact details for the contractor's representative to whom complaints regarding excessive dust, noise and vibration can be directed.

Disruption to local neighbourhoods caused by work activities associated with a development need to be minimised and the developer needs to comply with any reasonable requests by the Local Government relating to neighbourhood disruption. Transport routes to and from development sites need to be approved by the Local Government, and the developer shall ensure that such routes are used by all contractors.

1.17.2 Hours of work

All work shall be contained between the hours as set down by the *Environmental Protection (Noise) Regulations 1997*, and no work shall be carried out outside these hours without the prior written approval of the Local Government or the Department of the Environment and Conservation.

Generally, normal working hours for construction work are 7.00 am to 7.00 pm everyday except Sundays and public holidays. No work shall be undertaken outside these hours without prior Local Government approval. Construction work includes deliveries to the site of the works and the onsite servicing and fuelling of machinery.

Any application for work outside of normal hours shall demonstrate that it is reasonably necessary to perform the work outside of normal hours and additional neighbourhood consultation is required.

1.17.3 Inspection by consultants and supervision by contractors

The consulting engineer shall audit the contractor's work on a regular basis and in particular at the milestone stages as set out in the construction schedules and agreed to with the Local Government. Inspections by the Local Government shall not in any way diminish the responsibility of the consulting engineer to adequately audit the works. Auditing shall include regular site inspections.

The contractor's supervisor shall, when not personally present on site, be represented by a competent and experienced clerk of works as per the definition in section 1.2.2.1

The consulting engineer shall be available for the purpose of joint interim inspections where deemed necessary by the Local Government.

Where a developer and a Local Government wish to negotiate a different regime of inspections and auditing processes this is encouraged as long as the process is mutually agreed.

1.17.4 Commencement of works, meetings and inspections

The Local Government's representative, consulting engineer and contractor or clerk of works may jointly meet as well as inspect the site prior to any work commencing to discuss the methods of construction, preservation of significant vegetation, or the eradication of noxious weeds, dust control and any other matters to minimise the likelihood of any problems associated with the subdivisional works.

The contractor shall ensure that any particular stage of work to be inspected has been satisfactorily completed before requesting an inspection by the Local Government. A minimum of 24 hours notice is required to enable arrangements to be made for an inspection. Each stage shall be inspected prior to the next or following stage of construction being commenced. The Local Government shall to the best its ability carry out the inspection within 48 hours of the notification of an inspection being required.

In circumstances where there is concern about workmanship or materials, the Local Government representative may request a certificate endorsed by the consulting engineer who certifies the correctness of any work in accordance with the approved drawings and specifications for all or any of the main stages of construction. No further stages shall proceed until this certificate is received by the Local Government.

With the building industry requiring level sites there is generally considerable earthworks carried out to form lots and subsequently, the road reservations. This generally adds an inspection phase to the overall processes involved with roads and drainage. Overland flows form part of drainage systems and with such flows an integral part of the water sensitive urban design. An inspection of earthworks should be done prior to any road and drainage construction being commenced. There may be instances however, where major lot earthworks and road earthworks and construction proceed at the same time. In these cases the inspection stages can be amended between the concerned parties.

Where filling is required over an impervious layer it may be necessary to provide an inspection stage after the shaping of the impervious layer. This is an inspection process that could be the exception rather than the norm and should be negotiated between the developer and the Local Government.

The inspection and meeting phases that are recommended in approving subdivision construction are:

1. start-up meeting prior to any works commencing;
2. after completion of earthworks;
3. roads construction phases as per section 1.17.4.1;
4. drainage phases as per section 1.17.4.2;
5. completion of landscaping and irrigation processes; and
6. completion of defects liability period.

Where heritage issues are part of the subdivision there may be a need for specific site set-up inspections to ensure that heritage items are protected prior to any works commencing. This can be combined with the start-up meeting but both developers and local authorities need to be fully aware of their responsibilities at that early stage of subdivision.

Where public open space is developed inspections need to be carried out at the following stages:

1. when earthworks and the clearing footprint are marked out;
2. prior to earthworks commencing – could be done at start up meeting;
3. completion of earthworks;
4. where irrigation is installed at bore development stage, laying of mains prior to backfilling and at commissioning of system;

5. prior to grassing;
6. completion of play equipment and fencing if included in plans; and
7. relevant inspections should be implemented where buildings are being constructed as part of the subdivisional works.

It is also noted that in some areas level building sites are not possible due to natural topography. As major earthworks may then not occur, the building industry will need to design buildings to suit the final earthworks levels rather than the other way around. In some instances it may be a more efficient practice to have the building industry design home to suit the site rather than have the site designed to suit the buildings.

Where some construction phases overlap or precede in tandem to other processes, inspections should be negotiated with the Local Government to ensure that construction phases are inspected by the relevant personnel.

1.17.4.1. Inspections for road works

The minimum inspection and regular site meetings regime for the construction of road works is:

1. when the road has been boxed out and the sub-grade shaped and compacted;
2. when the sub-base has been placed, graded and compacted to shape, level and specifications;
3. when the base course has been placed, graded, compacted and water bound to correct shape and level before priming or where asphalt is used as a base course medium this surface has been laid and compacted;
4. immediately after kerbing;
5. before the placement of asphalt or sprayed surface wearing course; and
6. prior to construction of pathways.

1.17.4.2. Inspections for drainage works

The minimum inspection and regular site meetings regime for the construction of drainage works is:

1. when the trenches have been excavated and the pipes laid true to line and level;
2. when using sub-soil drainage pipes, after the calibrated aggregate has been placed; and
3. after junction pits, gullies and other structures have been constructed.

Where water sensitive urban design criteria have been used and much of the drainage system includes overland flows, inspections need to be carried out:

1. after earthworks completion;
2. after appropriate drainage structures have been completed but prior to backfilling; and
3. after plantings are completed.

The consulting engineer shall be present to attend and record findings of stage inspections for roads and drainage.

1.17.4.3. Indicative Inspection Standard Form – Roadworks

ROADWORKS
QUALITY ASSURANCE CERTIFICATION

Project: _____
Contract No: _____
Contractor: _____
NATA Tester: _____

SUB BASE
Material used _____
Material Test certificates attached _____ date _____
Compaction results attached _____ date _____
As Con checked by _____ date _____
As Con attached _____ date _____

BASE
Material used _____
Material Test certificates attached _____ date _____
Compaction results attached _____ date _____
As Con checked by _____ date _____
As Con attached _____ date _____

SEALING
As Cons checked by _____ date _____
Suppliers Compliance Certificate attached _____ date _____
Application rates and details attached _____ date _____
Aggregate rates and details attached _____ date _____
Aggregate type _____ date _____

KERBING
As Con checked by _____ date _____
Concrete suppliers compliance Certificate attached _____ date _____
Expansion and Contraction Joints in place _____ date _____
As Con attached _____ date _____

ASPHALT
As Con checked by _____ date _____
Material Mix details attached _____ date _____
Suppliers Certification _____ date _____
Materials Tests _____ date _____
Core Tests attached _____ date _____
As Con attached _____ date _____
Ponding Checked by _____ date _____

DUCTS
As Con checked by _____ date _____
Contractor Certification _____ date _____

SIGNS/POSTS
Footing to each post checked by _____ date _____

TME Standard Specification Section 7

Contractor Certification _____date _____

LINEMARKING
As Con checked by _____date _____

TRAFFIC MANAGEMENT PLAN/RECORDS
Copy of Plan and records attached _____date _____

CONTRACTOR VERIFICATION

I certify that the works have been completed in accordance with the Specification and drawings.

Signed: .....(Contractor) Date___/___/___

Source: TME Standard Specification for Subdivisions

1.17.5 Testing

The consulting engineer shall provide to the Local Government, a copy of all test results related to the subdivisional works. Testing shall be carried out by a laboratory approved by the National Association of Testing Authorities (NATA) in accordance with the relevant Australian Standards. Where testing of a stage of construction is requested the next stage can proceed on the proviso that the Contractor accepts full liability for the previous stage. Should remedial works be required they shall be at the Contractor's expense.

In addition to the normal inspection and testing requirements as detailed elsewhere in these guidelines, the Local Government reserves the right to inspect and require samples to be tested to ascertain quantity and quality of materials being used in the construction work. The consulting engineer will be informed of any matters requiring remedial action. In the event that such testing reveals the work to be defective, the developer shall reimburse the Local Government for the cost of the testing.

1.18 Practical completion

Upon the satisfactory completion of all subdivisional work and soil stabilisation, the consulting engineer shall notify the Local Government in writing that the works have been inspected and are in accordance with the approved drawings and specifications. A Local Government may permit staging of practical completion as areas become finalised.

Upon receipt of this notification, the Local Government shall arrange a practical completion inspection of the completed works at a mutually convenient time. There may be a need, by negotiation, for water sensitive urban design and landscaping to have different dates for practical completion.

The inspection shall require the presence of the Local Government's representative, the consulting engineer and the contractor. The consulting engineer is to arrange for all road pavements to be swept, the drainage system cleaned out and gully and manhole covers temporarily opened for inspection. All drainage infrastructure needs to be accessible at the time of inspection.

At the time of practical completion or as soon as possible thereafter, the Local Government representative shall inform the consulting engineer of any item not in accordance with the specification and drawings.

Any such items shall be divided into:

- those items requiring completion, repair or alteration before clearance will be issued. A further inspection of these works when completed shall be deemed to be a continuation of the practical completion inspection; and
- those items that may be completed, repaired or altered during the defects liability period.

When all subdivisional works are completed in accordance with the approved drawings and specifications other than those agreed for completion during the defects liability period, the consulting engineer shall be notified of the practical completion date.

If at any time after the granting of practical completion, and during the defects liability period, the subdivisional work is found to be not in accordance with the approved specification and drawings then the works shall be rectified at the developer's cost. Minor items as agreed between the Local Government and the consulting engineer may be undertaken towards the end of the defects liability period.

1.19 Clearance

1.19.1 Certification of compliance

The contractor shall certify in writing that all the relevant engineering designs have been constructed as per the specifications. The consulting engineer shall supply copies of those certifications to the Local Government. The consulting engineer, in conjunction with the Local Government shall sign-off on the conditions imposed by the WAPC on the subdivision pertaining to survey release have been complied with and that the works have been completed in accordance with the approved drawings and specifications.

Certification documents could be as the example in section 1.17.4.3.

1.19.2 Conditions of clearance

The following items refer to the conditions which must be completed by the developer prior to approval of survey release of a stage of a subdivision:

- creation of the Diagram of Survey showing full details of all lots, road reserves, easements (temporary and permanent) and reserves;
- completion of all works associated with the subdivisional construction, including soil stabilisation where required, or the payment of an appropriate bond to cover outstanding works;
- receipt of the consulting engineer's confirmation that the works have been completed in accordance with the approved drawings and specifications;
- provision of as-constructed drawings in electronic format as specified by the Local Government;

- provide detail and value of the works so that it can be placed on the Local Government's asset register;
- payment of the appropriate engineering supervision fees;
- payment of a defects liability bond;
- payment of all or any monies required for works to be undertaken by the Local Government on the developer's behalf at some future date. eg. construction of roads, footpaths or development of public open space; and
- payment of any other specific monies relevant to the subdivision.

1.19.3 Creation of new roads

After the clearance of Diagram of Survey by the WAPC and Landgate, any land delineated and shown as a new road on such diagrams shall then be under the control and responsibility of the Local Government, subject to the defects liability requirements referred to in sections 1.18 and 1.21.

1.20 Bonding outstanding works

Bonding of incomplete works shall be by negotiation between the Local Government and the developer. Bonds may be in the form of a cash payment, bank guarantee or by written agreement between the Local Government and the developer.

1.20.1 Bond applications

The developer may lodge a bond in the form of cash or an unconditional guarantee from a financial institution (bank guarantee) acceptable to the Local Government in lieu of completion of all or part of the subdivisional works.

Applications for bonding shall be in writing and shall include the following information:

- concise reference to the extent, nature and location of the work to be bonded;
- a timetable for the proposed future completion of the bonded work;
- an itemised estimate of the costs of the bonded work, including the contract price and the name and address of the contractor responsible for the bonded works;
- reasons for requesting the bonding of the incomplete works; and
- any other information that will assist the assessment of the application.

Compliance with the above requirements does not necessarily imply acceptance of the bond and each request shall be subject to the approval of the Local Government.

1.20.2 Bond agreement

In cases where bonding is approved the developer shall enter into a written bond agreement with the Local Government, which clearly states:

- the name and address of the person or persons responsible for the payment or arranging the unconditional guarantee;
- the amount of the payment or unconditional guarantee;
- the name, stage number and location of the subdivision;
- the WAPC reference number of the subdivision; and
- a concise explanation of the purpose of the bond referring to all items for which it is to be utilised.

It is recommended that the earliest stage at which bonding will be considered is at the completed drainage infrastructure and the road limestone or sub-base stage. However, this is to be determined by the Local Government.

Agreements should detail what the bond is for, the amount agreed by the parties, the default conditions and how the Local Government can have unrestricted access to bond monies to complete works in case of the developer defaulting on the works in question.

A bank guarantee is recommended as an alternative to a cash bond as the Local Government is guaranteed access to funds should the developer default on works. It is however, recommended that the following conditions apply:

- the bank guarantee is clearly in favour of the Local Government;
- the conditions of the bank guarantee should clearly state its purpose and what works are being bonded;
- the bank guarantee has no expiry date and is only released upon the approval of the Local Government;
- the bank guarantee shall not have an expiry date but shall be directly tied to the outstanding works and the date on which the Local Government approves their completion;
- these conditions should also detail how the Local Government will demonstrate to the bank concerned that the developer/contractor has defaulted and that certain conditions of the bond have been ignored upon which demonstration the bank will release to the Local Government the bonded monies;
- the conditions of the bank guarantee must be clear that upon demonstrated default the bank concerned will release the bond monies without restriction upon demand by the Local Government; and
- the bond agreement must be legally checked to ensure the intent of the bond can be administered by the Local Government. This could be done by setting up a legal pro-forma which could be used from one development to another, reducing time delays with legal advisers.

1.20.3 Calculation of bond amount

The calculation of a bond amount is to be negotiated between the developer and the Local Government.

In calculating the amount, it is suggested to consider:

- the contractual amount for the works being bonded that can be taken from the contract documents supplied by the consulting engineer;
- a financial penalty against the developer should the Local Government have to carry out the works either by its own day labour workforce or by hiring another contractor. (it is suggested a 25 per cent surcharge be placed on the contractual cost for the work);
- obligatory GST charges by any new contractor who is brought in, which would need to be calculated on the contractual costs and the 25 per cent surcharge (it should be noted that if the Local Government was to engage a new contractor then GST would apply); and
- a non-refundable administration fee by Local Government to handle the setting up of the bond agreement and its implementation, should the need arise (a fee of $1000 plus GST is recommended as reasonable).

Bonds should be returned to developers on their written request in a timely manner.

1.21 Defects liability

1.21.1 General

It shall be deemed to be the responsibility of the developer to repair any defects resulting from faulty workmanship and/or defective materials on all roads and associated works for a period of 12 months from the date of practical completion – referred to as the defects liability period.

Where urgent defects requiring attention and become evident during the defects liability period, the Local Government may request such defects to be rectified immediately. Should the contractor fail to complete the rectification works within the time specified then the Local Government may arrange for the works to be undertaken using monies from the defects liability bond.

Prior to the expiry of the defects liability period the developer shall arrange an inspection after ensuring that all defects are repaired and swept. Should the developer delay or defer this process, any defects which arise during the deferment period may be deemed by the Local Government to be a defect under the defects liability period.

The developer shall apply in writing to the Local Government for defects liability release which will be subject to the effective repair of any defective works.

Where a developer chooses to delay seeking subdivisional clearance after the date of practical completion, the Local Government may determine the date of commencement of the defects liability period as being the date of subdivisional clearance.

In a rural environment in the mid or north-west there may be special circumstances (climatic hydro geological, etc.) where a Local Government may decide that a longer period is required, such as over two wet seasons and one dry season.

Defects liability periods can be extended past the twelve months period, and this should be negotiated between the developer and the Local Government.

1.21.2 Defects liability bond

Prior to the clearance of the subdivision, the developer may be required to pay to the Local Government a defects liability bond, which is to be five per cent of the works as calculated on the total contractual cost of the subdivision being the subject of the clearance.

This payment can be either in the form of cash or an unconditional guarantee from an acceptable financial institution and may be used at the discretion of the Local Government during the defects liability period for minor or urgent maintenance works after written notification to the consulting engineer of the need for such works. Minor works should be negotiated between the Local Government and the developer.

The defects liability period shall commence on the date of practical completion as agreed by the Local Government and the developer.

Upon the Local Government's acceptance of defects liability release, all monies will be refunded to the developer.

1.22 Asset register

Local authorities have the responsibility for the management of all infrastructure assets provided by developers as part of the land subdivision process. These assets include roads, drains, pathways, signage, streetscape, street furniture and public open space items such as irrigation, pathways, barbecues, playgrounds, retaining wall, gazebos and shade shelters.

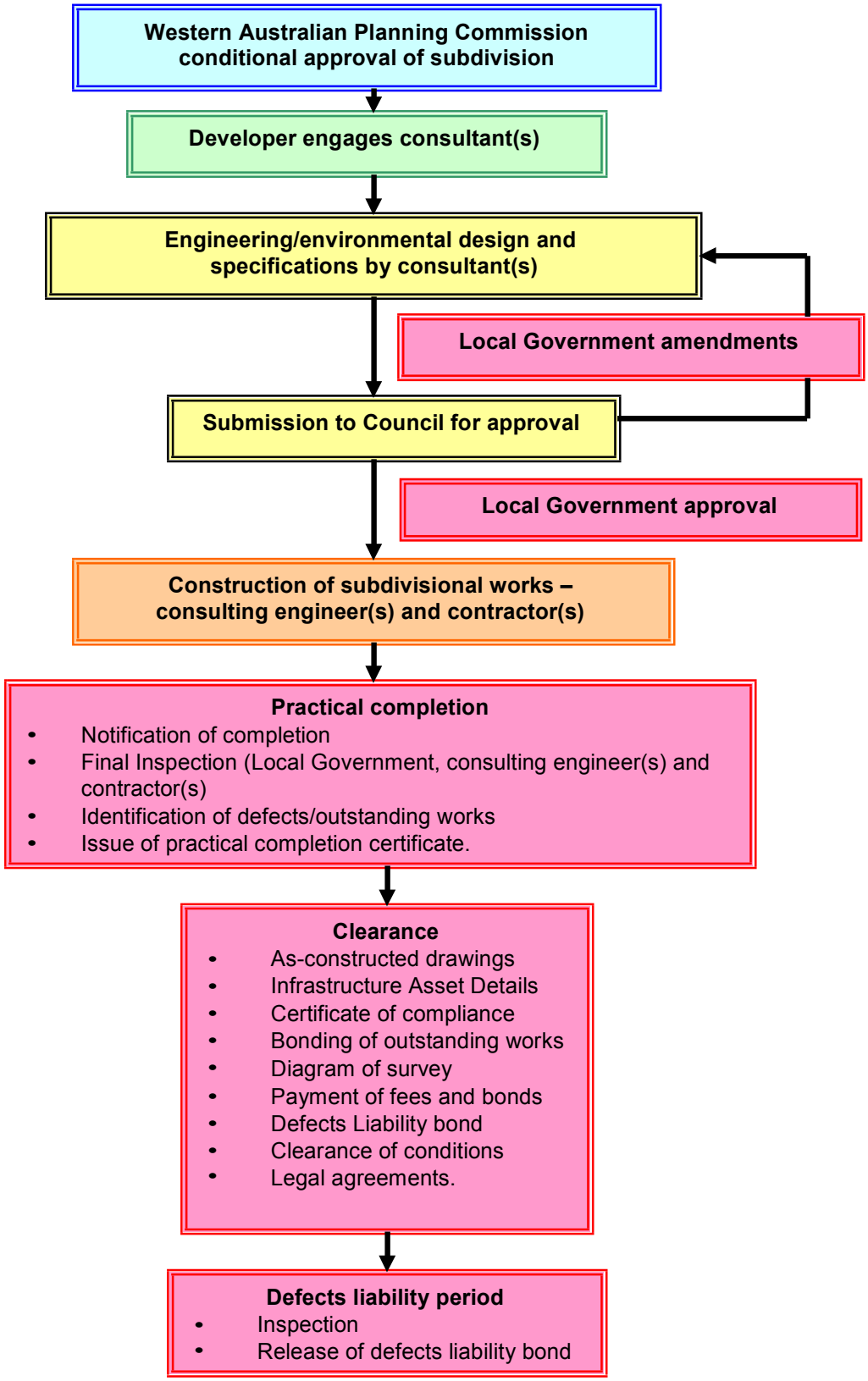
An electronic asset register, containing all details of infrastructure assets such as description, construction costs, quantities, estimated life and preventative maintenance programs is maintained by Local Governments.

Developers shall provide the infrastructure asset details in a format acceptable to the Local Government as part of the Survey Release process.

Subdivisional development process

Figure 1.2 shows the major elements and Local Government roles in the subdivisional development process.

FIGURE 1.2: SUBDIVISIONAL DEVELOPMENT FLOWCHART



Module No. 2

Site Preparation Guidelines

2 Module No.2 – Site Preparation Guidelines

2.1 General

This section has been separated to include lot earthworks as well as road earthworks due to the local authorities being required to sign-off on compaction details and also the levels and slopes on lots.

With the advent of water sensitive urban design and the need to assess stormwater flows throughout the whole subdivision the earthworks become a vital part of overland flows and the direction of the subdivision's total water management by the Local Government.

Earthworks can become a major constraint in retention of existing significant vegetation and major flood paths and storage areas. There is a growing awareness regarding:

- a need to retain existing significant vegetation in developments;
- incorporation of the remnant vegetation into the development;
- the development's environmental footprint;
- development's visual impact on the broad landscape and on identity of place and
- the need to retain existing flood paths and storage areas.

All reasonable measures should be considered during the entire land development process aiming at retention of significant trees and major flood paths and storages. Compliance with best management practice as per Australian Standards AS 4970 – 2009 Protection of Trees in Development Sites and best practice management as per Western Australia Water and Rivers Commission' Water Facts 14 - Floodplain Management (July 2000) are recommended.

2.2 Design

2.2.1 Earthworks, re-contouring and lot preparation

2.2.1.1. General

Filling of lots in a subdivision may be provided for a variety of reasons, such as:

- filling of local unwanted depressions;
- provision of sand fill in areas where the existing soils contain plastic and/or reactive soil conditions;
- raising the site to a sufficient level to economically provide for on-site effluent disposal in unsewered areas. The level of filling for the satisfactory performance of the effluent disposal systems shall be in accordance with the requirements of the *Health Act 1911*;
- filling may also be required for the provision of stormwater drainage systems which flow to the street drainage system or other discharge points;
- providing a level compatible with adjoining developed lots; and
- provision of a freeboard to the 100 year storm event and/or above the 1:100 year flood event.

The final fill requirement for lots, particularly those on clay soils where on-site effluent disposal is required, shall be determined by a geotechnical investigation.

Where it is necessary to fill to the boundary of a subdivision/lot, a suitable retaining wall shall be erected immediately inside the boundary of the subdivision/lot. Alternatively, the fill shall be carried beyond the boundary for a minimum distance of one metre and battered to a natural ground level at a slope not greater than 33.3 per cent (one in three). The written consent of the owner of the abutting land shall be obtained before proceeding with earthworks.

Where retaining walls are over 0.45 metres in height they shall be designed in accordance with the relevant Australian Standard(s) and must be approved by the Local Government. Such approvals require a building permit and payment of appropriate building fee(s). Certification by a practicing structural engineer will be required in most cases.

Design levels shall take into account drainage and access requirements together with consideration for the future development of the site. Land disturbed as part of development shall be stabilised to prevent wind or water erosion.

Where filling on a subdivision affects the drainage of adjoining land, provision shall be made to manage the water within or through the subdivision. No filled lots shall be permitted to drain onto abutting land. Extra precautions should be taken at lot driveways to prevent road drainage from entering private property especially for lots graded below kerb level.

Earthworks in areas containing vegetation which has been nominated for retention require careful approach. Compliance with Australian Standards AS 4970 – Protection of Trees in Development Sites must be considered.

2.2.1.2. Residential areas

Current housing sector preference and consequently development industry practice is for most greenfield lots to be relatively flat, especially smaller lots.

In areas where re-contouring is proposed the maximum gradient across lots and developed areas shall not exceed 12.5 per cent (one in eight), property boundary to property boundary, unless constrained by the existing site topography. On the low side the first 1.5 metres behind the kerb should be graded up two per cent from the adjacent road kerb height.

If overall re-contouring is not required, the maximum lot grading from the design verge level at the property boundary should not be greater than seven per cent (one in 14 for disability access) extending to the building set back line within the property.

Earthworks for public access ways and battleaxe access legs should have a level cross section boundary to boundary and an absolute maximum longitudinal gradient of 16.5 per cent (one in six).

Re-contouring of land adjacent to primary and/or district distributor roads with control of access, shall match the boundary levels for the road. Alternatively the land shall be retained with an approved retaining wall.

Re-contouring and earthworks in public open space shall be designed in consideration of the maintenance practices and equipment used by local government.

The whole area of re-contouring and earthworks shall be cleared of trees, shrubs and vegetation, and grubbed out to clear roots and stones. Topsoil shall be removed, stockpiled

and where a geotechnical report advises suitable topsoil shall be respread after re-contouring and earthworks to encourage vegetation regrowth. Clearing shall be restricted generally to those areas which require earth working. In some circumstances it may be possible to retain existing trees and vegetation in consultation with the Local Government.

2.2.1.3. Industrial areas

Industrial areas shall be re-contoured and earth worked to provide suitable grades to accommodate:

- sewerage disposal and stormwater drainage;
- large structures and storage areas requiring level pads; and
- large and oversize commercial vehicles.

The maximum grade across lots shall not exceed 6.67 per cent (one in 15).

In areas where overall re-contouring is not required, grading up a maximum of 12.5 per cent (one in eight) from the verge design level at the property boundary, to natural surface inside the property and extending no further than nine metres back into the property, may be accepted.

2.2.1.4. Rural areas

Re-contouring and earthworks would not normally be expected in rural areas other than adjacent to roadways.

All embankments and cuttings should be covered with topsoil to encourage the regrowth of native vegetation. Embankments should be in accordance with section 3.3.4.

The depth of topsoil should be a minimum of 100 millimetres and where applicable soil stabilisation may be required to prevent soil erosion by wind and/or water.

2.2.1.5. Soil filling

The design of filling on both the private lots and lots being required for public areas shall be usable by future residents, visitors and other users. A geotechnical approach is recommended but does not prevent consultants and Local Government officers resolving an alternative solution.

Earthworks in street areas should be set so that both longitudinal grades and cross section can be designed to conform to all standards and policies applying to the detailed design of roads.

Where overland drainage forms part of the subdivision then earthworks must also be designed to allow for drainage flowpaths.

Lot filling shall be set so as to provide the building industry with sites that reduce building costs to the customer. Where natural topography does not allow for such levels, exceptions can be allowed.

2.2.1.6. Fencing and landscaping to limited access roads

Fencing along the boundary of the road reserve shall be provided by the developer in those subdivisions where lots abut but do not have access to limited access roads. Fencing details and locations shall be included in the design drawings. Fencing shall also be constructed of vandal proof materials to limit future damage and possible replacement.

Fencing will be subject to an approval as specified by the Local Government. Should the area in question be subject to major winds or other issues which could cause structural damage to the fence, the design should be certified by a practicing structural engineer. A Registered Builder may be required to undertake fencing works as per Builders Registration Act.

The developer shall undertake the planting and establishment of vegetation to ensure the ultimate stabilisation of the cleared road verge, prevent sand blow and soften the appearance of the fence line.

The type and density of the vegetation shall take account of the future long-term maintenance of the area, weed suppression and fire resistance, and be approved by the Local Government.

2.2.1.7. Soil stabilisation, dust and smoke control

The *Local Government Act 1995* requires Local Government authorities to ensure that roads and properties are not injuriously affected by sand drift or wind borne dust and to take prompt action to abate any sand drift or dust problems.

The lighting of fires for the disposal of cleared timber or other purposes is controlled by the *Bush Fires Act 1954*. It is preferable that cleared timber and vegetation is mulched and either respread on site or remove from site.

The developer shall be responsible to control sand drift and wind borne dust on the subdivision construction site, until such time as the land ownership is transferred. The developer is also responsible to control erosion of soils and sediments from the site through the movement of vehicles or water. Measures to be adopted by the developer in relation to these are described in Section 2.1.2.1.5.4 Soil Stabilisation Strategy.

All works shall be carried out with minimum effect on the amenity of existing surrounding developments or land.

2.2.1.8. Soil stabilisation strategy

Prior to the commencement of any works on a development site involving the movement of soil and/or sand, the developer shall submit a site classification assessment and soil stabilisation strategy in accordance with “A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities”. (Department of Biodiversity, Conservation and Attractions March 2011).

Consideration shall also be given to the Department of Biodiversity, Conservation and Attractions’ publication: *Land development sites and impacts on air quality* and the requirements of the documents referred to in Section 2.2.1.5.3.above.

In order to minimise potential impact on near by properties, roads, waterways and drainage systems, the developer shall plan the works to minimised erosion on the site and the movement of soils, sediments and dusts off the site whether caused by vehicle, wind or action or water.

The stabilisation of topsoil, sand or other material or matter subject to movement over or near the subdivision shall generally be carried out in accordance with the above recommendations and/or requirements of the documents referred to in Section 2.2.1.7 above.

A soil management / stabilisation plan shall be prepared for the subdivision and shall form part of the planning approval process. This plan shall give consideration to sediment transport, dieback management and other soil transport issues. The soil management/stabilisation plan shall incorporate some or all of the following measures appropriate to the site to prevent the movement of soils, sediments and dusts off the site:

a) Minimising the area exposed by;
   - Minimising clearing
   - Staging of clearing operations.
   - Provision of wind-break fencing or work scheduling in low-wind conditions.
   - Use of dust suppression techniques.
   - Progressive stabilisation of the works as completed and,
   - Provision of temporary grassing.

b) Limiting the movement of vehicles and equipment to;
   - A single approved stabilised construction entrance and,
   - Prepared parking areas by the construction of temporary fencing.

c) Control surface run-off using a combination of measures which may include;
   - Construction of interception drains to divert run-off from undisturbed areas around the works area.
   - Installation of temporary drains.
   - Early stabilisation of floodways and,
   - Use of; filter banks, silt fences, swales, contouring, spreader banks.

d) Site maintenance measures
   - Regular site access and road sweeping
   - Covered loads
   - Drain clearing

The sediment, dust and erosion quality control measures shall be provided, operated and managed, maintained or replaced as necessary for the period of construction, including the consolidation period and/or the Defects Liability Period as required to fulfil the requirements of the Local Government and Environment agencies.

A Sedimentation and Erosion Control Plan should be provided by the developer to the Local Government for review prior to commencement of works on site.

2.2.1.9. Soil stabilisation bond

A soil stabilisation bond in the form of either cash or an unconditional guarantee from a financial institution acceptable to the Local Government may be required in areas where climatic, site and soil conditions are such that wind born dust or soil erosion and deposition may cause significant problems. The amount of bond should be in line with bonding agreements in Module No. 1.

The soil stabilisation bond amount will be based on area in accordance with the following table except that a minimum bond of $1000 applies. Areas will be measured on the basis of the total area of earthworks plus haul roads, stockpile areas and adjacent land impacted or disturbed by earthworks.

- Site Classification 1 – Negligible risk = $ Nil
- Site Classification 2 – Low risk = $600 /ha
- Site Classification 3 – Medium risk = $1800 /ha
- Site Classification 4 – High risk = $3600 /ha

The purpose of this bond is to provide a source of funds to cover the cost of dust or soil erosion and deposition control and for clean up operations in subdivisional developments should the developer fail to install or maintain adequate control measures.

The soil stabilisation bond shall cover any soil stabilisation work required on land owned by the developer, including land ceded for public purposes, and for any cleanup works that may be necessary on adjacent lands caused by wind erosion, water erosion and machinery movement emanating from the subdivisional works.

These monies may be used by the Local Government to control dust or soil erosion and deposition if the contractor is not taking adequate precautions to control dust and/or soil erosion and deposition during the progress of the construction work. The consulting engineer shall be advised in writing on each occasion it becomes necessary for the Local Government to use these monies for the control of, or cleaning up of, dust or sand drift.

The soil stabilisation bond, less any amount expended by the Local Government on the control of, or cleaning up of, dust or soil erosion and deposition, shall be refunded upon completion of the works.

A Local Government may require that subdivisional development works be carried out during prescribed periods where prevailing conditions may cause problems, to ensure that adjacent properties are not subjected to unacceptable dust or soil erosion and deposition nuisance.

To prevent dust nuisance to adjacent properties the Local Government may direct that no earthworks, including stripping, filling, trenching or placing of topsoil, be carried out when wind, soil and climate conditions are such as to cause or likely to cause dust or soil erosion and deposition to affect those properties.

2.2.1.10. Disposal of cleared vegetation

In considering the disposal of vegetation cleared from subdivisional development sites, priority should be given to options other than burning, such as:

- transplanting appropriate species;
- stacking and cutting of timber for fire wood for sale or collection. If this method is used it is necessary for the developer to ensure that appropriate arrangements are in hand to protect the public from injury and to protect the contractor, developer and the Local Government from any claim by the public;
- Chipping and mulching for soil stabilisation where approved by the Local Government.

Cleared vegetation shall be stored in a bushfire- safe manner, in consultation with the local fire officer.

Pollution of the atmosphere by smoke generated from burning cleared vegetation on a subdivisional development site is not acceptable. Where burning is the only practical alternative for the disposal of such cleared vegetation it shall be undertaken strictly in accordance with the requirements of the Department of Biodiversity, Conservation and Attractions and the *Bush Fires Act 1954*.

The burning of vegetation in the Perth Metropolitan Area is prohibited under *Environmental Protection Regulations 1987*, Part 7A, Regulation 1 6B. However, rural areas may not be subject to these conditions and developers should check local laws in relation to the disposal of vegetation.

Re-use of topsoil may also be restricted if adverse pathogens are present such as die back. There may be a need in some cases to have test, completed on topsoil to ascertain its suitability for re-use. However, this process should be made clear to developers when the initial design of the subdivision is commenced. This will ensure that developers are aware of the problem prior to the actual construction taking place.

2.2.1.11. Fire breaks for rural areas

All firebreaks are to comply with the *Bushfires Act 1957*. In rural areas there is a need to provide access to batters and drains for maintenance purposes and the design should incorporate such access. Also there is a need to negotiate property fencing to ensure that property access is in specific locations rather than an ad hoc access anywhere along a street frontage.

Part of this process will include fire breaks which are important prior to lots being sold. The outbreak of fire prior to the sale of a subdivision is the responsibility of the developer. This process will be required both by the Local Government and the fire and emergency services and should form part of the design processes. Firebreaks need to be provided in such a way to reduce the likelihood of erosion and flooding.

2.2.1.12. Retention of existing vegetation

All vegetation identified for retention must be adequately protected from damage during the subdivisional works. Temporary fencing to prevent access may be required where the conservation value of the vegetation is high.

2.3 Specifications

2.3.1 Filling

Areas of lot filling shall be cleared and stripped of all organic material and rubbish and the filling placed and compacted to the approved design levels. Unsuitable excavated material shall be disposed of as approved by the Local Government. The transport route for the excess unsuitable excavated material on the Local Government controlled roads is to be approved by Local Government.

The tolerances on lot filling shall be ±50 millimetres.

All fill material shall be clean, free draining, suitable fill material as determined by an appropriate geotechnical investigation, free from foreign and organic matter.

Where fill is required to be imported the material shall be certified as "Dieback" free.

No transport of filling operations are to be commenced on the Local Government controlled roads until the transport route is approved by the Local Government.

All fill shall be compacted to the full depth in accordance with AS 3798 – 2007 *Guidelines for Earthworks on Commercial and Residential Developments*.

The requirements of sections 2.2.1.5.3 and 2.2.1.5.4 for dust control, soil erosion and deposition and stabilisation shall apply to all lot filling. Where rock material is encountered within the building area of a proposed lot, a minimum of 450mm of clean compacted sand fill shall be provided over the rock material.

2.3.2 Hydromulching and seeding

Hydromulch shall consist of the application of a mixture of water, seed, wetting soil agent, fertiliser, binding agent and a biodegradable filler to the surface of the ground. Full details of the proposed seed/fertiliser mix are to be submitted for approval.

Hydromulching that does not incorporate seed and fertiliser is not acceptable as a permanent soil stabilisation measure.

Where germination satisfactory to the Local Government does not occur within the defects liability period, the Local Government may request reseeding prior to releasing the defects bond.

2.3.3 Mulching

Mulches must comply with AS 4454–2003 *Composts, soil conditioners and mulches*.

2.4 Retaining walls

2.4.1 General

Retaining walls may be provided as part of the subdivision works to all individual lots less than 600m² in area where the finished contours result in the slope across the lot parallel to the front or side boundary being greater than 1 in 25.

The retaining wall shall be located entirely within the future lot boundary. Retaining walls shall not straddle common boundaries between lots (walls and associated structure are to be constructed 25mm to 150mm from the boundary and contained fully within the allotment which is being serviced).

Retaining walls abutting existing or proposed road reserve, proposed public open space, parkland, or bushlands areas are to be contained within the proposed allotments serviced (must not straddle common boundaries).

All materials used in the construction of the retaining walls are to have a minimum design life of 100 years.

Where retaining walls are provided as part of the subdivision works, the fall across the lot; i.e. from side to side, shall not exceed 300 mm.

2.4.2 Side walls

Retaining walls between residential lots shall not exceed 2.5m in height. Where it is proposed to retain heights in excess of 2.5m, retaining walls shall be terraced and landscaped. The height of the lower-level terrace shall not exceed 1.5m to assist with access for maintenance. The height of the upper level terrace shall not exceed 2.5m. The width of the terrace shall be a minimum of 1.5m.

2.4.3 Front walls

Retaining walls at street boundaries shall not exceed 1.5m in height. Level differences adjacent to street boundaries exceeding 1.5m are not encouraged but may be approved where terracing and landscaped is provided. Terraces shall be separated by a minimum of 1.5m and each retaining wall shall not exceed 1.5m in height.

2.4.4 Approvals

Approval of the Engineering Drawings by the Local Government only provides approval for the location and layout of all retaining walls plus those retaining walls not exceeding 1000 mm in height and/or not subject to surcharge (i.e. retaining the earth only and no imposed loads).

Where the retaining walls is not subjected to surcharge, but the wall height exceeds 1000mm, the consulting engineer must submit to the Local Government's Building Service detailed design plans for all such retaining walls as they require a building permit before they may be constructed.

Retaining walls exceeding 1000 mm in height and/or subject to surcharge constructed without a valid building licence may result in prosecution in accordance with section 374 of the *Local Government (Miscellaneous Provisions) Act 1960* and the service of notice on the developer or builder in accordance with section 401 of this Act requiring that the retaining walls be demolished.

Module No. 3

Road Guidelines

3 Module No.3 – Road Guidelines

3.1 General requirements

The application of various planning policies and principles to road design is intended as a guide to help provide minimum standards for the geometric elements of the road. Other factors of some importance to the total efficiency of the road system include the coordination of vertical and horizontal alignments; fitting the road to the natural contours of the land rather than carrying out major earthworks to produce road grades, which are in conflict with those contours; preservation of natural features (including vegetation); and using higher than minimum standards to provide a functional and aesthetically pleasing streetscape.

In maximising the use of the existing physical features within a subdivision, consideration must also be given to the practicalities of lot access, building requirements, the provision of a pleasant living environment and in some cases the provision of public transport facilities. It is desirable that engineering input occur during the planning process to ensure that good engineering principles are achieved from the outset, without compromise.

The long-term maintenance of roads is another important factor in the design of subdivisional roads. The road design should reflect features that provide for a safe and practical road system that can be maintained by the Local Government at a reasonable cost.

Fitting the road design to the natural contours of the land, or locating the road elements to minimise the cut and fill requirement while maintaining reasonable vertical and horizontal alignments, should be considered secondary to the application of good engineering practice and correct geometric road design to achieve a safe and functional road design for the determined speed environment.

There should be a suitable level of engineering input during the structure planning phase and subdivisional planning phase to adequately provide for the installation of all services, stormwater drainage and suitable road reserve widths.

Consideration should be given to the likely differences in site levels associated with fill requirements to produce an “A” or “S” site classification and suitable finished lot levels above groundwater. Areas of land to be left unfilled (generally POS or service infrastructure corridors) may require adjacent road reserves to be wider than that defined in the “Liveable Neighbourhoods” policy document.

3.2 Policies and standards

3.2.1 Policies

General road layout, intersections, road hierarchy and major pedestrian and cycle path locations are determined at structure planning stage. Road reserves, pavement widths, embayment parking and footpath locations are generally determined at subdivision stage. Road engineering drawings are to be in accordance with road design details, such as reserve and/or pavements widths and/or truncation dimensions shown on a plan of subdivision or in conditions approved by the Western Australian Planning Commission pursuant to the *Planning and Development Act 2005.*

The following WAPC policies are predominantly used and apply to subdivision design and assessment:

- State Planning Policy 3.1 Residential Design Codes;
- State Planning Policy 3.6 Development Contributions for Infrastructure;
- Liveable Neighbourhoods, WAPC;

- Development Control Policy 1.1 Subdivision of Land - General Principles;
- Development Control Policy 1.5 Bicycle Planning;
- Development Control Policy 1.7 General Road Planning;
- Development Control Policy 2.2 Residential Subdivision; and
- Development Control Policy 2.6 Residential Road Planning, WAPC;

3.2.2 Standards

Additionally, road designs should conform to the relevant Austroads standards and have regard to Australian Road Research Board and other publications, which include:

- Guide to Traffic Management: Parts 1–13, Austroads;
- Austroads Design Vehicles and Turning Path Templates, Austroads (2013);
- Guide to Road Design, Part 1-8, Austroads (2010);
- Guide to Pavement Technology, Part 1-10, Austroads;
- Guide to Road Transport Planning, Austroads (2009);
- Cycling Aspects of Austroads Guides, Austroads (2017);
- Utility Providers, Code of Practice for Western Australia, MRWA (2010);
- Sealed Local Roads Manual, Australian Road Research Board (2005);
- AS/NZS 1158 Lighting for Roads and Public Spaces, Standards Australia (2010);
- AS 2150-2005: Hot Mix Asphalt – A Guide to Good Practice, Standards Australia (2005);
- AS 2008-1997: Residual Bitumen for Pavements, Standards Australia (1997);
- AS 3727-1993: Guide to Residential Pavements, Standards Australia (1993); and
- Technical Specification, Tender Form and Schedule for Supply and Laying of Hot Asphalt Road Surfacing, IPWEA/AAPA (2016) Rev 4.

3.3 Design

The design of the road network should be developed in consideration of Australian Standards, the surrounding road network, liveable Neighbourhoods and the following:

Traffic control devices shall be installed where required to properly regulate traffic flows or where traffic problems are anticipated to occur in the future. Traffic control devices shall comply with appropriate Austroads standards and other relevant industry standards and guidelines.

Pedestrian facilities shall be installed where required. The pavement design life shall be 25 years.

3.3.1 Road hierarchy

A road hierarchy shall be established for the development that enables the safe and orderly movement of vehicles, cyclists and pedestrians within, between and across roads. The road hierarchy shall be based on the road classifications shown in *Liveable Neighbourhoods* (reproduced in Table 3.1 and Table 3.2) and be subject to detailed road planning.

Intersection designs, road traffic calming devices and pedestrian facilities shall be designed in consideration of the ultimate classification of the roadway as defined by the Metropolitan Functional Road Hierarchy.

3.3.1.1. Urban roads hierarchy

The road reserve is required to accommodate a variety of pedestrian and vehicular activities as well as public utility providers. It should also be safe for the various users; contribute to the amenity of the area; and to be able to carry out its transport function.

Liveable Neighbourhoods classifies roads slightly differently to MRWA, but general categories align except for the nomenclature which refers to roads as integrators rather than distributors. *Liveable Neighbourhoods* is the adopted policy for the WAPC and the Department of Planning, Lands and Heritage.

TABLE 3.1: ROAD CLASSIFICATIONS

Route type and function	Route characteristics	Route name	Max speed limit (km/hr)	Indicative volume range* (vehicles per day)	Indicative street reserve width (metres)**	Indicative road pavement width (metres)
Primary distributors Form the regional grid of Main Roads WA traffic routes, including Highways; and catering for inter- and intra-regional traffic. Major truck routes.	Should be designed to be fronted by development and connected with service roads wherever possible. Usually median divided.	Six lane **Primary distributor**	80	50,000	Determined by MRWA	
	Intersections limited and often signal-controlled.	Four lane **Primary distributor**	80	35,000		
Integrator arterials Form a finer grain of routes than the primary distributors, with frequent connections to local streets. Low percentage of trucks. Usually bus routes. On-street bike lanes and separate dual-use paths are usually required.	Four lane and two lane arterial road types. Integrators outside centres typically have service roads and development frontage to support a mix of uses.	**Integrator A** (Four lanes, outside centres)	70 or 60	15,000–35,000	50.6–52.6	2 x 8.2 including bike lane and 2 x 5.5 service roads with parking.
	Direct vehicle access from adjoining property should be limited where no service roads are provided. On-street parking desirable.	**Integrator A – centres** (Four lanes, in centres)	60	<25,000	35.6	2 x 10.7 in centres including combined on-street parking and bike lane.
	Integrators through centres typically will have at least one clear travel lane in each direction, and a parking and/or manoeuvring lane. Volumes above 15,000 vehicles per day need detailed design to manage traffic at intersections, facilitate bus movement and deal with parking and access.	**Integrator B** (Two lanes, outside centres)	60	7000–15,000 15,000–20,000	29.2	2 x 7.5 including on-street parking and bike lane. 2 x 7.5 including bike lane. Parking requires special consideration, or service roads may be needed.
		Integrator B – centres (Two lanes)	40–50	15,000	25.2	2 x 7.5 including on-street parking.

Source: Liveable Neighbourhoods, WAPC

Note: Wider central medians are to be provided where a route is planned to be used for a future bus transit way or light rail route, or possibly for drainage swales to provide stormwater infiltration. Where an integrator is constructed in an interim situation at a higher posted speed than that intended as the ultimate speed limit, the horizontal and vertical alignment should suit the higher speed but the lane widths and planned intersection spacings should be designed to the ultimate speed standard. All functions of streets need to be considered as well as traffic volume and through-traffic needs.

Refer to figures in *Liveable Neighbourhoods* for indicative cross-sections.

Adequate reserves need to be provided to accommodate space for trees, varied service requirements, or wider shared path requirements, particularly where densities are at 15 dwellings per hectare or greater, and/or mixed-use development is anticipated. Widening for intersections may also be required.

The urban road hierarchy may also be classified under the following MRWA's criteria.

- Primary distributor roads are used for carrying long distance traffic across the urban area and may connect to the national highway network. Traffic volumes are high, usually in excess of 6000 vehicles per day. These roads are designed to integrator road standards with access control.
- District distributor roads are used to convey traffic between adjacent suburbs. Traffic flows are usually greater than 3000 vehicles per day. They are often designated as bus routes and must be designed with that consideration.
- Local distributor roads carry traffic within a residential cell and usually have traffic volumes of less than 3000 vehicles per day with direct lot frontages. Care should be taken in the design of residential cells to ensure that local distributor roads do not become short cuts between district distributors.
- Rear laneways provide vehicular access to the rear of lots. They can be used to improve parking and/or access provisions.

Liveable Neighbourhoods also designates access roads as shown in Table 3.2.

TABLE 3.2: ROAD CLASSIFICATIONS

Street type and function	Street characteristics	Street name	Max design speed/ target operating speed (km/hr)	Indicative volume range* (vehicles per day)	Indicative street reserve width (metres)+	Indicative road pavement width (metres)
Neighbourhood connectors Streets with mostly residential frontage that typically provide the lower order sub-arterial network. These streets service and link neighbourhoods and towns	A two-lane divided street used for higher neighbourhood connector volumes, or for character, stormwater infiltration swales or safety. These are often special streets and their design needs to have particular regard to context, function and adjacent land uses.	**Neighbourhood connector A** (Median)	50/50	7000	24.4 **	2 x 7.1 including parking, on-street bikelane, median plus shared path on one verge.
	A two-lane undivided street for lower volume neighbourhood connectors. Typically can accommodate buses, will have at least one shared path and above 3000 vehicles per day separate on-street bike lane.	**Neighbourhood connector B** (Minor)	50/50	3000	19.4	11.2 including parking, plus shared path on one verge.
Access streets Access streets are to accommodate shared pedestrian, bike and vehicular movements. The requirements of adjacent land uses should be supported through street design.	Varied formats to suit a range of typical conditions in predominantly residential areas at different densities, and with different traffic volumes. An avenue access street (Access street A) with median is particularly suited to incorporation of a drainage swale.	**Access street A** – avenue	50/40	3000	20–24	2 x 3.5 (or 2 x 3.6 under some conditions) plus indented parking.
	Access street B is a wider undivided street for situations with increased parking and/or traffic demand.	**Access street B** – wider street	50/40	3000	16.5–18	9.7
	The most typical and most common residential street will be Access street C – Yield street.	**Access street C** – yield or give way street	50/40	3000	15.4–16	7.2 (7–7.5)
	Access street D is for short, low volume and low parking demand streets. In addition, a comprehensively designed variant with 3.5 m travel lane with indented parking, is also specified for very low volume short	**Access street D** – narrow yield or give way street	50/30	1000	14.2	5.5–6
			50/20	150	14.2	3.5 (plus parking indents)
Laneways Provide access to the side or rear of lots principally for access to garages.	Laneways may incorporate some services and can provide rubbish collection access. Laneways usually contain some studio units over garages for surveillance. Lane may be widened in parts to create mews courts.	**Laneway/rear lane**	15	300	6**–6.4	typical 3–6.4 (range)

Street type and function	Street characteristics	Street name	Max design speed/ target operating speed (km/hr)	Indicative volume range* (vehicles per day)	Indicative street reserve width (metres)+	Indicative road pavement width (metres)
Small town centre street Suited to small secondary streets in centres.	For use in predominantly pedestrian areas in centres, where the street is short and is specifically designed for pedestrian emphasis, and visual containment is required.	**Small town centre street**	50/20	300	10–12	5.5 m

*** Lesser reserves and road pavement widths may be applied over limited lengths where performance can be justified, such as laneway entrances.*

Source: Liveable Neighbourhoods

Table 3.3 shows the classifications in *Liveable Neighbourhoods* and how they align with those set down by MRWA.

As these Subdivision Guidelines are underpinned by *Liveable Neighbourhoods* the classifications will be used from that document rather than the classification from MRWA.

TABLE 3.3: COMPARISON OF ROAD CLASSIFICATIONS FOR LIVEABLE NEIGHOURHOODS AND MRWA

Road Classifications – Liveable Neighbourhoods versus MRWA	
Liveable Neighbourhoods	**MRWA**
Primary distributor	Primary distributor
Integrator arterial A	District distributor A
Integrator arterial B	District distributor B
Neighbourhood connector A	Local distributor
Neighbourhood connector	
Access street A	Access street
Access street B	
Access street C	
Access street D	
Access place	
Access laneway	Rear laneway
Small town centre street	

FIGURE 3.1: EXAMPLE OF ROAD LAYOUT

Key

1 Integrator A – with service roads
2 Neighbourhood connector A or B
3 Access street A – Avenue
4 Access street B – Wider access street
5 Access street C – Yield (or give way) street
6 Access street D – Narrow yield (or give way) street
7 Rear lane

Source: Liveable Neighbourhoods

Residential road design guidelines should generally be in accordance with the WAPC's *Development Control Policy 2.6* and the Summary of Planning Criteria for Residential Roads shown in Table 3.4. However, where conflicts arise *Liveable Neighbourhoods* should be considered to override the policy.

TABLE 3.4: SUMMARY OF PLANNING CRITERIA FOR RESIDENTIAL ROADS

Function/Road type	Integrator category B	Neighbourhood connector	Access way	Access place	Access lanes and rear laneways
Network role	Major tributary to Primary Distributor	Housing access Neighbourhood tributary	House access and minor tributary	Housing access only	Housing access only
Degree of connectivity	Important between neighbourhoods	Moderate within neighbourhood	Very low	Through or none	Through or none
Connects with	Primary distributor District distributor Category A & B Local distributors	District distributors Local distributors Access ways	Local distributors Access ways Access places	Access ways Access places Occasionally Local distributors	Access ways Access places Occasionally Local distributors
Maximum desirable traffic volume vehicles/day	8000	3,000 with direct lot frontage 3,000 with direct lot frontage and frontage treatments	600	200	100
Maximum desirable operating speed km/hr	60	40 with driveways 60 without driveways	30	20	20 or less
Speed for sight distance criteria	70	60	40	40	20
Bus route	Yes	Yes	Occasional mini bus	No	No
Shared pedestrian/vehicle carriageway	No	No	No	Yes	Yes
Separate footpath/dual use path provision	At least one side	At least one side	Desirably one side	No	No
Carriageway edges	Barrier or semi barrier kerb	Mountable	Mountable	Mountable or flush kerb	Flush kerb
Parking provisions	On carriageway Off carriageway in widened strips	On carriageway Off carriageway in widened strips	On carriageway Off carriageway in widened strips	In road parking bays	In road parking bays
Acceptable carriageway width (excluding parking)	7.4m–10.0m See note 1	6.0m–10.0m See note 2	5.5m–6.0m	4.0–5.5m Where 4 dwellings or less are serviced, 3.0m acceptable	4.0m–5.5m
MINIMUM TO ACCOMMODATE SERVICES					
Verge widths	5.0m–6.3m	4.2m–6.3m	4.0m–4.5m	4.0m–4.5m	1.5m–4.0m

Total road reserve width	20.0 Min	15.0m–23.0m	11.5m–15.0m	10.0m–14.5m	6.0m–13.5m

Notes: To be read in conjunction with Table 3.4.

Note 1 10-metre carriageway widths for distributor roads will only be approved in cases where residential access is restricted, traffic volumes, vehicle turning movements and/or carriageway parking are expected to be high and/or on-road cycling facilities are provided.

Note 2 Six-metre carriageway widths for local distributor roads will only be approved in cases where parking on the carriageway is prohibited and widened parking strips are provided.

Note 3 The minimum carriageway width in an area zoned commercial or industrial shall be nine metres.

Note 4 Truncations in rural and industrial/commercial areas shall be based on design needs with a minimum of 10 x 10 metres.

A minimum truncation of 6 x 6 metres shall be used in all cases where the classification of a road in the functional road hierarchy is in doubt.

Note 5 Where a developer requires the minimum widths specified in Table 3.3 for access ways, access places, access lanes and rear laneways, it is essential that all public utility services and drainage facilities are designed prior to approval of the layout.

Note 6 Local distributor roads, where traffic volumes are expected to be between 3000–7000 vehicles per day, shall be designed to recognise the integrator arterial as a residential street. Frontage management techniques shall be used to improve safety and amenity.

Note 7 Foreshore access roads are a special category of local distributors which give access to linear open spaces such as beach, lake or river foreshores. Foreshore access roads may carry up to 10,000 vehicles per day near the district distributor network and up to 5000 vehicles per day adjacent to the foreshore.

Note 8 Higher design standards will generally be required for primary distributor and district distributor category A roads.

Note 9 All parking areas shall have a contrasting surface finish to the Carriageway and should comply with Australian Standard 2890.1.

Note 10 Adequate provision shall be made in the design of median islands for the safety of pedestrians and cyclists. Ideally islands shall have a minimum width of two metres with an absolute minimum width of 1.2 metres at the crossing location. All other details of the road crossing shall be in accordance with *Guidelines for the Design of Bicycle Facilities* (Bikewest).

Note 11 Flush kerbs or broken kerbs are allowable options with Local Government approval on all roads to provide for water sensitive urban design outcomes where desired traffic outcomes allow (eg. allowing road run-off to drain directly to public parkland, wide mediums and verges or non-active frontages).

Note 12: Rear laneways should be designed to accommodate the access and turning requirements of emergency and service vehicles.

Note 13: Minimum verge width to allow tree planting and pedestrian footpaths.

Note 14: Consideration needs to be given for additional road reserve widths to be provided for traffic control devices and also where water sensitive urban design devices are to be included within the road reserve.

Note 15: *Liveable Neighbourhoods* also has several sections relating to the following issues, which should be referred to when assessing design criteria for developments:

- road widths on bus routes refer to R27;
- walkable catchment requirements R28;
- treatment around railway lines R29;

- on street cycle lanes R40;
- stopping sight distances and truncations R54 and R55;
- intersection design R57 to R61;
- treatment of fur way intersections R62 to R65;
- roundabouts R66; and
- service roads R67.

3.3.1.2. Rural roads hierarchy

Rural roads may be defined as where the roads service lots are equal to or greater than 4000m^2. However, there may be instances where the development clearly is within the urban environment despite the size of the lots being developed.

The rural road hierarchy may be divided into two major categories:

1. Collector roads which convey traffic to the integrator road system. The minimum pavement width shall be 7.4 metres with 1.2-metre wide shoulders located in a road reserve with a minimum width of 22 metres.

2. Local roads which provide lot frontage and property access. The minimum pavement width shall be 5.6 metres with 1.2 metre wide shoulders for culs-de-sac and six metres with 1.2 metre wide shoulders for loop roads, located in a road reserve with a minimum width of 20 metres.

In all cases, sufficient verge width shall be provided to allow for the provision of services, such as overhead power lines, underground power provision, table drains and protection of vegetation.

The road formation shall provide for a berm with a minimum width of 600 millimetres between the shoulder edge and start of the table drain.

3.3.2 Road Alignments

3.3.2.1. General

Roads shall be designed to give the best possible grade to suit the natural ground conditions and minimise the amount of cut and fill. Natural ground levels shall be obtained from a topographical survey. The assumption of natural ground levels from contour plans is not acceptable as it does not provide the required accuracy.

The maximum longitudinal grade on all roads shall be 10 per cent (one in 10) unless the resultant earthworks and access to adjacent lots are impractical, in which case steeper grades may be approved.

The minimum longitudinal grade shall be 0.5 per cent (one in 200) on all roads that are to be kerbed or likely to be kerbed at some future time. Due to water ponding problems however, higher grades should be used where possible. In cases where terrain does not allow steeper grades, kerb and channel arrangements may be implemented to cope with the drainage run-off.

All changes of grade of more than one per cent shall be joined by a vertical curve. The length of all vertical curves shall be in accordance with the relevant Austroads publications and shall take into account overtaking and stopping sight distances and comfort factors.

Design ground levels are to be obtained from actual field survey. The assumption of levels from contour or other types of plans is unacceptable.

3.3.2.2. Rural road grades

Roads are to be designed to give the best possible grade to suit the natural / existing ground, and minimise the amount of cut and fill.

Table 3.5 shows the general maximum and minimum grades.

TABLE 3.5: MAXIMUM AND MINIMUM GRADES

		Sealed Roads	Unsealed Roads
Desirable Maximum %		8	6
Absolute Maximum %		10	8
Desirable Minimum %		0.5	0.5
Absolute Minimum %	Straight alignment	0.30	0.60
	Up to 60m radius curve	0.40	0.50
	Less than 60m radius curve	0.75	0.75

Source: Shire of Wyndham East Kimberley Guidelines for Rural Road Design

The absolute maximum grades may be approved in special cases. Redesign is to be considered where these grades are contemplated and only after complete examination of all options will they be accepted. Where natural topography does not permit the use of the grades in Table 3.5, steeper or flatter grades can be used with the approval of the Local Government.

Where grades exceed three per cent longitudinal grade, the designer is to accommodate appropriate drop structures and erosion control devices in the table drain to reduce transportation of silts and sands from the table drain.

3.3.3 Road crossfalls

The crossfall on the cross-section of the road pavement shall generally be three per cent each way from the road crown/centre line. Depending on the natural contour of land there may be instances where one way crossfalls should be considered to reduce earthworks on adjacent land.

One way crossfall or superelevation shall be applied on horizontal curves in accordance with the appropriate Austroads publications, except on local roads or those with a lower classification in urban areas.

One way crossfall and inverted crowns may be used for access ways and access places and on other roads where excessive natural slope across the road reserve dictates the necessity for such treatment.

In situations where minimum longitudinal grades are inevitable, the use of a minimum crossfall of 3 % should be applied to ensure adequate drainage.

3.3.4 Verge and property grades

Verge grading should be +2 per cent from the top of the kerb to the property boundary. In areas of steep grades, the verge on the high side of access ways and access places may be graded to suit the land configuration. The verge on the high side of a local distributor road may be graded at +2 per cent for three metres and then battered to suit the finished contours at a maximum of 1:6 slope.

In areas of deep cut and fill, on rural roads or district distributors in urban areas, the maximum grade of fill in the road reserve shall be 25 per cent (one in four) and the maximum grade of cut shall be 33.3 per cent (one in three).

In heavily earthworked areas each lot shall have access at a grade not exceeding 10 per cent (one in 10). The absolute maximum access grade shall be 16 per cent (one in 6.25) unless natural topography does not allow and this must be approved by the Local Government.

3.3.5 Kerbing

All urban roads and only intersections on rural roads shall be kerbed unless otherwise approved.

The minimum kerb radius at intersections shall be nine metres in residential areas and 12 metres in industrial areas. On roads that connect to district distributor roads with no requirement for channelisation, a 12 metre minimum kerb radius is required. Smaller radii can be negotiated where road speeds are considered low.

All kerb cross-sections and their use shall be in accordance with the details shown in Table 3.6 and Figure 3.2.

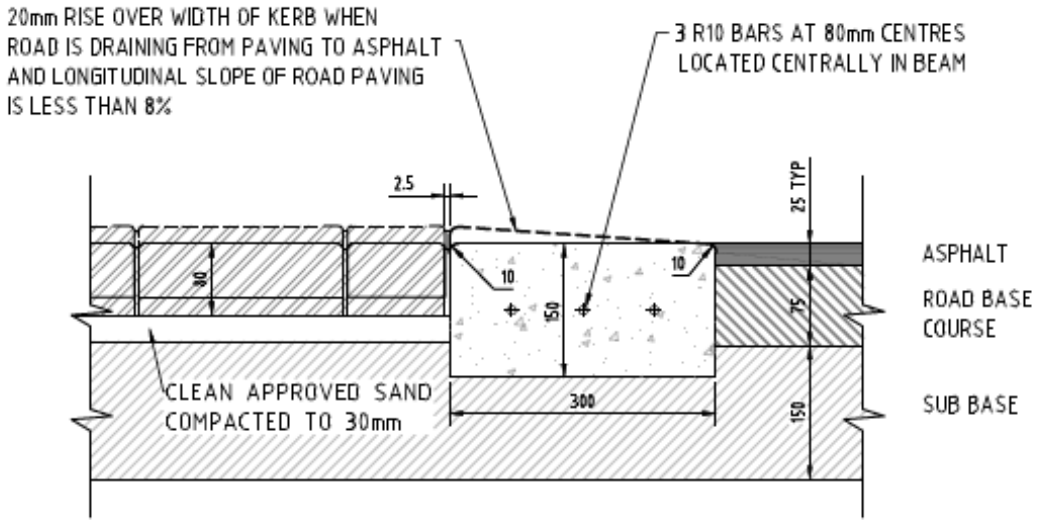
TABLE 3.6: KERB TYPE CROSS-SECTIONS

Use of kerb types			
Flush	**Mountable**	**Semi-mountable**	**Barrier**
• Adjacent to public open space areas and non-active areas to achieve water sensitive urban design outcomes. • The edges of through carriageway, abutting eyebrow and battleaxe driveway treatments. • Car parks. • Access streets and laneways. • Median islands where water sensitive urban design is used.	• All single carriageway residential streets providing access to new properties. • Neighbourhood connector roads.	• Median Islands on dual carriageways. • Channelisation islands. • Roads providing access to industrial or commercial properties. • All intersections on rural roads unless otherwise approved. • Integrator arterial roads (see also barrier).	• Integrator arterial roads. • Outside kerbs on dual carriageways. • Roads abutting public open space. • Roads in which future paths will be constructed adjacent to the kerb line.

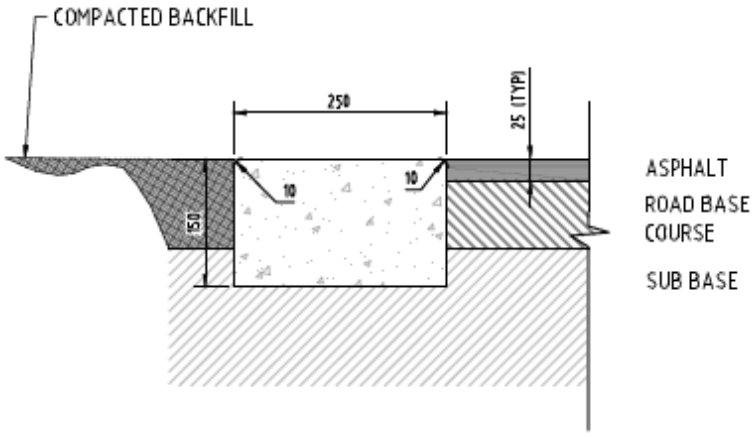
Source: Liveable Neighbourhoods

Where water sensitive urban design is not used on public open space the standard kerbings adjacent to public open space should be barrier to prevent intrusion by vehicles. It is preferred to place barrier kerbing adjacent to public open space rather than install bollard fencing which causes major maintenance problems in the future.

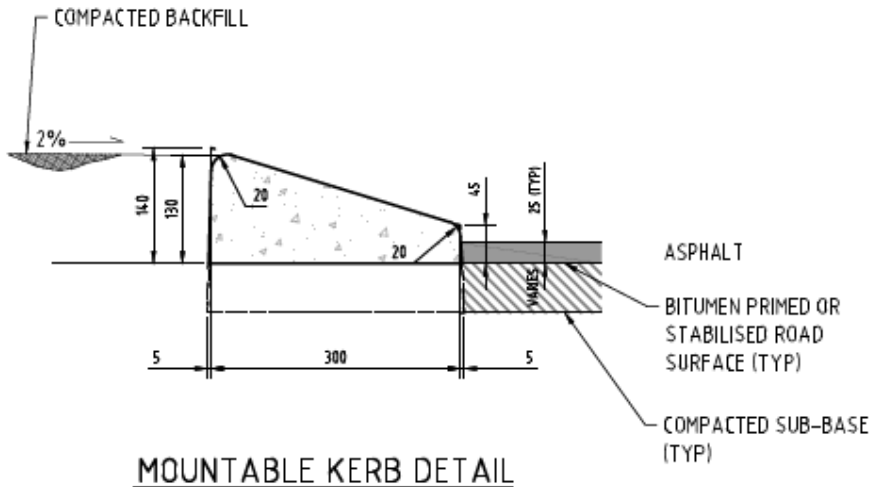
FIGURE 3.2: KERBING PROFILES



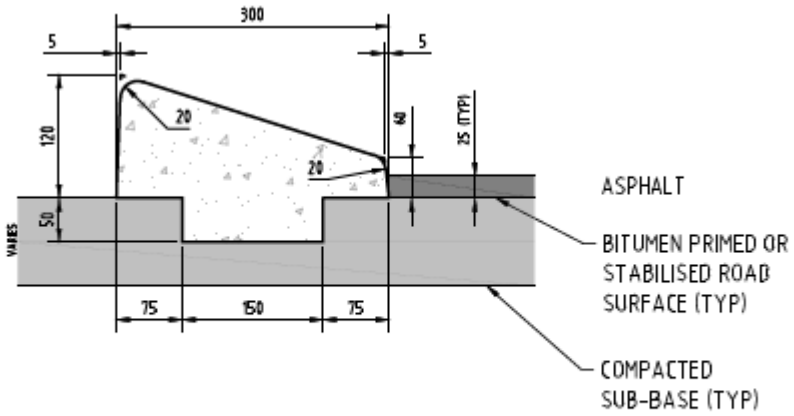
REINFORCED FLUSH KERB WITH BRICK PAVING



FLUSH KERBING DETAIL

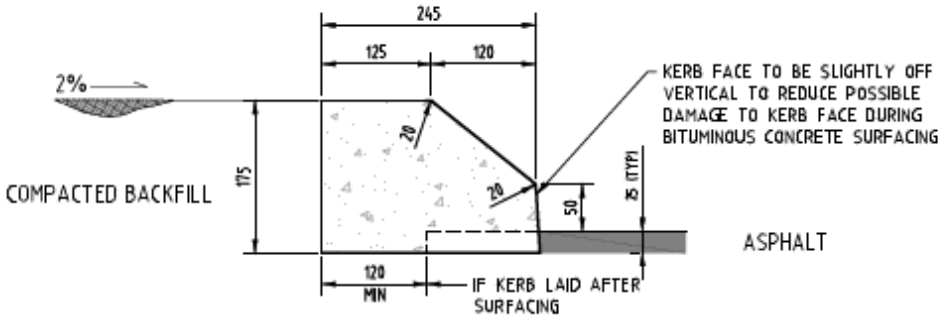


MOUNTABLE KERB DETAIL

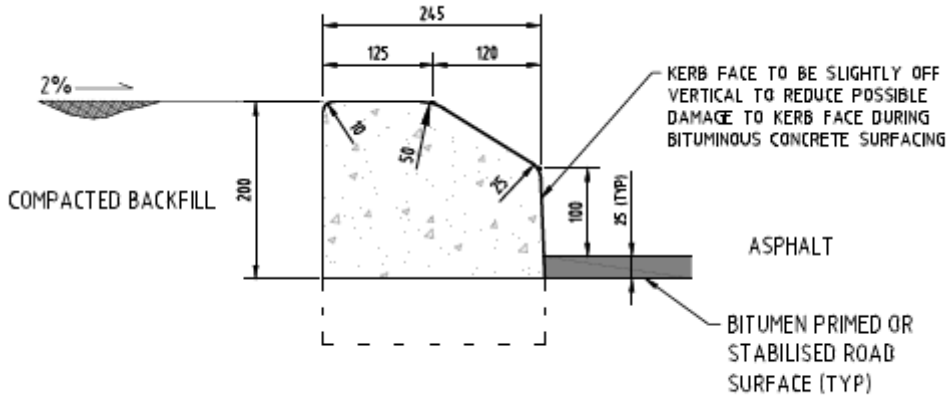


MOUNTABLE KERB WITH KEY

ROAD CURVE RADIUS LESS THAN 40m

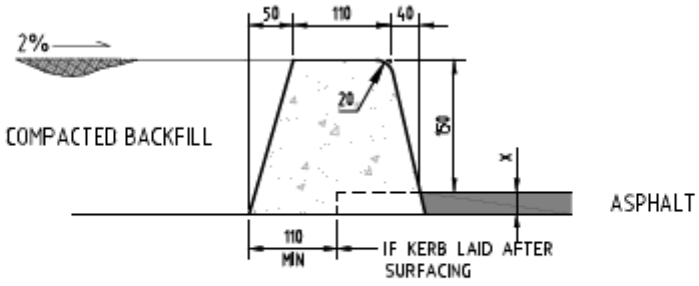


SEMI-MOUNTABLE - TYPE 1

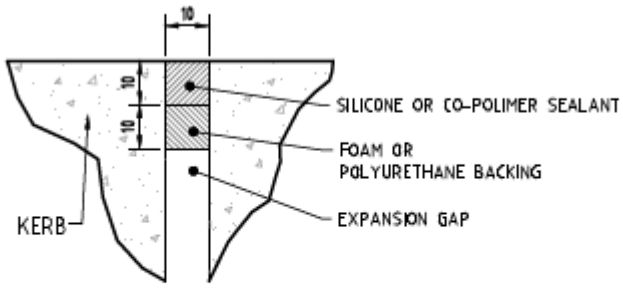


SEMI-MOUNTABLE - TYPE 2

The dashed line shown on the semi-mountable kerb profile indicates the increased depth required for kerbs on brick paved roads where the kerb cannot be laid directly on the base course.



BARRIER KERB DETAIL - TYPE 2



DETAIL OF EXPANSION JOINT

3.3.6 Cul-de-sac turning circles

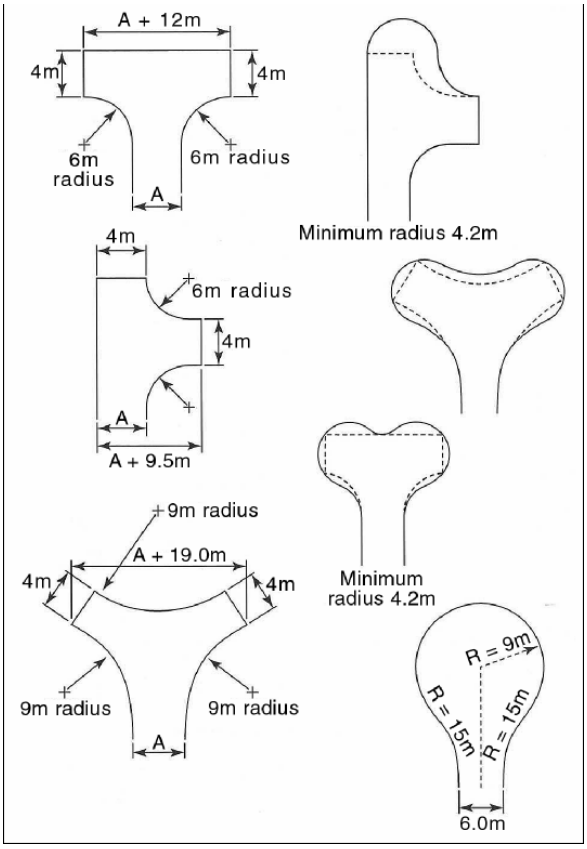
Cul-de-sac turning circles in residential and rural areas can have a minimum radius of nine metres with 15-metre radius transitions. For industrial areas the minimum radius shall be 12 metres with 20-metre radius transitions.

Other turning configurations may be acceptable subject to compliance with WAPC typical layout requirements in *Liveable Neighbourhoods*. Figure 3.3 shows turning and manoeuvring treatments for cul-de-sac for residential streets.

Cul-de-sac configuration shall ensure accommodation of the largest design vehicle (usually determined by the Local Government garbage collection vehicle) using Austroads design and turning templates. The developer needs to consult with the Local Government to determine required design vehicle.

Where a road is not constructed for its full length, a temporary turning circle shall be constructed to required standards at the termination point as determined by the Local Government. A “no through road” sign shall be installed at the intersection where traffic is likely to enter the road and a chevron sign indicating the termination of the road shall also be installed.

FIGURE 3.3: CUL-DE-SAC TURNING DESIGN EXAMPLES



Source: Liveable Neighbourhoods

Radii are to be measured to edge of seal on unkerbed sealed roads.

3.3.7 Pavement thickness

Designs shall be prepared of the road pavement thickness in accordance with the Australian Road Research Board and/or:

- A Guide to Pavement Technology Part 2: Pavement Structural Design (Austroads, 2012);
- A Guide to the Design of New Pavements for Light Traffic (APRG Special Report No. 21, 1998); and
- MRWA Engineering Road Note 9 – Procedure for the Design of Flexible Pavements.
- Update of the Austroads Sprayed Seal Design Method AP T68/06 (Austroads 2006)

The consulting engineer shall provide for pavement drainage where necessary to maintain a moisture free sub-grade and base course as determined by the site investigation.

MRWA's *Engineering Road Note 9* is available online at

https://www.mainroads.wa.gov.au/BuildingRoads/StandardsTechnical/MaterialsEngineering/Pages/Engineering_Road_Notes.aspx

Appropriate geotechnical investigations are required to identify sub-grade conditions prior to pavement design.

Refer to section 3.3.12 for wearing course specifications.

3.3.8 Design life of pavements

Unless specified otherwise by the Local Government, the permanent deformation of the granular pavement must have a minimum design life of 40 years.

Unless specified otherwise by the Local Government asphalt must have the following minimum design life:

- open graded asphalt – 10 years;
- dense graded asphalt 50 millimetres total thickness or less – 20 years fatigue life;
- dense graded asphalt greater than 50 millimetres total thickness – 40 years fatigue life.

In the rural situation all sealed roads are to be designed to provide a pavement design life of 40 years and the wearing coarse design life of 15 years.

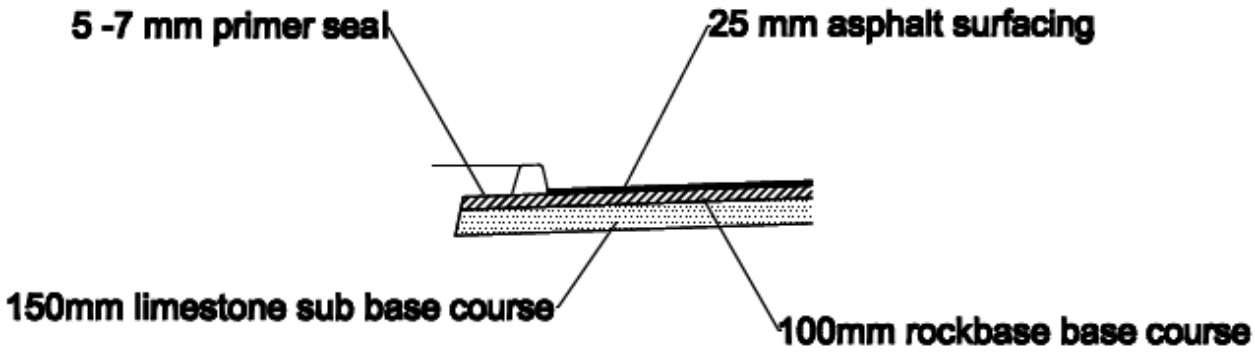
Whilst profiles recommended in the following sections are preferable, there are also many materials that can be used where availability of urban materials is not possible. Also, materials such as stabilised limestone may be substituted for base materials shown with the approval of the Local Government.

3.3.9 Urban base course profiles

Notwithstanding the design thickness obtained using the above guidelines, a generally accepted minimum pavement for urban residential roads in sandy soil conditions comprises:

- limestone sub-base with a minimum compacted thickness of 150 millimetres;
- base course with a minimum compacted thickness of 100 millimetres;
- a primer seal; and
- asphalt wearing course with an absolute minimum compacted thickness of 25 millimetres (Refer Figure 3.4).

FIGURE 3.4: TRADITIONAL BASE COURSE PROFILE

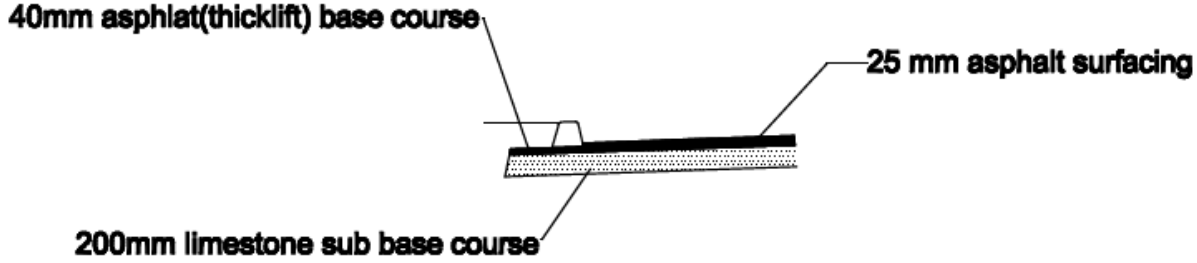


Source: IPWEA Guide to Pavement Profiles in Residential Streets

In an effort to reduce reflective cracking the current recommendation by the IPWEA is to remove the plastic base course and use the new base profile as follows:

1. limestone sub-base with a compacted thickness 150 millimetres to 225 millimetres;
2. thicklift asphalt base course with a compacted thickness 40 millimetres to 50 millimetres, and
3. asphalt wearing course with a minimum compacted thickness of 25 millimetres.

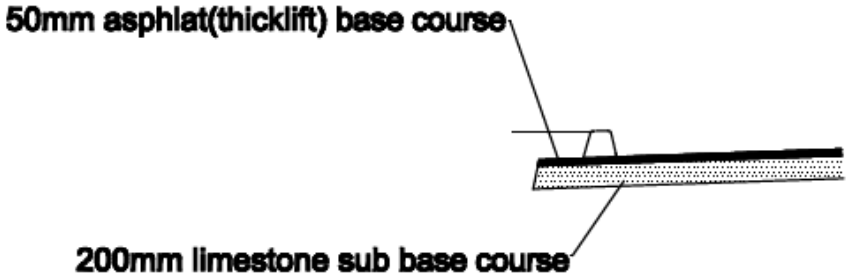
FIGURE 3.5: ALTERNATIVE BASE COURSE PROFILE



Source: IPWEA Guide to Pavement Profiles in Residential Streets

Asphalt thicknesses should conform to 30 millimetres for AC14, 25 millimetres for AC10 and 40 millimetres minimum for AC14.

FIGURE 3.6: ALTERNATIVE CROSS-SECTION WITH NO WEARING COURSE



Source: IPWEA Guide to Pavement Profiles in Residential Streets

In some areas there is also a minimum pavement thickness of 100 millimetres, which is shown on the Australian Road Research Board and MRWA Equivalent Standard Axles (ESA) versus Californian Bearing Ratio (CBR) and Pavement Thickness. This depth of pavement however, is not recommended where any reasonable traffic volumes are in service.

3.3.10 Rural base course profiles

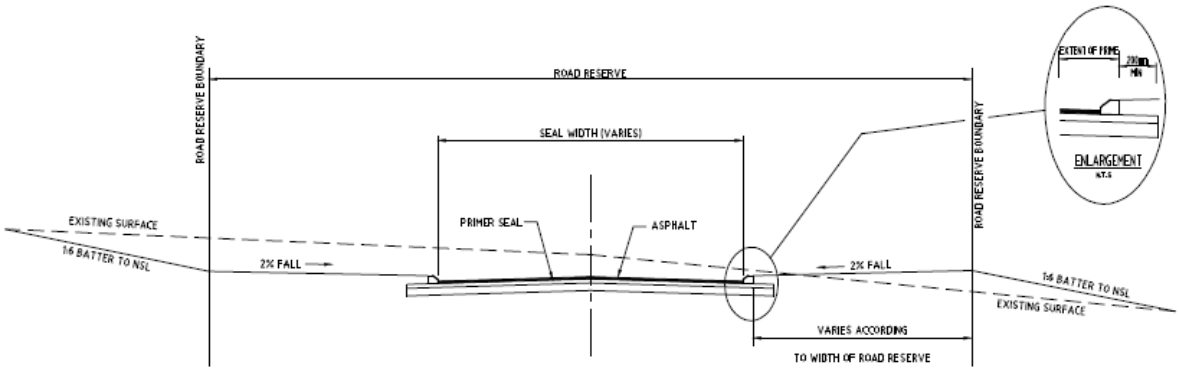
In the rural situations the base profile is not necessarily split into two mediums (limestone and roadbase or thicklift asphalt) but is one medium – typically being laterite as a full depth base course. Ferricrete and full depth road base pavements can also be constructed depending on availability of materials and cost.

It should be noted that the base course profiles used in the urban areas can also be used in rural areas where materials are available and are cost effective in comparison to the full depth base-course materials. Where alternative materials are required then the depth of base courses may vary by design based on the mechanistic properties of the materials in question.

3.3.11 Typical cross-sections

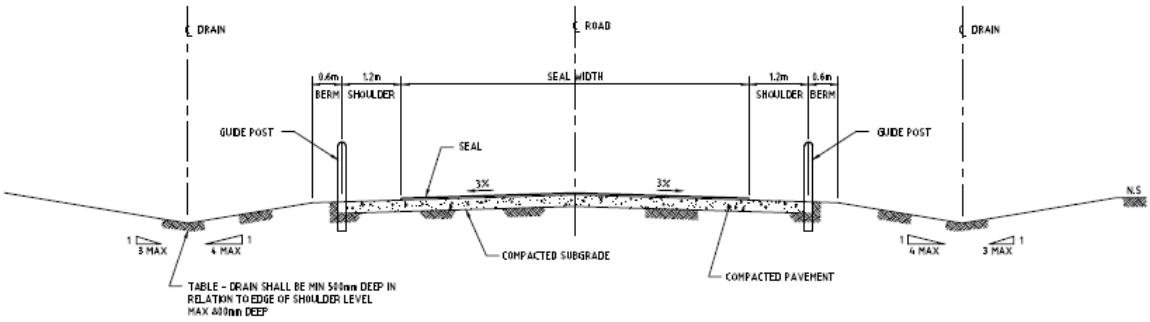
Figures 3.7, 3.8 and 3.9 show basic cross-sections for roads. These will change with road layouts and the environment in which the road is to be constructed.

FIGURE 3.7: TYPICAL CROSSSECTION – URBAN RESIDENTIAL AREAS



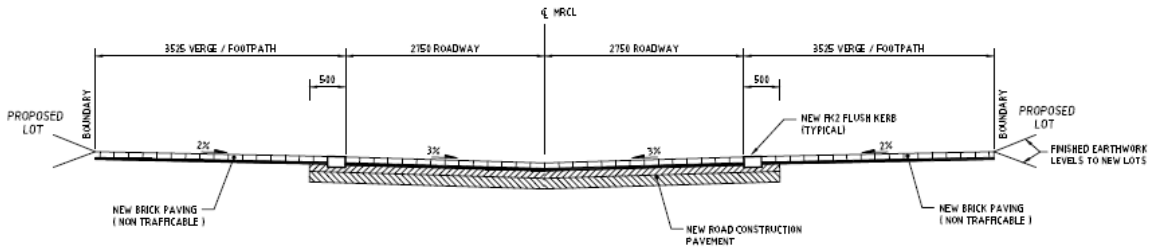
TYPICAL CROSS SECTION - URBAN RESIDENTIAL AREAS
N.T.S

FIGURE 3.8: TYPICAL CROSS-SECTION – RURAL RESIDENTIAL AREAS



TYPICAL CROSS SECTION – RURAL RESIDENTIAL AREAS
N.T.S

FIGURE 3.9 TYPICAL 'VEE DRAINED' CROSS-SECTION



The vee drained roadway is generally constructed in access roads or places where the carriageway is narrow or the total road reserve is paved. The type of kerbing can be changed with approval of the Local Government. It is also noted that paving of a full road reserve does not necessarily comply with water sensitive urban design.

3.3.12 Wearing course

The wearing course on all urban roads shall generally be asphalt over a primer seal where road base is used as the base course.

Where thicklift asphalt replaces the roadbase then the 25 millimetres asphalt is directly applied to the thicklift.

Rural roads may be surfaced with either asphalt or a single or two coat sprayed bitumen/aggregate seal. Intersections and cul-de-sac heads shall be asphalt surfaced where asphalt is available. Where two coat seals are used the second coat may be applied after a considerable time difference depending on traffic usage and the need to have the full seal in place.

Heavy duty trafficable bricks or blocks with a minimum thickness of 76 millimetres, laid strictly in accordance with the manufacturer's recommendations and section 3.4.13, may be used to replace the wearing and base courses.

3.3.13 Traffic management – urban roads

Traffic management design shall comply with the following publications:

- Guide to Traffic Engineering Practice Parts 1–14 (Austroads)
- Turning Path Templates (Austroads, 1995).

A traffic environment shall be provided such that vehicle speeds recommended in tables 3.1 and 3.2 are not generally exceeded, with due consideration being given to the requirements of the various emergency services.

Intersections, except those being treated with roundabouts, shall be designed with the turning radii as indicated in Table 3.7.

TABLE 3.7 INTERSECTION TURNING RADII

	Integrator Category A	Integrator Category B	Neighbourhood connector	Access street
Integrator arterial Category A	ST	ST	ST	ST and SU
Integrator arterial Category B	ST	ST	ST	ST and SU
Neighbourhood connector	SU	ST	ST	SU
Access street	ST and SU	ST and SU	SU	SU

Source: Liveable Neighbourhoods, especially R57 to R61and based on Austroads design vehicles

Note 1 ST denotes a design semi-trailer with a turning path radius of 12.5 metres.

Note 2 SU denotes a design single unit truck/bus with a turning radius of 12.5 metres.

Note 3 Any road in an area zoned commercial/industrial shall be designed to accommodate a design semi-trailer.

Note 4 Designers should be aware that as transport functions of roads change there may be need at the planning stage to consider the size of vehicles using roads and how the design will be structured to suit. (eg. B doubles which are

now considered an integral part of the transport system and these access industrial areas on a regular basis). Whilst designs may not be based on such vehicles their access to areas should be considered.

Note 5 Designers should use refer to *Liveable Neighbourhoods* Element 2 Section R58 for details relating to the requirement for land correct turning movements for the design vehicles.

Note 6 Traffic management devices may be required in Access Ways and Places, where special circumstances exist, for example:- where an access way leads to a school.

3.3.13.1. Traffic speed – leg length impact

Traffic management devices can be placed in streets to ensure that desired operating speeds can be achieved. The use of slow points can achieve this goal.

Once desirable speeds for residential areas are set they then have an impact on leg lengths that should be attained to satisfy a safe environment for the community (Table 3.8).

TABLE 3.8 STREET TYPE – TARGET SPEEDS AND LEG LENGTH COMPARISONS

Street type	Target operating speed	Desirable leg length between slow points
Access street D* (6 m road width with parking on pavement)	30 km/hr	70–80 m
Access street C* (7.2m road width with parking on pavement)	40 km/hr	100–130 m
Access street A & B** (Avenue access street or Wider access street with travel lanes unconstrained by parking)	40 km/hr	100–130 m

Source: Liveable Neighbourhoods

* Additional speed constraint measures may not be needed on an access street C or D up to 200 metres in length where the traffic volume is less than 1500 vehicles per day and the street pavement width combined with the adjacent land use will generate periodic parking on the road pavement (not just on the verge).

** Slow points may include:
- the applicable street terminating at a T-intersection, or
- a street junction with the priority on the other street, or
- a roundabout with pre-deflection on the approach, or
- any other local area traffic management device that will constrain speeds to 20 km/hr to 30 km/hr.

Refer to MRWA Guidelines for Local Area Traffic Management devices August 2003, Austroads Part 10 Local Area Traffic Management revision (when finalised) or Public Transport Authority Traffic Management and Control Devices (bus routes).

Target speed limits are for design purposes and their implementation is part of the design process. Physical traffic management devices can ensure that target speed limits are attained. Posting speed limits on signs may have limited effect and it is recommended that where target speed limits are crucial to create the safe environment then physical speed restricting devices form part of the design.

3.3.14 Parking provisions

Parking facilities should take into account the following documents and the specification on development densities and the consolidation of parking embayments and numbers:

- Guide to Traffic Management Austroads Part 11 Parking;
- Australian/New Zealand Standards (for on street and off street parking);
- WAPC Residential Design Code;
- *Liveable Neighbourhoods*; and
- AS 2890.5 – On-street car parking
- AS 2890.1 – 2004 Parking Facilities – Off-Street Car Parking

Roads abutting public open space and schools shall be provided with a car parking embayment at appropriate locations. Such embayments may be designed to accommodate either angle parking or parallel parking, depending upon the available verge width, length of road frontage and the class of road on which the public open space or school is situated.

Designers should be aware that parallel parking is recommended over angle parking based on safety issues with children not having to access vehicles by being in between parked and moving vehicles.

The design of subdivisional roads abutting school sites shall incorporate provision for the safe and convenient pick up and set down of students.

Some changes in planning structure plans, small lot developments and increased densities also gives rise to the need for structured on street parking as onsite parking areas are limited.

The provision of appropriate turning and manoeuvring areas within a car park will be required. The designer will be required to submit turning path plots for the design vehicle defined in Appendix B of AS 2890.1 in conjunction with the design where manoeuvring areas will be restricted.

The location and layout of car parks should be optimised by considering the following:

- concentrate car parks to the rear of buildings and/or divide large car parks with buildings, covered walkways, open space or plantings;
- on sloping sites locate car parks on terraced levels designed to a maximum gradient of 1 in 10 for sites where shopping trolleys will be used;
- prioritise the pedestrian in the layout by providing pedestrian walkways through the car park;
- provide pedestrian entrances to premises with wheel chair and trolley ramps;
- locate wheel stops to prevent vehicle overhang on to walkways and road reserves or provide sufficient width to pathway;
- clearly identify entry and exit points and traffic routes;
- provide pedestrian set-down bays and public transport stops;
- orientate parking bays and shade tree planting patterns to optimise the seasonal shade patterns and minimise the glare from afternoon sun;
- incorporate water sensitive urban design infrastructure within car parks. Examples include tree-pits in tree stations, vegetated swales and biofilters in landscaped medians and bordering garden beds, pervious paving for parking bays, and underground stormwater detention and reuse tanks and
- landscaping is to be provided as detailed in the Landscape Design section of this manual.

3.3.15 Eyebrow treatments

Eyebrow treatments shall be provided at right angle bends on roads where lot boundaries and frontages are arranged in such a manner as to create an irregular verge area. This is to be implemented where the access to lots is designed such that normal access at right angles to the roadway is not possible. This generally occurs on loop roads.

3.3.16 Verge management – rural roads

In the development of rural and special rural subdivisions much of the aesthetic and environmental amenity of the subdivision may depend upon the conservation of the roadside vegetation. Some of the positive values of roadside vegetation include:

- existing roadside flora is usually stable and requires little management;
- it is less of a fire hazard than weeds and therefore takes less effort to maintain;
- the reduction of sunlight and the competition provided by roadside shrubs and trees can suppress the growth of weeds;
- roadside flora assists in erosion control; and
- remnant native roadside vegetation provides a habitat and shelter for native animals and birds.

To minimise the detrimental effects of disturbing roadside vegetation the following matters should be considered in conjunction with the ultimate safety and efficiency of the road system:

- a reduced standard of vertical alignment will decrease the damage caused by cuttings and embankments;
- the generally accepted batters for cuttings and embankments may be varied to reduce the space occupied by earthworks;
- table drains may be modified or deleted where natural surface levels are below the road surface, soil is suitable and no concentration of run-off occurs;
- imported fill may be used for embankments as an alternative to borrow from alongside the road;
- special environmental areas that contain rare flora should be avoided;
- vary the clearing width to accommodate only the space actually required for earthworks and retain stands of vegetation;
- minor variations of the road alignment may reduce the disturbance of an area of significant vegetation;
- roadside flora should be protected against damage from manoeuvring or parking of construction vehicles and/or machinery;
- avoid dumping weed contaminated soil in areas of natural vegetation;
- cleared vegetation should not damage existing roadside flora;
- methods of establishing regrowth on areas disturbed during road works and on erosion prone areas;
- the timing of construction works has an important bearing on the preservation of natural revegetation;
- cleared vegetation should be stacked in a manner that does not damage existing roadside flora and that burning of such vegetation is discouraged (refer section 2.2.1.5.6); and
- use of kerbing and separated drainage routes can also assist in protecting roadside vegetation.

3.3.17 Battleaxe access legs

3.3.17.1. General

Where urban, industrial or rural subdivisions contain lot(s) to which access is provided by a distinct access leg, then that access leg shall be constructed in accordance with these guidelines. Battleaxe leg widths are determined by the WAPC.

3.3.17.2. Urban areas

Where urban, industrial or rural subdivisions contain lot(s) to which access is provided by a distinct access leg, then that access leg shall be constructed in accordance with these guidelines. Battleaxe leg widths are determined by the WAPC.

Battleaxe pavements shall be constructed in accordance with the Local Governments requirements. In the rural areas the previous materials can be used to seal a battleaxe leg but it is also permissible to use a two-coat seal. Sufficient verge width for all services shall be allowed in all cases.

Where a battleaxe leg is unsealed and connects to a sealed roadway it shall be sealed for a minimum of the first 5–6 metres.

The access leg shall be drained to ensure that no stormwater from the access way flows on to the frontage road, into the lot, or into any abutting lots.

Stormwater can be collected and piped into the subdivisional drainage system or collected into an approved soakage system located within the access leg.

Where verge widths are not available for public utilities to be installed at a later date the developer, with the approval of the Local Government and the public utilities, can lay conduits under the roadway with draw wires where applicable.

Drainage of the battle axe leg to the subdivisional drainage system can only be permitted where this has been allowed for in the overall drainage strategy for the area. Otherwise on-site retention/detention measures will have to be implemented. Consultation with the Local Government is required to determine drainage requirements.

Battleaxe widths shall be consistent with Liveable Neighbourhoods. Battleaxe pavements shall be constructed in accordance with the Local Government's specifications.

3.3.17.3. Rural areas

In semi or special rural developments the access leg and pavement widths shall be in accordance with the specifications shown in Table 3.9.

TABLE 3.9: ACCESS LEG AND PAVEMENT WIDTHS

Lot size	1000 m^2–2 ha	2 ha–5 ha	>5 ha
Min. access leg width single lot	5 m	6 m	7 m
Min. access leg combined width two lots	4 m	5 m	6 m
Min. pavement width single lot	4 m	4 m	4 m
Min. pavement combined width two lots	3 m	3 m	3 m
Width of shoulders	500 mm	500 mm	500 mm

Source: Liveable Neighbourhoods

The minimum standard for semi or special rural access leg pavements shall be a bitumen aggregate seal.

In general, the minimum width of access legs in rural areas shall be 10 metres with a pavement width of 3.5–5 metres, depending on the number of lots serviced by the access leg.

In rural subdivisions where the access leg services a single lot and there is no requirement for dust suppression, the minimum construction standard is compacted gravel, limestone or equivalent pavement.

In those cases where the access leg services two or more lots in a rural subdivision, the access leg shall be sealed with an aggregate seal. The minimum width of seal shall be four metres with 500 millimetres wide shoulders on both sides.

Appropriate drainage to battleaxe access legs in rural areas shall be provided.

3.3.17.4. Industrial subdivisions

Under WAPC Policy DC 4.1, it is noted that shared battleaxe legs are not permitted in industrial subdivisions.

3.3.18 Signs and pavement marking

3.3.18.1. Regulatory and traffic control signs

MRWA is the responsible authority for all traffic control signs and pavement marking. Temporary warning signs for road works are the responsibility of the party undertaking the works.

The consulting engineer shall request approval from the Local Government prior to submitting plans to MRWA for signs and pavement markings. The submission should include contact officers for both the design and construction of the works. The consulting engineer shall also forward two copies of the traffic design drawings showing clearly the full extent of the works. Prior to any signs and lines being installed on the project the developer shall have MRWA approval of the appropriate drawings. The drawings to scale 1:250 (or 1:500 for larger road sections) shall comply with:

- MRWA Design Guidelines for Channelisation Pavement Markings and Regulatory Signing;
- Austroads Guide to Traffic Control Devices; and
- Australian Standard AS 1742.3 – Manual of Uniform Traffic Control Devices.

Where traffic signs and/or road line marking are required and MRWA has approved the design plan, the developer shall arrange for the signs and line marking to be installed. All signage including posts are to be designed and installed in accordance with the appropriate standard.

3.3.19 Special design requirements

3.3.19.1 Temporary turning circles

Where a road is not constructed for its full length, a temporary turning circle with an inner radius measurement agreed to by the Local Government shall be constructed to base course

standards at the termination point. A “no through road” sign shall be installed at the intersection where traffic is likely to enter the road and a chevron sign indicating the termination of the road shall also be installed.

Temporary turning circles are to be located wholly within the road reserve or balance lot created as part of the subdivision.

Where a road is required to extend into an adjoining property to allow for future road construction, the road shall be fully constructed to the property boundary and the temporary turning circle shall be located in the adjoining lot. The following is required:

- A written agreement between the land owner and the Local Government that allows turning movements within the private land or
- A formal easement is to be implemented.

Where the road is less than 20m in length, the Local Government will determine whether a temporary turning circle is required.

3.3.19.2 Work on existing roads

The Contractor is responsible for the preparation, installation and maintenance of an approved traffic management plan for any road works on a public road until all works have been completed and it has been fully line marked and the signs installed.

Warning Signs, indicating the changed traffic conditions are to be erected in accordance with AS 1742.2 Part 3.11.3.5.

Where work on an existing road is required as part of a development and the work involves changing the level or alignment of the existing road, the developer shall fulfil the requirements of Section 3.51 of the *Local Government Act 1995*. This includes a requirement to consult with the owners of the affected properties and negotiate an agreement on any accommodation works required.

3.3.19.3 Island treatments

The finished infill treatment for traffic islands is to be discussed and agreed with the Local Government. All paving shall be trafficable.

3.4 Materials specifications

These guidelines refer to materials that are readily available within the metropolitan area. This may not be the case however, in the regional areas and substitute materials will be required.

The characteristics of the materials referred to in these guidelines give rise to mechanistic properties that allow them to carry vehicular, cycle and pedestrian loads. Alternative materials must display the ability to carry the same loads to the satisfaction of the Local Government prior to them being used as substitute materials for road and pathway construction.

For example, pavement depths may require extra depth where the mechanistic characteristics of a substitute material does not equal the materials specified in these guidelines. These characteristics can be demonstrated through standard materials testing and the appropriate comparisons being made to those in the guidelines.

3.4.1 Saline environments

The consulting engineer/contractor shall be diligent in design and construction of all roads, drainage and associated structures in salt environments.

Any proposal to use saline water in the preparation of all concrete and mortar mixes, spray seals and road pavements should be carefully considered. Such proposals will need to be supported by appropriate commentary from a geotechnical engineer experienced in pavement construction.

The contractor shall ensure the total soluble salts content is less than 3000 mg/litre (total dissolved salts for use in construction) and shall provide evidence of construction water salt contents.

3.4.2 Crushed limestone

3.4.2.1. General

Crushed limestone shall be obtained and crushed to comply with the grading in this specification. The limestone shall be free from sand, loam, capstone, roots and other foreign material and shall not contain either oversize spalls or an excessive proportion of fine grained material.

3.4.2.2. Testing

Methods of sampling and testing of crushed limestone shall be in accordance with the following Australian standards (AS):

- AS 1141: Methods of Sampling and Testing Aggregates
- AS 1289: Methods of Testing Soils for Engineering Purposes

3.4.2.3. Properties

When tested the crushed limestone shall conform to the following requirements:

- A resistance to abrasion when determined in accordance with the Los Angeles Abrasion Test to show a weight loss not exceeding 60 per cent nor less than 20 per cent.
- Calcium carbonate content shall not be less than 60 per cent or more than 80 per cent by weight.

3.4.2.4. Grading

The crushed limestone for sub-base shall comply with the grading requirements shown in Table 3.10.

TABLE 3.10: LIMESTONE SUB-BASE

Sieve Size	Percent Passing By Weight
(Square Opening AS Sieve)	
75 mm	100 %
19 mm	50–75%
2.36 mm	30–50%
0.075 mm	0–15%

3.4.3 Bitumen emulsion

3.4.3.1. Bitumen emulsion – specification

The bitumen emulsion shall be of an approved slow breaking anionic type and shall contain only water, emulsifying agents and Class 170 bitumen. No other materials shall be present. The bitumen content shall be a minimum of 60 per cent.

3.4.4 Bitumen stabilised limestone

3.4.4.1. General

The specification for the limestone shall be as per section 3.4.2 – Crushed limestone.

3.4.4.2. Bitumen stabilised limestone specification

The bitumen stabilised limestone shall be supplied from an approved source (which can provide material to the specifications under the contract) and shall be a thoroughly mixed and homogenous mixture when delivered to the site. The mixture shall contain a minimum of two per cent residual bitumen by weight of the limestone.

The product shall conform to the following requirements:

- maximum dry density (Modified ASSHO) – 1750 kg/cubic metre minimum; and
- maximum dry compressive strength (unconfined, cured 1 day and oven dried for 16 hours) – 10.5 kPa minimum.

The stabilised material shall be mixed for such a length of time to ensure even dispersion of the bitumen emulsion.

3.4.5 Gravel

3.4.5.1. General

A gravel base course shall consist of a combination of soil binder, sand and laterite gravel and shall conform with this specification. It shall be free of vegetable matter and lumps or balls of clay and shall not contain excessive quantities of pyrites or other foreign substances.

3.4.5.2. Properties

Coarse aggregate retained on a 2.36 millimetres sieve shall consist of hard, durable particles or fragments of gravel. Materials that break up when alternatively frozen and thawed or wetted and dried shall not be used.

Coarse aggregate shall have a percentage wear by the Los Angeles Abrasion Test of not more than 45 per cent.

Fine aggregate passing a 2.36 millimetres sieve shall consist of natural or crushed sand and fine mineral particles passing the 0.065 millimetres sieve.

The ratio of the portion passing the 0.075 millimetres sieve to the portion passing 0.425 millimetres sieve shall fall within the range 40–60 per cent.

The portion of the sample which passes the 0.425 millimetres sieve (soil mortar) shall conform to the requirements shown in Table 3.11, when tested in accordance with *AS 1289: Methods of Testing Soils for Engineering Purposes*.

TABLE 3.11: SOIL TESTING

Property	Value
Plastic limit shall not exceed	20
Liquid limit shall not exceed	25
Plasticity Index shall not exceed	5
Linear shrinkage shall not exceed	1%
Dry compressive strength shall not be less than	1.75 MPa
Dust ratio shall not exceed	0.67

3.4.5.3. Grading

The grading of the gravel shall conform to the requirements shown in Table 3.12.

TABLE 3.12: GRAVEL GRADING

Sieve size (Square opening AS Sieve)	Percentage by weight passing
19 mm	100%
4.75 mm	45–65%
2.36 mm	30–50%
0.425 mm	12–30%
0.075 mm	0–12%

3.4.6 Fine crushed rock (roadbase)

3.4.6.1. General

Crushed rock material shall be quarried from an approved source and shall consist of quartzite, granite, diorite, ironstone or other stone of approved hardness and durability. It shall be free from clay lumps and excess organic matter or other foreign material. It shall be freshly blended prior to delivery.

3.4.6.2. Grading

The grading of the portion passing a 19 millimetres sieve shall conform to the requirements shown in Table 3.13.

TABLE 3.13: GRADING 19 MILLIMETRES AS SIEVE

Sieve size (square opening AS Sieve)	Percent by weight passing
19 mm	100%
9.5 mm	70–80%
4.75	40–65%
2.36	30–50%
0.425 mm	12–30%
0.075 mm	3–12%

The ratio of the portion passing 0.075 millimetres sieve to the portion passing 0.425 millimetres sieve shall fall within the range of 40–60 per cent. The portion of the total sample retained on

the 19 millimetres sieve shall not exceed five per cent of the total sample.

3.4.6.3. Properties

The portion of the sample which passes the 0.425 millimetres sieve (soil mortar) shall conform to the following requirements shown in Table 3.14 when tested in accordance with *AS 1289: Methods of Testing Soils for Engineering Purposes*.

TABLE 3.14: GRADING AS 0.425 MILLIMETRES SIEVE

Soil characteristic	Value
Plastic limit shall not exceed	20
Liquid limit shall not exceed	25
Plasticity index shall not exceed	5
Linear shrinkage shall not exceed	1%
Dry compressive strength shall not be less than	1.75 MPa
Dust ratio shall not exceed	0.67

3.4.7 Ferricrete

The base course material known as ferricrete shall consist of a blend of crushed massive ferricrete and natural ferricrete gravel conforming with the requirements of this specification. The proportion of crushed material shall be not less than 60 per cent.

The source rock shall be massive ferricrete meeting the following requirements.

Los Angeles Abrasion= 45% or less

or

Point Load Index I50 = Average of tests on 20 samples to be not less than 0.5Mpa

Source rock shall be durable material, which does not break-up when alternately wetted and dried.

The portion of sample passing a 0.425 millimetres sieve shall conform to the following requirements:

Liquid limit = 30 or less
Plasticity index = 6 or less
Linear shrinkage = 3% or less

The ratio of the percentage passing a 0.075 millimetres sieve to the percentage passing a 0.425 millimetres sieve shall fall within the range 0.4 and 0.6.

3.4.8 Recycled materials for base course construction

It is recommended that the IPWEA/WALGA Specification for the supply of recycled road base is considered when using recycled materials. However approval is subject to a certification from a NATA Certified materials testing laboratory confirming the material as suitable for use as base course.

3.4.9 Bitumen

3.4.9.1. General

The bitumen shall be a straight run slightly blown bitumen distilled from asphaltic base petroleum. The grade shall be Class 170 (140–200 Pascal second viscosity at 60°C) and comply with *AS 2008: Residual Bitumen for Pavements*.

3.4.9.2. Bitumen emulsion

Bitumen emulsion shall conform as regards physical qualities, sample and testing with *AS 1160: Bituminous Emulsions for the Construction and Maintenance of pavements for Class 50 bitumen*. The bitumen content shall be a minimum of 60 per cent.

3.4.9.3. Medium curing cutting oil

Medium curing cutting oil shall be a petroleum product conforming to the requirements shown in Table 3.15.

TABLE 3.15: MEDIUM CUTTING CURING OIL SPECIFICATIONS

PROPERTY	REQUIREMENT
Distillation	
Initial boiling point	132°C–160°C
Final boiling point	265°C max
Temperature at 50% recovery	220°C max
Flash point open	35°C min
Relative density at 25°C	0.78–0.92 kg/l
Miscibility with equal parts of class	Complete
160 bitumen	No precipitation
Percentage of aromatics (% vol)	15% min
Water content	0.05% max
Viscosity at 40°C	1.0–1.4 mm^2/s

3.4.9.4. Fluxing oil

Flux oil shall be the recognised petroleum products furnace fuel oil conforming to the requirements shown in the following sections.

3.4.9.4.1. Property requirements

The distillation properties are shown in Table 3.16.

TABLE 3.16: PROPERTY REQUIREMENTS

Property	Value
Distillation	
Initial boiling point	190°C min
Temperature at 50% recovery	320°C min
Viscosity at 50°C	50–100 mm^2/s
Flashpoint	65°C min
Miscibility with equal parts of class	Complete

170 bitumen	No precipitation
Water content	0.5% max
Sulphur content	3.5% max
Sediment content	0.15% max
Pour point	65°C max

3.4.10 Polymer modified binder

There are many types of binders and polymer binders. Tables 3.17, 3.18, 3.19 and 3.20 provide some specifications for the most commonly used modified binders.

Source: AAPA – Shell Oil Company

TABLE 3.17: POLYMER MODIFIED BINDERS FOR SPRAYED SEALING

Test Method	Minimum Testing Frequency [1]	CLASS / Binder Property	S10E	S20E	S25E	S35E	S45R	S55R
AG:PT/T1 21	3-monthly [2]	Consistency at 60°C (Pa.s) min.	**400** [5, 11]	**2000** [4]	**6000**	**350** [11]	**1800**	**4000**
AG:PT/T1 21	3-monthly [2]	Stiffness at 15°C (kPa) max. [6]	140	130	95	160	180	140
AG:PT/T1 42	Weekly	Rubber content by analysis (%)	NA[3]	NA	NA	NA	TBR	TBR
AG:PT/T1 32	3-monthly	Compression limit at 70°C, 2 kg (mm) min.	NA	NA	NA	NA	0.2	0.2
AG:PT/T1 21	3-monthly	Elastic recovery at 60°C, 100 s (%) min.	NA	NA	85	NA	25	35
AG:PT/T1 21	3-monthly	Elastic recovery at 15°C, 100 s (%) min. [6]	NA	NA	65	NA	30	50
AG:PT/T1 24	3-monthly [2]	Toughness at 4°C, 100 mm (Nm) min.	TBR [7]	TBR	TBR	TBR	TBR	TBR
AG:PT/T1 11	Each batch	Viscosity at 165°C (Pa.s) max. [8]	0.55	0.55	0.8	0.55	4.5 [10]	4.5 [10]
AG:PT/T1 12	Annually	Flash point (°C) min.	250	250	250	250	250	250
AG:PT/T1 03	Annually	Loss on heating (% mass) max.	0.6	0.6	0.6	0.6	0.6	0.6
AG:PT/T1 22	Each batch [9]	Torsional recovery at 25°C, 30 s (%) min.	22	50	52	16	25	30
AG:PT/T1 31	Each batch [9]	Softening point (°C) min.	48	65	80	48	55	62
Other	Each batch	Other as proposed by supplier (e.g. penetration, ductility recovery)	TBR	TBR	TBR	TBR	TBR	TBR

Notes to Table 5.1

1. Testing frequencies provided are suggested minima. Different testing frequencies may be agreed between the purchaser and the supplier.
2. For classes S10E and S20E, this minimum testing frequency shall be 1-monthly.
3. 'NA' throughout indicates that the property is considered not applicable for that PMB class.
4. Manufacturers shall aim for a target consistency of 3200 Pa.s at 60°C for S20E within the range 2000 to 5000 Pa.s.
5. Manufacturers shall aim for a target consistency of 450 Pa.s at 60°C for S10E within the range 400 to 600 Pa.s.
6. AG:PT/T1 21 (for determining stiffness and elastic recovery at 15°C) is under trial, hence the specified values are experimental, and must be agreed between the purchaser and supplier.
7. 'TBR' throughout = to be recorded.
8. The shear rate involved in determining viscosity by AG:PT/T1 11 should be calculated and reported.
9. The specified 'As Manufactured' limits for Softening Point and Torsional Recovery are to be used as the 'Point of Delivery' control properties.
10. To assist the binder user determine the quantity of added cutter oil required for spraying, the manufacturer must report on the effective concentration and type of process oil used in the formulation.
11. Consistency at 60°C of S10E and S35E shall be determined using Mould B with a breakpoint of 5 mm and a test speed of 1.5 mm/s.

TABLE 3.18: POLYMER MODIFIED BINDERS FOR ASPHALT APPLICATIONS

Test Method	Minimum Testing Frequency [1]	CLASS / Binder Property	A25E	A35P	A20E	A15E	A10E [7]
AG:PT/T1 21	3-monthly	Consistency at 60°C (Pa.s) min.	600 [6]	2400	2200	8000	12000
AG:PT/T1 21	3-monthly	Stiffness at 25°C (kPa) max. [2]	45	120	35	30	30
AG:PT/T1 24	3-monthly	Toughness at 4°C, 100 mm (Nm)	TBR [3]	TBR	TBR	TBR	TBR
AG:PT/T1 11	Each batch	Viscosity at 165°C (Pa.s) max. [4]	0.6	0.6	0.6	0.9	1.1
AG:PT/T1 12	Annually	Flash point (°C) min.	250	250	250	250	250
AG:PT/T1 03	Annually	Loss on heating (% mass) max.	0.6	0.6	0.6	0.6	0.6
AG:PT/T1 22	Each batch [5]	Torsional recovery at 25°C, 30 s (%) min.	17	6	38	58	60
AG:PT/T1 31	Each batch [5]	Softening point (°C) min.	52	62	65	82	88
Other	Each batch	Other as proposed by supplier (e.g. penetration, ductility recovery)	TBR	TBR	TBR	TBR	TBR

Notes to Table 5.2

1. Testing frequencies provided are suggested minima. Different testing frequencies may be agreed between the purchaser and the supplier.
2. AG:PT/T1 21 (for determining stiffness at 25°C) is under trial, hence the specified values are experimental, and must be agreed between the purchaser and supplier.
3. 'TBR' throughout = to be recorded.
4. The shear rate involved in determining viscosity by AG:PT/T1 11 should be calculated and reported.
5. The specified 'As Manufactured' limits for Softening Point and Torsional Recovery are to be used as the 'Point of Delivery' control properties
6. Consistency at 60°C of A25E shall be determined using Mould B with a breakpoint of 5 mm and a test speed of 1.5 mm/s.
7. A10E is a specialty binder not recommended in standard applications. For applications using this high modification binder, discuss technical requirements with the manufacturer.

Source: AAPA – Shell Oil Company

Property	Method	M1000/320 (1)	M500/170 (1)
Viscosity at 60°C (Pa.s) (5)	AS2341.2	report	400 – 600 (2)
Penetration at 25°C 100 g, 5 s, (pu)	AS2341.12	report	65 min (2)
Viscosity at 135°C (Pa.s)	AS2341.2	1.5 max	1.0 max
Viscosity at 60°C after RTFOT (Pa.s) (4, 5)	AG:PT/T1 03 AS2341.2	3,500 - 6,500 (3)	report
Penetration at 25°C after RTFOT 100 g, 5 s, (pu) (4)	AG:PT/T1 03 AS2341.12	26 min (3)	report
Matter insoluble in toluene (% by mass)	AS2341.20	1.0 max	1.0 max
Flashpoint (°C)	AS2341.14	250 min	250 min
Density at 15°C (t/m^3)	AS2341.7	report	report
Ductility at 15°C after RTFOT (mm) (4)	AG:PT/T1 03 AS2341.11	report	report
Loss on heating (% max)	AG:PT/T1 03	0.6	0.6

Notes to Table 5.3

1. M1000/320 is a Multigrade Bitumen developed primarily for use in asphalt. M500/170 is a Multigrade Bitumen which may be used in both sealing and asphalt applications.
2. For the (primarily) sealing class material (M500/170), pre-RTFO viscosity and penetration values are specified. The pre-RTFO condition corresponds more closely to the condition of a sprayed binder. Post-RTFO viscosity and penetration values are also reported so that a comprehensive database of properties can be developed to assist future specification developments.
3. In the case of the asphalt class material (M1000/320), post-RTFO viscosity and penetration values are specified since the post-RTFO binder is believed to have similar properties to the binder in an asphalt at the time of placement. Pre-RTFO viscosity and penetration values are to be reported to assist future specification developments.
4. The original Rolling Thin Film Oven (RTFO) Treatment (Australian Standard 2341.10) has been modified and the new procedure including the procedure for determining loss on heating is described in Austroads test method AG:PT/T1 03. The AG:PT/T1 03 procedure should be used since improvements in between-laboratory reproducibility can be expected.
5. To improve testing precision, a schedule of Asphalt Institute vacuum capillary viscometer tubes has been provided in Austroads test method AG:PT/T1 61.

Table 5.4: Properties of Field Produced Crumb Rubber Binders

Property	Method	Minimum testing frequency	S15RF (1)	S18RF (1)	A27RF (2)
Nominal rubber concentration			15	18	25 – 30
Rubber concentration (by analysis) % min.	AG:PT/T1 42	weekly (3)	13	16	
Softening point (°C) min.	AG:PT/T1 31	weekly	55	62	
Consistency at 60°C	AG:PT/T1 21	weekly	TBR	TBR	
Torsional recovery (%) min.	AG:PT/T1 22	weekly	25	30	

Notes to Table 5.4

1. Specification for two grades of crumb rubber (see Table 5.5) available for either sealing class. Size 30 is normally used for the 'Dry mix' asphalt system.
2. 'Dry mix' asphalt is normally based on an asphalt mix design with the crumb rubber added at 25 to 30% crumb rubber in the total binder. Refer to Austroads *Guide to the Selection and Use of Polymer Modified Binders and Multigrade Bitumens* (Austroads 2005a) for more detail.
3. For sealing grades, the weekly sampling is from a sprayer load after digestion but prior to the addition of cutter oil. Samples must be free of diluents for subsequent testing to be meaningful. The agreed digestion period (at temperature) must be completed before sampling.

TABLES 3.19 and 3.20: BITUMENS AND RUBBER BINDERS

Source: AAPA – Shell Oil Company

Further major specifications are available on the Austroads website at

http://www.austroads.com.au/pavement/testmethods.html

3.4.11 Road sealing aggregates

3.4.11.1. Aggregate

The aggregate shall be crushed diorite, granite or basalt, unless otherwise approved. It should consist of clean, tough, durable fragments free from an excess of thin or elongated pieces; soft or disintegrated pieces; and dirt or other foreign matter.

3.4.11.2. Particle shape

The proportion of flat or elongated particles in any grading of course aggregate shall not exceed 20 per cent. A flat particle is one having a ratio of width to thickness of greater than three and an elongated particle is one having a ratio of length to width greater than three. There shall not be more than 2.5 per cent of particles of greater length in any direction than twice the gauge and there shall not be more than 20 per cent of particles of greater dimensions in any direction than 25 per cent in excess of the gauge.

3.4.11.3. Hardness

The aggregate shall have a Los Angeles Test abrasion value not exceeding 20 per cent of wear for diorite and basalt and 40 per cent for granite.

3.4.11.4. Specific gravity

The bulk specific gravity of the particles shall be not less than 2.9 for diorite, 2.8 for basalt and 2.6 for granite.

3.4.11.5. Elongation factor

The elongation factor, which shall be defined as the ratio of the average long dimension to the average least dimension shall not exceed 2.75 for the sample.

3.4.11.6. Method of sampling and testing

The method of testing the aggregate shall be in accordance with *AS1141: Methods for Sampling and Testing Aggregates*.

3.4.11.7. Flakiness index

The flakiness index of granite shall not exceed 30.

3.4.11.8. Grading requirements (percentage by weight)

Aggregates should conform to the properties shown in table 3.21.

TABLE 3.21: GRADING REQUIREMENTS

Size No.	1	2	3	4
NOMINAL SIZE	**14 mm**	**10 mm**	**7 mm**	**5 mm**
Passing AS mm Sieve				
37.5				
26.5				
19				
16	100			
13.2	80–100	100		
9.5	0–20	80–100	100	
6.7	0–2	0–25	80–100	100
4.75		0–2	0–30	80–100
2.36				0–30
1.18				0–0.5
600 micron				

3.4.11.9. Average least dimension requirements

The average least dimension of aggregate should comply with Table 3.22.

TABLE 3.22: AVERAGE LEAST DIMENSION

SIZE No.	1	2	3
Nominal size	8–13 mm	5–19 mm	7 mm
Average least dimension	9–13 mm	6–8 mm	4–6 mm

3.4.12 Asphalt

3.4.12.1. General

This specification is to be read in conjunction with the following documents:

- AS 2150: Hot Mix Asphalt;
- AS 2008: Residual Bitumen for Pavements;
- AS 2734: Asphalt (Hot Mixed) Paving – Guide to Good Practice;
- MRWA, Methods for Sampling and Testing of Asphalt;
- Technical Specification, Tender Form and Schedule for Supply and Laying of Hot Asphalt Road Surfacing (IPWEA/AAPA).

3.4.12.2. Specification

All asphalt pavements and wearing courses shall be laid in accordance with the IPWEA/AAPA specification. Any deviations to the listed mixes shall be at the discretion of the Local Government.

3.4.12.3. Characteristics of the asphalt design

The design for the asphalt surface course shall meet the requirements shown in table 3.23 to 3.30 (drawn from the IPWEA/AAPA specification), by weight, when determined by Australian

Standard (AS) sieves.

The residual binder (residual asphaltic bitumen), shall be determined as a percentage by weight of the total mixture.

TABLE 3.23: ASPHALT MIXES – HIGHWAYS, ARTERIAL, INDUSTRIAL AND DISTRIBUTOR ROADS

Property	Mix Designation		
	AC10	**AC14**	**AC20**
Grading Limits % passing AS Sieve			
26.5mm			100
19.0mm		100	90-100
13.2mm	100	85-100	75-90
9.5mm	90-100	70-85	60-80
6.7mm	70-90	62-75	50-70
4.75mm	58-76	53-70	40-60
2.36mm	40-58	35-52	25-43
1.18mm	27-44	24-40	18-35
600µm	17-35	15-30	14-27
300µm	11-24	10-24	9-21
150µm	7-16	7-16	6-15
75µm	4-7	4-7	3-7
Bitumen Content	5.0-7.0	4.5-6.5	4.0-6.0
Marshall Voids (%)	4.0-6.0	4.0-6.0	4.0-6.0
Voids in Mineral Aggregates (Min)	15	14	14
Refusal voids (350 cycles gyropac) 75 blow Marshal mixes only	2.5	2.5	2.5
Minimum Marshall 50 blow Stability 75 blow	6.5kN 8.0kN	6.5kN 8.0kN	6.5kN 8.0kN
Marshall Flow (mm)	2.0-4.0	2.0-4.0	2.0-4.0
Marshall Quotient (min) 50 blow (kN/mm) 75 blow	1.7 2.0	1.7 2.0	1.7 2.0

TABLE 3.24: TRAFFIC RECOMMENDATIONS – OVER 20 YEARS DESIGN TRAFFIC

Range/type	Mix	Bitumen type
Heavy truck traffic	75 blow	Class 320
Less than 2,000,000 ESA	50 blow	Class 170
Greater than 2,000,000 ESA	75 blow	Class 320
Maintenance	50 blow	Class 170
Intersections	75 blow	Class 320

TABLE 3.25: ASPHALT MIXES – RESIDENTIAL STREETS/CUL-DE-SACS/RECREATIONAL AREAS

Property		Mix Designation			
		AC5	AC7	RAC10	RAC14
Grading Limits % passing AS Sieve					
19.0mm					100
13.2mm				100	90-100
9.5mm			100	95-100	70-90
6.7mm		100	80-100	80-95	62-75
4.75mm		85-100	70-90	65-80	47-67
2.36mm		55-75	45-60	45-60	34-52
1.18mm		38-57	35-50	35-50	25-41
600µm		26-43	22-35	25-40	16-32
300µm		15-28	14-25	15-25	9-21
150µm		8-18	8-16	7-15	5-13
75µm		4-11	5-8	4-7	4-7
Bitumen Content		5.0-7.0	5.0-7.0	5.0-7.0	4.5-6.5
Marshall Voids (%)	35 blow 50 blow	2.5-4.5 3.0-5.0	2.5-4.5 3.0-5.0	2.5-4.5 3.0-5.0	2.5-4.5 3.0-5.0
Voids in Mineral Aggregate (VMA) (%) 35 blow 50 blow		-	17	16	15
Minimum Marshall Stability	35 blow 50 blow	4.0kN 5.0kN	4.0kN 5.5kN	4.0kN 6.5kN	5.5kN 6.5kN
Marshall Flow (mm)	35 blow 50 blow	2.0-5.0 2.0 - 4.0	2.0-5.0 2.0-4.0	2.0-5.0 2.0-4.0	2.0-5.0 2.0-4.0
Marshall Quotient(min) (kN/mm)	35 blow 50 blow	1.0 1.7	1.0 1.7	1.0 1.7	1.0 1.7

TABLE 3.26 TRAFFIC RECOMMENDATIONS – OVER 20 YEARS DESIGN TRAFFIC

Range/type	Mix	Bitumen type
Greater than 500,000 ESA	Use distributor road mix	
Greater than 50,000 ESA	50 blow	Class 170
Less than 50,000 ESA	35 blow	Class 170
Maintenance	50 blow	Class 170

Note: Bitumen shall be Class 170 unless otherwise approved.

TABLE 3.27: TRAFFIC RECOMMENDATIONS

Range/type	Mix
Cycle paths, basketball courts, etc. Maintenance	35 blow 50 blow

TABLE 3.28: ASPHALT MIXES: STONE MASTIC ASPHALT (SMA) – SPECIAL REQUIREMENTS (SKID RESISTANCE)

Property	Mix Designation			
	SMA 5	SMA 7	SMA 10	SMA 14
Grading Limits % passing AS Sieve				
26.5mm				
19.0mm				100
13.2mm			100	90-100
9.5mm		100	90-100	30-40
6.7mm	100	90-100	25-40	20-30
4.75mm	90-100	25-45	18-30	18-30
2.36mm	25-40	15-28	15-28	15-28
1.18mm	13-24	13-24	13-24	13-24
600µm	12-21	12-21	12-21	12-21
300µm	10-18	10-18	10-18	10-18
150µm	9-14	9-14	9-14	9-14
75µm	8-12	8-12	8-12	8-12
Bitumen Content	6.0-8.0	6.0-8.0	6.0-8.0	5.5-7.5
Marshall Voids (%) 50 blow	3-5.5	3-5.5	3-5.5	3-5.5
Voids at 80 Cycles of the Gyratory Compactor (%) (Mix Design Process only)	3-5.5	3-5.5	3-5.5	3-5.5
VMA (min) (%)	19	19	18	17
Binder Draindown (max) (%)	0.3	0.3	0.3	0.3
Cantabro Abrasion Unconditioned Loss (Max) (%) Conditioned	25 35	25 35	25 35	25 35

TABLE 3.29: SPECIAL APPLICATION RECOMMENDATIONS

Range/type	Mix	Bitumen type
Special applications requiring good, rut resistance and fatigue performance	50 blow	Class 320

Note: Recent literature and research has indicated that there may be reduced skid resistance during the early life of the stone mastic asphalt material. The literature also states that the long-term skid resistance of such material is superior to that of dense graded asphalt.

TABLE 3.30: ASPHALT MIXES – DEEP LIFT: SPECIAL APPLICATION

Property	Mix Designation			
	AC14 Base Course	AC20 Base Course	AC20 Intermediate Course	AC28 Base Cours
Grading Limits % passing AS Sieve				
37.5mm				100
26.5mm		100	100	90-100
19.0mm	100	90-100	90-100	73-88
13.2mm	85-100	71-86	71-86	58-76
9.5mm	70-85	58-75	58-75	47-67
6.7mm	62-75	46-64	46-64	37-58
4.75mm	53-70	37-55	37-55	30-50
2.36mm	35-52	24-42	24-42	20-37
1.18mm	24-40	15-32	15-32	13-28

600µm	15-30	10-24	10-24	9-22
300µm	10-24	7-17	7-17	6-16
150µm	7-16	4-12	4-12	4-10
75µm	4-7	3-6	3-6	3-6
Bitumen Content (%)	4-6	4.8-5.4	3.8-5.8	3-5
Marshall Voids (%) 75 blow	2.5-4.5	2.5-4.5	2.5-4.5	2.5-4.5
Voids at 350 Cycles of the Gyratory Compactor (%) (Mix Design Process only)	2.5	2.5	2.5	2.5
VMA (min) (%)	14	13	13	12
Minimum Marshall 75 blow Stability	8kN	8.0kN	8.0kN	8kN
Marshall Flow (mm) 75 blow	2.0-4.0	2.0-4.0	2.0-4.0 .0	2.0-4.0
Marshall Quotient(min) 75 blow (kN/mm)	2	2	2	2

3.4.13 Paving units

Paving units for paved roads shall be high temperature fired with exposed faces of an extruded, wire cut or pressed finish. Interlocking pavers are preferred where possible, for long-term reliability for evenness and level of surface. Refer to the Local Government's standard drawings for specifications.

3.4.13.1. Dimension tolerance

The paver shall be of 230 millimetres nominal length and 114 millimetres nominal width and have a minimum depth of 76 millimetres with a ±2 millimetres tolerance on all nominated manufactured dimensions, provided that the paver complies with the length to width relationship as determined by *Paver Note 1 (*Clay Brick and Paver Institute, February 1990).

Intersecting faces of pavers shall subtend an angle of 90°.

Bevelled edges of pavers shall have a plan width not exceeding five millimetres and round-edged pavers shall have an edge radius not exceeding five millimetres.

All faces including sides, ends, top and bottom, shall be free from convex or concave deformation and when tested with a straight edge, placed on any face, the deviation from the contact edge shall be less than 1.5 millimetres.

The maximum and minimum limits of length and width for a sample of 20 pavers when measured in accordance with *AS/NZS 4456: Masonry Units and Segmental Pavers – Methods of Test* shall comply with *Paver Note 1*.

3.4.13.2. Transverse strength

Transverse strength (Modulus of rupture) shall be not less than 2.0 MPa when measured in accordance with *AS/NZS 4456*. Alternatively, the minimum transverse breaking load of individual pavers shall be 5kN when measured in accordance with Appendix A of *Paver Note 1*.

3.4.13.3. Compressive strength

The minimum characteristic compressive strength shall be 30 MPa when measured in accordance with *AS/NZS 4456*.

3.4.13.4. Efflorescence

Liability to efflorescence shall be 'nil' to 'slight' when measured in accordance with *AS/NZS 4456*.

3.4.13.5. Abrasion Resistance

A sample of five pavers shall have an average abrasion index greater than 1.5 when tested in accordance with Procedure C of *ASTM C779-76: Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces*, as modified by the Perth City Council.

3.4.13.6. Pitting (lime particles)

The liability to pitting due to expansion of lime particles shall not exceed 'moderate' when measured in accordance with *AS/NZS 4556*.

3.4.13.7. Absorption

Water absorption shall be less than 12.5 per cent, and variations between pavers shall not exceed two per cent when measured in accordance with *AS/NZS 4456* (24 hour test). Variations between bricks tested in accordance with this method shall not exceed two per cent.

3.4.13.8. Resistance to salt attack

Pavers laid in areas liable to salt attack shall withstand 40 cycles of the Sodium Sulphate Test as detailed in *AS/NZS 4456*.

3.4.13.9. Permanent expansion

The estimated long-term (five years) unrestrained expansion shall not exceed 0.6 millimetres per metre when measured in accordance with *AS/NZS 4456*.

3.4.13.10. Slip or skid resistance

The slip or skid resistance (BPN) of a new paver shall be not less than 60 BPN when measured using the British Pendulum Skid Resistance Tester, in accordance with the procedure detailed in Appendix B of *Paver Note 1*.

3.4.13.11. Colour

The brick shall be the same or similar approved colour as shown on the approved drawings.

Module No. 4

Drainage Management Guidelines

4 Module No.4 – Drainage Management Guidelines

4.1 General requirements

The objective of the drainage management guidelines is to achieve best practice for managing both water quantity and quality in a sustainable way, as required by the WAPC's *State Planning Policy 2.9 Water Resources*. Reference is required of the Department of Water and Environment Regulation and the Department of Biodiversity, Conservation and Attractions for requirements. Special effort should be given to the retention and management of areas of natural significance within public open space areas

To satisfy conditions of subdivision approval relating to stormwater, developers need to liaise with Local Government and refer to the Department of Water's *Stormwater Management Manual* and the WAPC's *Better Urban Water Management* (2008) document, together with any specific information, including *Australian Rainfall and Run-off* and other standards given in this section.

4.2 Policies, standards and guidelines

4.2.1 Policies

- State Water Plan (Department of the Premier and Cabinet, Perth Western Australia, 2007).
- State Water Strategy (Department of the Premier and Cabinet, Perth Western Australia, 2003).
- State Planning Policy 1 – State Planning Framework Policy (WAPC, Perth Western Australia, 2006).
- State Planning Policy 2 – Environment and Natural Resources (WAPC, Perth Western Australia, 2003).
- State Planning Policy 2.9 – Water Resource 2006 (WAPC, Perth Western Australia) (available online).
- State Planning Policy 2.10 – Swan Canning River System (WAPC, Perth Western Australia, 2006.
- Planning Guidelines – Acid Sulfate Soils 2008 (WAPC, Perth Western Australia) (available online).
- Planning Bulletin 92 – Urban Stormwater Management (WAPC, Perth Western Australia, 2008).

4.2.2 Standards and guidelines

All drainage designs should comply with the following industry design standards:

- *Better Urban Water Management* 2008 (WAPC, Perth Western Australia).
- Urban Water Management Plans – Guidelines for preparation and compliance with subdivision guidelines (Department of Water, Perth Western Australia, 2008).

- Developing a local water management strategy (Department of Water, Perth Western Australia, 2008).
- Stormwater Management Manual for Western Australia (Department of Water, Perth Western Australia, 2004–2007). (Available online).
- Water resource considerations when controlling groundwater levels in urban development (Department of Water, 2013).
- Decision process for stormwater management in WA (Department of Water, Perth Western Australia, 2009). (Available online).
- Australian Rainfall and Run-off: A Guide to Flood Estimation (Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) , Commonwealth of Australia, 2016).
- Australian Run-off Quality: A guide to water sensitive urban design (Institution of Engineers Australia, Melbourne Victoria, 2006).
- *Liveable Neighbourhoods* – January 2009 update 02: A Western Australian government sustainable cities initiative, 4th edition (WAPC, Perth Western Australia, 2007). (Available online).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy (Australian and New Zealand Environment and Conservation Council, Canberra, Australian Capital Territory, 2000).
- Interim Position Statement: Constructed Lakes (Department of Water, Perth Western Australia, July 2007).
- Guidelines for Stormwater Biofiltration Systems (Payne, E.G.I., Hatt, B.E., Deletic, A., Dobbie, M.F., McCarthy, D.T. and Chandrasena, G.I., Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities, 2015)
- Stormwater Infrastructure Design as a Function of Road Hierarchy (Evangelisti, M., Edwards, R. and Barry, A., Perth Australia, IPEWA State Conference, 2016).
- Guildford Formation (Hillman, M., Cocks, Geoff. and Ameratunga, J., Australian Geomechanics Vol 38 No 4., December 2003).
- Stormwater Infiltration Testing in W.A. (Davies, J. R., Rogers, A.D., Bott, D.L., Serafini, G., Siew, J. and Barnett, J.C., Perth Australia, IPEWA State Conference, 2016).
- Disposal of Stormwater Runoff by Soakage in Perth Western Australia (Cocks. G., Australian Geomechanics Vol 42 No 3., September 2007
- Specification: Separation distances for groundwater controlled urban development (IPEWA, Western Australia, Version 2, February 2016).

4.3 Design

4.3.1 Drainage design objectives for water sensitive urban design

The following design criteria is to be used as a guide for development of the urban water management system for strategic planning, subdivision and development, unless other specific objectives have been defined in other approved water management plans/strategies.

Demonstration of compliance with these design objectives may be through appropriate computer modelling or other assessment methods acceptable to Department of Water and Environment Regulation. Water management will need to address water quality as well as quantity. Water quality will be essential in water sensitive locations such as rivers and wetlands and where stormwater infiltration into shallow groundwater is occurring.

Figure 4.1 demonstrates available tools and resources available to assist Local Government develop water sensitive urban design.

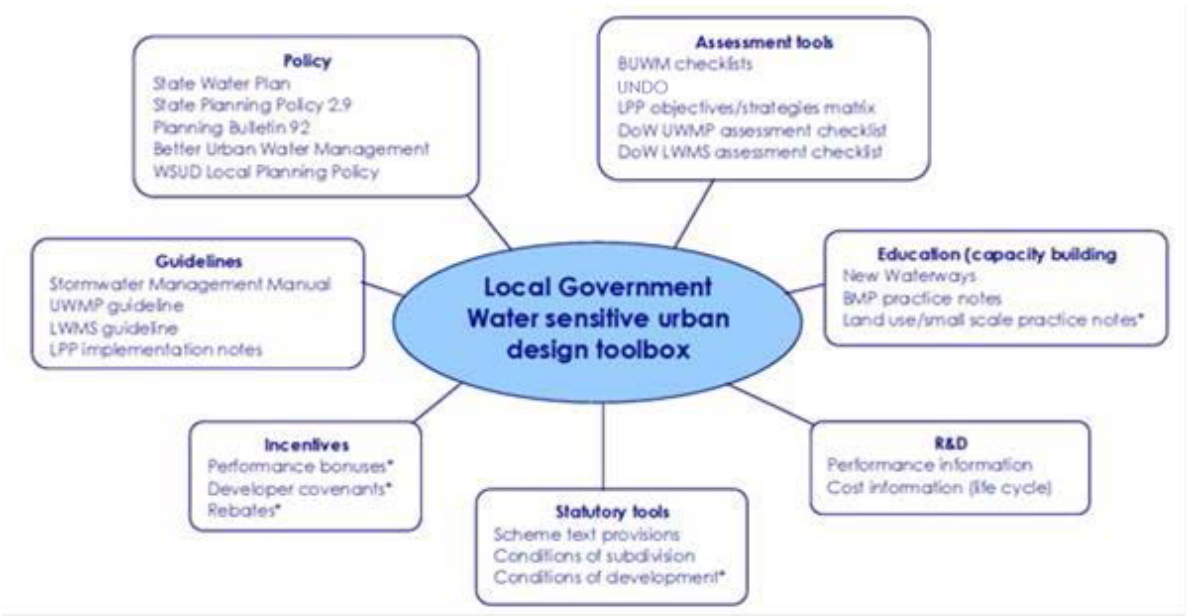


FIGURE 4.1: LOCAL GOVERNMENT WATER SENSITIVE URBAN DESIGN TOOLBOX

Source: Department of Water, 2008

4.3.1.1. Water quantity management

4.3.1.1.1. Principle

Maintain post-development annual discharge volume and peak flow relative to pre-development conditions, unless otherwise established through determination of ecological water requirements for sensitive environments.

Protect the built environment from flooding and water logging; and minimise public risk to the community, including injury or loss of life.

4.3.1.1.2. Criteria

Ecological protection – Maintain pre-development peak flow rates and total volume runoff from the outlets of the development area for the critical 1 exceedance per year (EY) event.. Desirable environmental flows and/or hydrological cycles are to be maintained or restored as specified by the Department of Water and Environment Regulation.

Minor rainfall event management – Design stormwater management systems to provide serviceability, amenity and road safety during minor rainfall events.

Flood management – Implement the flood criteria identified in Drainage and Water Management Plans published by the Department of Water and Environmental Regulation.

Maintain the 1 per cent Annual Exceedance Probability (AEP) pre-development flood regime (flood level, peak flow rates and storage volumes) for catchments that do not have a published Drainage and Water Management Plan. Alteration to the pre-development flood regime depends on the constraints of the catchment and the receiving environments. Any proposed alterations to the flood regime will require assessment and flood modelling (to the satisfaction of the Department of Water and Environmental Regulation and other relevant agencies) of the capacity of the entire system and the cumulative impacts of permitting multiple similar developments across the entire catchment.

4.3.1.2. Water quality management

4.3.1.2.1. Principle

It is necessary to maintain surface and ground water quality at pre-development levels and if possible, improve the quality of water leaving the development area to maintain and restore ecological systems in the sub-catchment in which the development is located.

4.3.1.2.2. Criteria

Contaminated sites – to be managed in accordance with the *Contaminated Sites Act 2003*.

All other land – if the pollutant outputs of development (measured or modelled concentrations) exceed catchment ambient conditions, the proponent shall achieve water quality improvements in the development area or, alternatively, arrange equivalent water quality improvement offsets inside the catchment. If these conditions have not been determined, the development should meet relevant water quality guidelines stipulated in the *National Water Quality Management Strategy (ANZECC and ARMCANZ, 2000)*.

Subsoil - Installation of water quality treatment measures should be included at controlled groundwater level subsoils and drains and/or outlet points, unless investigations demonstrate that treatment is not required (see DoW, 2013).

Drainage – Determine the water quality treatment required based on the quality of stormwater/surface water_and mobilised/discharged groundwater, potential pollutant pathways towards receiving environments and on the requirements of receiving environments.

The volume of runoff to be treated should be based on:

- Department of Water and Environmental Regulation recommendation to treat a rainfall depth value of 15 mm; or
- Alternative depth values as agreed with Local Government such as based on road hierarchy as shown in Figure 4.2 to avoid infrastructure being over or under designed.

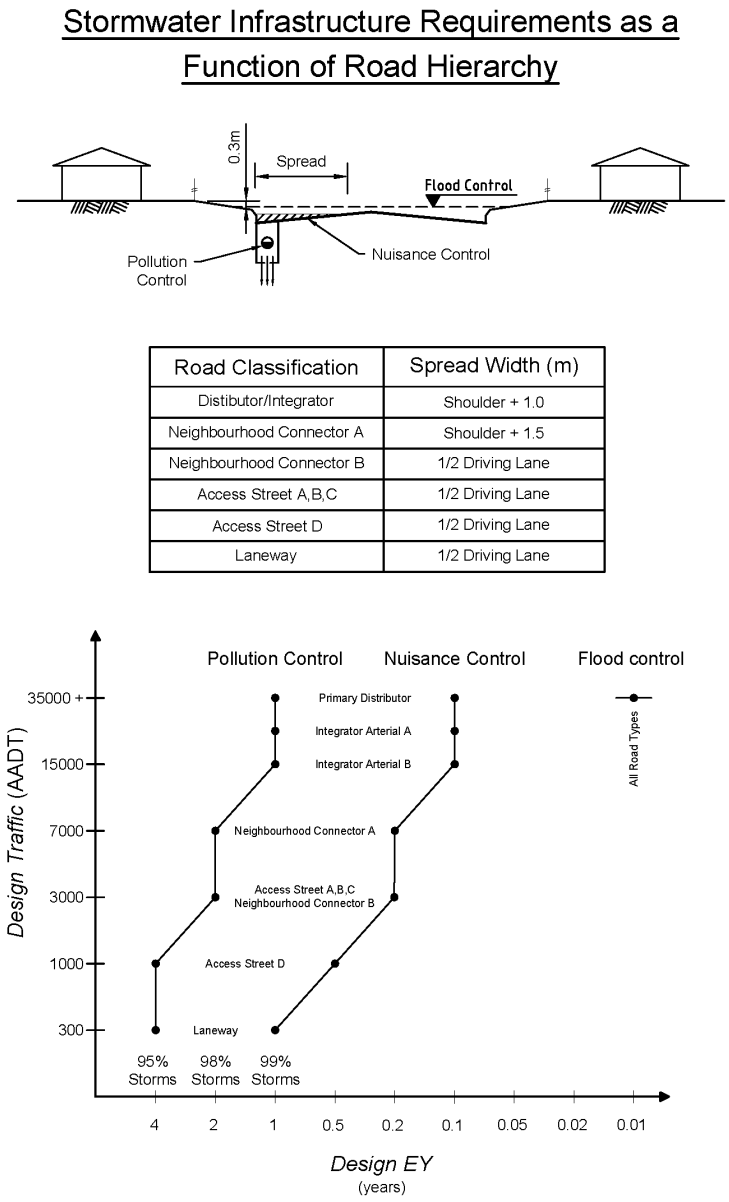


Figure 4.2: Stormwater infrastructure requirements as a function of road hierarchy
Source: Evangelisti, Edwards and Barry, 2016

Targets are to be achieved through adopting a treatment train approach and managing (retain and/or detain and treat, if required) stormwater runoff from constructed impervious surfaces generated by pollution control events at-source as much as practical.

- non-structural measures (ie. education and institutional and pollution-prevention practices) to prevent, reduce and treat pollutants;
- In areas of deep sands and deep groundwater table; lot runoff should be managed within lots and road runoff should be managed within road reserves as much as practical.
- In areas of shallow or no sands and shallow groundwater table; soils are unsuitable for disposal of lot and road runoff. Roof drainage should be connected to the local

government drainage system. Similarly sumps and/or drainage basins are unlikely to be suitable for the disposal of road run-off as described in Hillman et al. 2003).

4.3.1.2.3. Stormwater quality modelling criteria

There are a number of models and modelling software for urban stormwater quality, including the Urban Nutrient Drainage Objective (UNDO) model developed by the Department of Water. Research on stormwater quality modelling parameters appropriate for Western Australia is being undertaken through the CRC for Water Sensitive Cities and others.
Therefore the outputs of stormwater quality modelling should be used cautiously for demonstrating compliance with water quality objectives in Western Australia.

4.3.1.3. Disease vector and nuisance insect management

To reduce health risks from mosquitoes, retention and detention treatments should be designed to ensure that there is no standing water for more than 96 hours following rainfall events. Un-aerated, permanent water bodies are discouraged but where accepted by the Local Government, must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the Local Government on advice of the Departments of Water and Health.

4.3.1.4. Planning and integrated water cycle management

The planning system has a significant role to play in the achievement of total water cycle management and water sensitive urban design via strategic planning and the statutory approvals process. Better urban water management can be achieved through capacity building and assessing new development to ensure the principles and practices of integrated water cycle management are incorporated into the design and development of new urban and redevelopment areas.

The consideration of water issues must be integrated with other planning and development matters, including natural resource management issues, so that land and water planning are undertaken concurrently, rather than independently and consecutively.

The consideration of water should be founded on sustainability principles where a comprehensive range of issues is assessed using a triple-bottom-line approach.

Developers and consulting engineers are to note that Local Water Management Strategies (LWMS) and urban water management plans must be prepared for assessment and approval prior to or in conjunction with subdivision Engineering Drawings being submitted for approval.

4.3.1.4.1. State Planning Policy 2.9 Water Resources (State Government, 2006)

The *State Planning Policy 2.9 Water Resources* requires land use planning to contribute to the protection and wise management of water resources by ensuring that local and regional land use planning strategies, structure plans, schemes, subdivisions, strata subdivision and development applications take into account total water cycle management and water sensitive urban design principles.

It also ensures that development is consistent with current best management practices and best planning practices for the sustainable use of water resources, particularly stormwater, which is currently defined by the content of *State Planning Policy 2.9 Water Resources and the Stormwater Management Manual for Western Australia*. *Liveable Neighbourhoods* (WAPC, 2007) defines best planning practices for urban water management and includes specific requirements in Element five.

4.3.1.4.2. Better urban water management

Better Urban Water Management provides a framework and hierarchy of planning and water management documents to be prepared as a development proposal progresses from strategic planning to metropolitan regional scheme and town planning scheme zoning to structure planning and then to subdivision and lot development. This is outlined in the Figure 4.2.

This guideline is principally aimed at the detail required at the subdivision and development phases, however it forms part of the overall process. The designs developed utilising this guideline must be consistent with and implement the strategies, objectives and concept designs approved in the preceding district and local water management strategies.

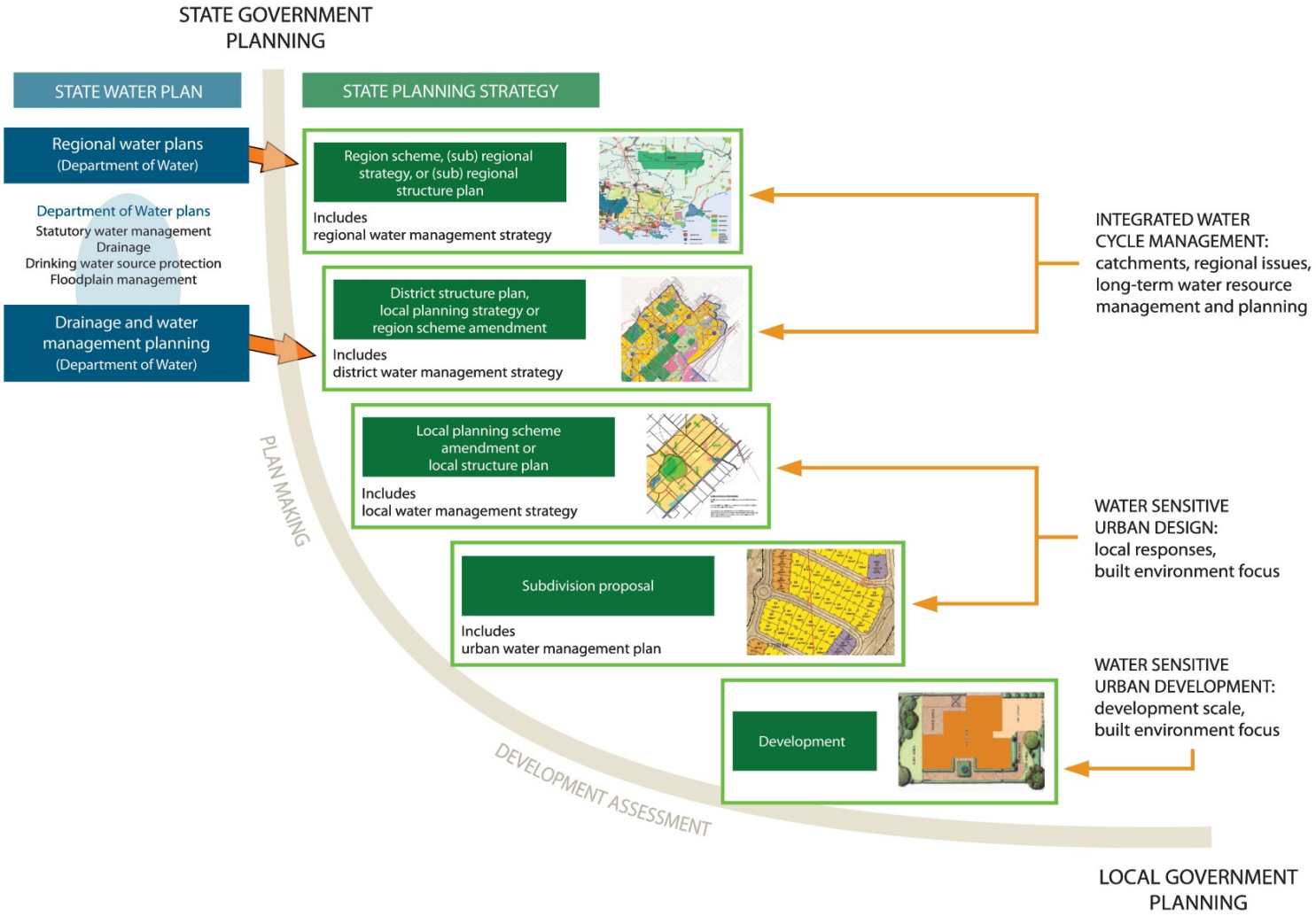


FIGURE 4.3: BETTER URBAN WATER MANAGEMENT FRAMEWORK

Source: Department of Water, 2008

4.3.2 Key elements for water-sensitive urban design

4.3.2.1. Water balance, conservation, use and efficiency

Demonstrate the understanding of how water is used across the site. Pre-development water balance should have been agreed during the structure planning, or earlier.

As described in Australian Runoff Quality (Engineers Australia, 2006), Water Sensitive Urban Design (WSUD) should focus on integrated water cycle management solutions to achieve an ecologically sustainable development, focusing on environmental protection of the receiving water bodies. WSUD objectives include:

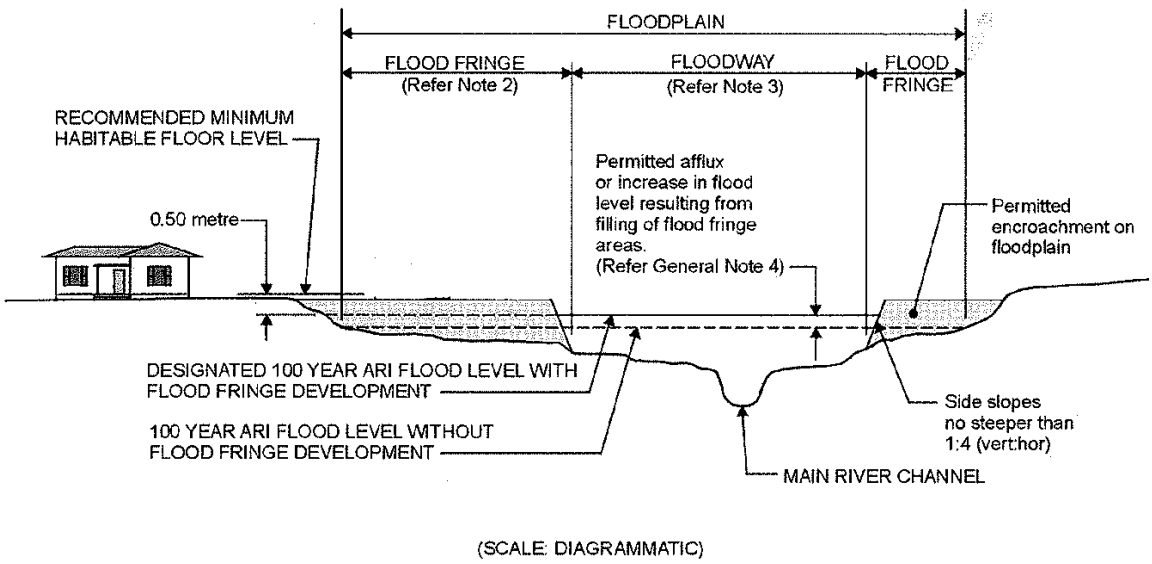
- Reducing water demand through water efficient appliances, rainwater and greywater reuse.
- Minimising wastewater generation and treatment of wastewater to a standard suitable for effluent reuse opportunities and/or release to receiving waters.
- Treating urban stormwater to meet water quality objectives for reuse and/or discharge to source and/or groundwater.
- Preserving the natural hydrological regime of catchments.

4.3.2.2. Flood protection (managing major storm events)

The development needs to conform to the following flood protection considerations.

- Demonstrate that the development is not within a floodway. Development is not permitted within flood ways; however, development may occur within a floodplain (flood fringe), but only if approved in the local structure plan.
- A minimum habitable floor levels of 0.5 metres above the adjacent 1% AEP flood level is required for new developments on adjacent to flood prone land as shown in Figure 4.3.
- In all other parts of the catchment, development can have a minimum habitable floor level 0.30 metre above the 1% AEP event level, calculated for the local drainage systems. It is advisable to check with the Local Government and to consider climate change.
- Accommodate floods events in road reserves in accordance with Figure 4.2, and public parkland, living streams, waterways and wetlands in accordance with the agreed local water management strategy.
- Identify the likely flood event flow paths, flow rates and velocities, storage volumes and areas and hydraulic grade lines, including top water levels.

RECOMMENDED FLOODPLAIN DEVELOPMENT STRATEGY



(SCALE: DIAGRAMMATIC)

GENERAL NOTES

1. The 100 year ARI flood level is expected to occur, on average, once every 100 years. Floods higher than this level will occur but will be less frequent.

2. The flood fringe is an area affected by a 100 year ARI flood. Development (ie, filling, building, etc) that is located within the *flood fringe* is considered acceptable with respect to major flooding. However, a minimum habitable floor level of 0.50 metre above the adjacent 100 year ARI flood level is recommended to ensure adequate flood protection.

3. Development (ie, filling, building, etc) that is located within the *floodway* and is considered obstructive to major flows is not acceptable as it would increase flood levels upstream. No new dwellings are acceptable within the floodway.

4. The increase in flood level that will result from total development of flood fringe areas has been calculated to be no greater than 0.15 metre.

5. A failure to properly adhere to these recommendations will result in a greater exposure to risks of flood damage.

FIGURE 4.4: FOODPLAIN DEVELOPMENT STRATEGY

Source: Water and Rivers Commission, 2000

4.3.2.3. Small rainfall events

Design

Manage, retain and/or detain, and treat (if required) stormwater runoff from constructed impervious surfaces generated by the first 15mm of rainfall at-source as much as practical.

At-source means that lot runoff is managed within lots and road runoff is managed within road reserves and the stormwater has not entered a piped or lined channel conveyance system.

Where site conditions do not allow for the full runoff to be managed at-source, manage as much as practical at-source, subject to the pre-development hydrology. Convey the remaining runoff from the lot or road reserve via overland flow wherever practical.

At-source treatment using a stormwater quality treatment system may be required depending on the pre-development environment and the post-development land uses. Determine if at-source stormwater quality treatment is required based on the:

- quality of pre-development surface water and groundwater
- quality of post-development stormwater and groundwater (mobilised or discharged)
- potential pathways towards receiving environments, by considering factors such as soil types, depth to groundwater and horizontal distance to receiving environments
- requirements of receiving environments.

If unable to manage entire small events at-source, then install off-line stormwater quality treatment systems at the outlet of pipes or lined channels that directly convey small rainfall event runoff from constructed impervious surfaces.

Ensure the emptying time of stormwater management systems is based on the type of system, requirements for prevention of disease vector and breeding of nuisance insects, and amenity requirements for useability of systems post-rainfall.

Groundwater

If groundwater management is part of the proposal, indicate the proposed controlled groundwater level. For example, through the installation of a sub-soil drain. If a controlled groundwater level is proposed close to environmentally sensitive areas, it must be shown that the new regime will be similar to that currently existing.

Treat any additional outflow of groundwater (eg. via sub-soil drainage) through a structural control, ie. bio-retention system or riparian vegetation zone (see Chapter 9 of the *Stormwater Management Manual for Western Australia* or the *River Restoration Manual for WA*) before it reaches the receiving environment.

4.3.2.4. Stormwater drainage design – general principles

Developers subdividing land for urban residential, commercial or industrial developments are required to provide a stormwater drainage system. The subdivision of rural land may also require the provision of a similar system and in low lying areas or areas subject to a high water table, sub-soil drainage may be required.

Consulting engineers should discuss with State and Local Governments the requirements for drainage of a new subdivision prior to the preparation of engineering drawings.

The consulting engineer shall examine the total drainage catchment area and ensure that any upstream drainage that may pass through the particular subdivision is included in the design and that the drainage system for the subdivision is capable of carrying the ultimate design flow from the upstream catchment. Guidance may be available from a Department of Water and

Environment Regulation drainage and water management plan or the approved local water management strategy for the development area. In instances where this guidance is not available, consultants shall follow the checklists in the guidelines for preparing local water management strategies and urban water management plans in preparing the stormwater drainage designs for the development area.

Developers are responsible for negotiating their own cost sharing arrangements.

Developers whose land shares a common drainage catchment have a shared responsibility for ensuring that the whole of the catchment including distributor roads is drained. Where development is to be staged, an overall drainage plan for the whole of the catchment is required before approval will be given to any individual stage. Drainage of each stage shall be in accordance with the overall plan.

Where a new subdivision occupies the upper part of a catchment in common with existing developed land, for which there is no overall plan, the existing drainage system of the Local Government may not be able to carry the design storms applicable to the recurrence intervals detailed in these guidelines. In these circumstances the following requirements shall apply.

- The consulting engineer shall prepare and submit an overall drainage catchment plan indicating the boundaries of the catchment and the estimated run-off from the catchment and each sub-catchment.
- The consulting engineer shall examine the complete downstream drainage network to evaluate the maximum quantity of water which may be discharged into the existing network. If the capacity of the existing drainage network is exceeded, the surplus water shall be either retained or detained within the subdivision at the upper part of the catchment, or the existing drainage system upgraded to accommodate the design run-off.

In cases where stormwater is proposed to be discharged onto private land downstream of a subdivision or development, arrangements shall be made by the developer with the owner of the downstream land to provide an easement in favour of the Local Government over the route of the surface water flow path. Any modifications to the existing channel/flow path should be carried out by the developer.

The developer shall liaise with the Water Corporation where the stormwater discharges into a Water Corporation main drain; the Department of Water and Environment Regulation and/or Department of Biodiversity, Conservation and Attractions where the stormwater discharges into a river,creek or wetland; and liaise with Local Government where discharging to an LGA drain.

An approved outfall structure shall be provided in those situations where the subdivisional drainage system is to be connected to an approved outlet in the district drainage system.

Due to the variation of land, land use and soil types throughout Western Australia, it is not practical to list run-off coefficients in these guidelines. Consulting engineers are expected to assess and confirm the run-off coefficients applicable to a particular development prior to undertaking drainage design for that development.

The consulting engineer shall design the road drainage network to provide serviceability, amenity and road safety during minor rainfall events. Designers should refer to Australian Rainfall and Runoff (2016) for information on how to design minor rainfall event management systems. A typical drainage network should be sized for 0.2 Exceedances per year (EY) except in the case of arterial drains and commercial and industrial areas, where a 10% AEP shall be used.

Provision shall also be made using overland flow paths and storage facilities for critical 1% AEP storm events associated with the 1% AEP such that the floor level of all buildings shall be a minimum of 300 millimetres above the 1% AEP storm event level as shown in Figure 4.5 below (nuisance control).

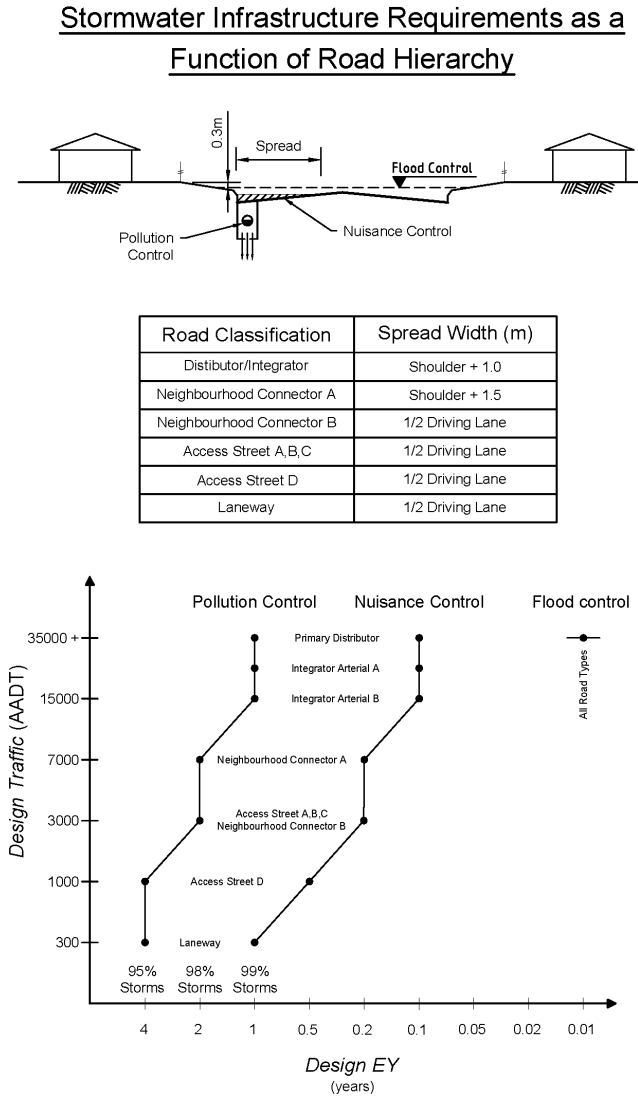


Figure 4.5: Stormwater infrastructure requirements as a function of road hierarchy
Source: Evangelisti, Edwards and Barry, 2016

Where filling on a subdivision affects the drainage of adjoining land, provision shall be made to manage the water within or through the subdivision. No filled lots shall be permitted to drain onto abutting land unless it coincides with an existing natural waterway, in which case only the excess water from post works run-off exceeds the pre works, run-off shall be redirected through a separate drainage system.

The stormwater discharge to the Local Government's drainage system must be at or below pre-development rates unless otherwise approved by Department of Water and Environmental Regulation and the Local Government. Post-development flow rates are to be attenuated to pre-development flow rates through the provision of adequate detention and/or retention systems. “Pre-development” state of infill developments refers to the original undeveloped state of the block and appropriate runoff coefficients will apply.

In areas with flat topography and shallow or perched groundwater levels use a combination of stormwater storage/use systems (e.g. above and/or below ground storage systems), sufficiently graded stormwater conveyance (e.g. pipes, swales, lined biofilters or living streams), sealed stormwater detention systems (e.g. detention chambers on lots) and wide, shallow detention areas in parks. Limit the use of infiltration systems, unless a subsoil drainage systems or shallow groundwater abstraction regime has been implemented to limit groundwater rise. To reduce volume requirements of individual structures (and therefore installation depth and/or width and subsequent interception of groundwater or larger uptake of public open space), install smaller, distributed systems.

Where specific circumstances require an alternative treatment, the approval of the Local Government will be required.

Systems should be designed to prevent entry of sediments into piped sections and transmission through the piped system.

4.3.2.5. Groundwater drainage design

Groundwater drainage networks must be designed to ensure:

- water dependent ecosystems are protected;
- mobilisation of poor quality groundwater is minimised;
- free-draining outlets to the surface drainage system; and
- adequate separation between the development surface and groundwater.

Consequently, the design of the overall surface and ground water drainage network is an important part of the development design process.

Groundwater drainage networks are generally constructed in areas where maximum groundwater levels reach within one to two metres of the ground surface every year. If a subsurface drainage network is not installed the development surface level should be determined in accordance with standards set for building foundation and other infrastructure integrity and other factors relating to the proposed land use by the appropriate authority.

When designing drainage systems to control groundwater levels, ecological water requirements, groundwater resource requirements and land surface waterlogging issues should be addressed. These considerations are important to ensure the groundwater resource and environmental assets are protected and that infrastructure is not compromised by groundwater or standing water.

For information on controlling groundwater levels, see *Water resource considerations when controlling groundwater levels in urban development* (Department of Water 2013).

4.3.3 Design in urban areas

The design of stormwater system described in the following section should be undertaken with consideration for:

- Australian Rainfall and Run-off: A Guide to Flood Estimation (Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) , Commonwealth of Australia, 2016).
- Stormwater Management Manual for Western Australia (Department of Water and Environment Regulation, Perth Western Australia, 2004–2007). (Available online).

The design process for stormwater drainage systems made up of components such as pits, pipes, open channels and storages is described in Figure 4.6.

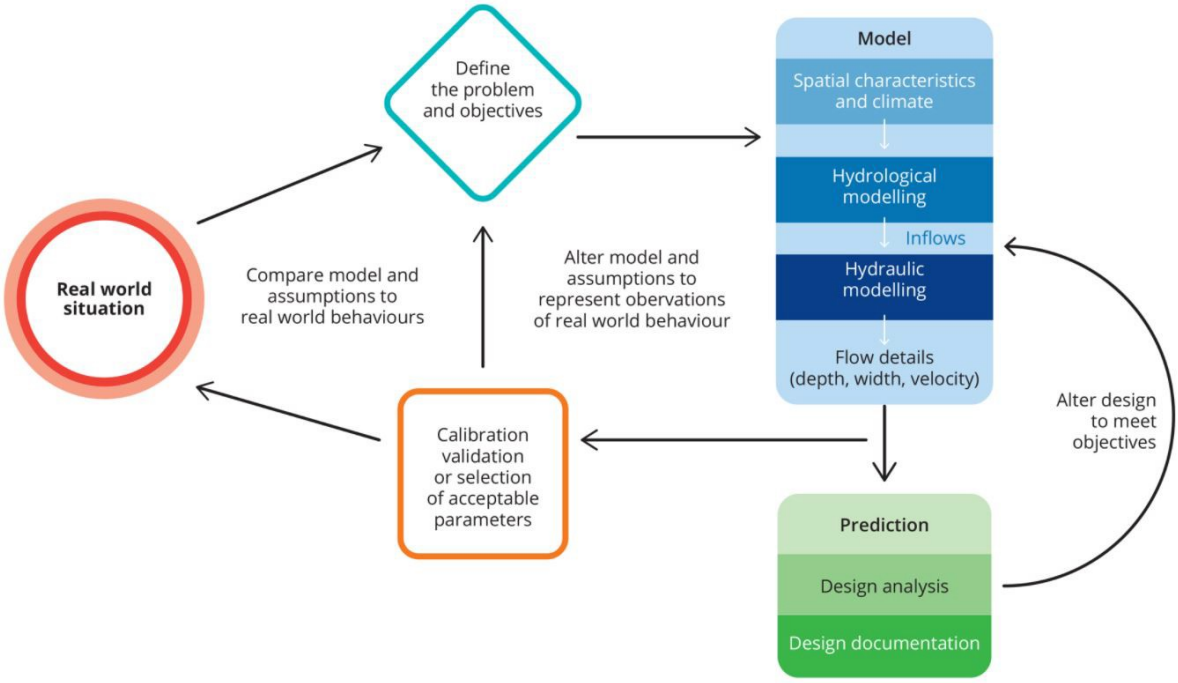


Figure 4-6 Stormwater Drainage System Design Process
Source: AR&R 2016

4.3.3.1. Drainage systems

All drainage systems shall be designed to include water sensitive urban design principles. Such principles set down pollution control exceedance events (Figure 4-4), where soil conditions are satisfactory for the level of infiltration that is required for the peak flows calculated. Greater AEP storms will require a conveyance system to cater for the extra water. Where overland flows can cater for the higher peak flows then the conveyance system can be reduced to suit.

All piped drainage lines shall be designed in accordance with the recommendations of the pipe manufacturers and the appropriate Australian standards. The minimum pipe diameter shall be 300 millimetres and Class two concrete or equivalent pipes are the minimum standard to be used in the road reserve. Minimum cover to pipes to be 600mm unless approved otherwise by the Local Government.

The pipe system shall have the capacity to accommodate the design rainfall with the design top water level in gullies a minimum of 150 millimetres below the surface and, in junction pits, a minimum of 300 millimetres below the surface. Energy losses shall be allowed for in junction pits and gullies.

The velocity of stormwater in pipes and box culverts should ensure that:

- Self-cleaning of the pipe and box culvert is maintained.
- Scouring and erosion of the conduit (particularly the invert) does not occur.

Consulting engineers shall employ self-cleansing criteria or an alternative methodology to determine minimum pipe grades to the satisfaction of Local Government.

Stormwater drainage lines in road reserves shall generally be aligned in accordance with the *Utility Providers Code of Practice for Western Australia* (January 2007). Approval from the Local Government is required for alignments other than those specified in the code.

Sealed joints shall be used for all drainage lines located under road pavements.

Pipes located within property allotments shall be laid centrally in easements granted in favour of the Local Government. The minimum easement width shall be three metres for pipe diameters of 450 millimetres or less and at depths up to 1.5 metres. Increased easement widths shall be provided for pipe diameters greater than 450 millimetres and drainage lines deeper than 1.5 metres. A drainage line crossing an allotment boundary shall be laid approximately perpendicular to the boundary of the allotment.

A drainage connection or provision of an overland flood flow path shall be provided to each lot. The connection or overflow path shall be sited at the lowest point of the lot, subject to the Local Government's requirements for stormwater detention on the lot.

The Water Corporation's approval shall be obtained for any drainage line connection to a Water Corporation main drain.

Drainage structures must be located where they can be accessed for maintenance.

The conveyance system should incorporate overland flows wherever feasible.

4.3.3.2. Grated gullies and side entry pits

Road gullies may be of the grated or side-entry type. Gutter flow widths depend on the road function and hierarchy (Figure 4-5). Gutter flow widths are to comply with flow-velocity criteria prescribed in Austroads Guide to Road Design Part 5A: Drainage – Road Surface, Networks, Basins and Subsurface. Gullies shall be placed at all low points, the upstream side of intersections and at intermediate positions to limit the width of flow in the gutter. For access ways and access places with one way crossfall, this gutter flow width may be increased.

Gullies shall be installed on the upstream side of pedestrian ramps and pedestrian crossing points to limit the width of flow. Road low points and accompanying pits shall be located at the centre of single residential lots and opposite the side boundaries of multi-unit lots.

Double side entry pits to be installed at all trapped low points as a minimum and critical 100-year average recurrence interval storage addressed.

Grated gullies shall be designed to be safely traversed by cyclists.

The last gully before the drainage enters the main drainage line shall be fitted with an effective sand trap.

Gullies shall be designed as ‘infiltration devices’, unless this poses a threat to the road foundations or the soil is heavy clay which would retain water between rainfall events or shallow groundwater prevents effective infiltration.

The geo-fabric under the pits is required for maintenance purposes. While there can be a clogging of the fabric it does prevent the aggregate below the pit from being sucked up during pit eduction and cleaning.

4.3.3.3. Junction and lot connection pits

A junction pit is to be constructed at all pipe junctions and where the pipe changes direction or grade. The maximum distance between junction pits shall be 90 metres and their location shall not unduly restrict the future access to residential lots.

Junction pits shall be designed as 'infiltration devices', unless this poses a threat to the road foundations or the soil is heavy clay which would retain water between rainfall events or shallow groundwater that prevents effective infiltration.

Junction pits are to be positioned at the common boundary of adjoining lots, to minimise the impact at crossovers and on landscaping within the road reserve, where possible.
Where a lot connection pit services an adjacent lot, a 100mm diameter spigot pipe is to extend at least 1 metre into the adjacent lot.

Junction pits connecting directly to the main stormwater drainage system shall be fitted with an effective sand trap.

4.3.3.4. Sub-soil drainage

Sub-soil drainage shall be generally provided as a complimentary system and enter the stormwater drainage system through a junction pit.

Sub-soil drainage lines may consist of perforated, slotted or open-jointed pipes of minimum diameter 150 millimetres or other system as may be approved. The sub-soil drainage shall be laid to control the water table to suit the requirements of the site.

Calibrated aggregate filter material to sub-soil pipes shall be placed to a minimum thickness of 100mm around the full circumference of the pipe. Trench widths shall be designed to allow for the effective compaction of backfill material around the pipe and/or the placement of sub-soil drainage filter material.

New drainage lines located over existing drainage lines, sewer lines or other structures shall be provided with an independent support structure.

All sub-soil drainage shall be provided in accordance with the Local Authorities' specifications and standard drawing J in Appendix.

Where poor quality groundwater is mobilised by sub-soil drains, treatment shall be required before discharge to the receiving environment.

Subsoil drains should be located within road reserves where feasible.

Further information on subsoil design can be found in IPWEAs (2016) specification for separation distances for groundwater controlled urban development.

4.3.3.5. Primary and district distributor road drainage

Where a primary or district distributor road reserve passes through or adjacent to a subdivision, and such road is not required to be constructed as part of the development, the developer shall provide the necessary infrastructure and system capacity to manage stormwater from the road reserve.

Junction pits shall be provided at the edge of the road reserve to serve as connection points between the subdivision drainage system and the road drainage system.

4.3.3.6. Open access flood storage/detention facilities

Open stormwater storage/detention structures and/or facilities shall comply with the following requirements where it is not proposed to restrict public access:

- maximum side slopes shall not exceed 16.5 per cent (one in six). Steeper grades may be accepted by Local Government on a case by case basis. Base of area shall have a minimum slope of 0.5 per cent, with low point for storage of up to one year event. This area may also incorporate a bio-retention treatment area for water quality management;
- the maximum water depth shall be 1.2 metres up to the critical 1% AEP event unless a risk assessment is completed to the satisfaction of the Local Government;
- the surface shall be suitably vegetated where the structure or facility is integrated into public open space;
- with the exception of ornamental lakes, all other structures or facilities shall be designed to only retain water during storm conditions and for 96 hours following rainfall events; and
- a stormwater gross pollutant trap should be installed at the end of the line prior to discharge in consultation with Local Government.

Approved fencing shall be provided in cases where it is proposed to restrict public access or if the above requirements cannot be met.

4.3.3.7. Stormwater infiltration

Infiltration areas shall be sized according to the following criteria:

- the consulting engineer shall undertake such tests as are necessary to ascertain the appropriate infiltration rates and shall provide the Local Government with the test results and calculations to support the design;
- the depth of the water table shall be carefully considered in calculating the area required for infiltration.
- infiltration areas shall be free of standing water within 96 hours of any single rainfall event occurring in the catchment draining to the infiltration area;
- the areas of inundation shall be calculated in accordance with the requirements of *Liveable Neighbourhoods*, in order to determine the areas of restricted and unrestricted public open space to be provided in the development area; and
- if an overland flow path has not been provided for the infiltration area then the overall public open space area shall be designed to accommodate the flow from a storm of 1% AEP duration without flooding any adjacent lots. Where ‘at source’ infiltration can be accommodated or is a requirement, then verge areas will need to be assessed for space for such infiltration structures to be installed. However, this requires the Local Government to assess such infiltration when the water management plans are being assessed at structure plan stage, not when detailed design is underway after subdivisional conditions have been issued by the WAPC.

4.3.4 Design in rural areas

Developers of rural or special rural subdivisions are required to provide for run-off from all areas in accordance with *Australian Rainfall and Runoff 2016*. Drainage will normally be accommodated by unlined open drains where grades and soil types permit.

Design shall be In accordance with water sensitive urban design principles – pollution control rainfall exceedance events (Figure 4-5), 0.2 EY and 1% AEP events and should incorporate features to improve water quality.

The minimum time of concentration shall be six minutes.

The top water level for the design water flows shall be greater than 300 millimetres below the level of the road shoulder.

Where stormwater discharges onto private property there is a need for an agreement to guarantee continual acceptance of road run-off.

4.3.4.1. Open channels

The maximum velocity of flow shall be considered by the consulting engineer to ensure erosion does not occur. The longitudinal slope of open channels may be adjusted by means of bed control (riffle or drop) structures to minimise velocity to limit erosion.

Scour protection should be given consideration in changes in direction of flow.

Appropriate safety devices such as guide posts shall be provided at the road shoulder to protect and/or advise road users of the presence of the drain.

4.3.4.2. Crossover culverts

All culverts under roads and crossovers and all pipe entries and outfalls shall have approved headwalls. Protective works are required at culvert exits and entries to reduce the velocity to ensure erosion does not occur. Refer to the Local Government for detailed crossover/culvert standards that will be required.

4.3.4.3. Overland flows

Detention storage areas shall be provided at suitable locations to reduce peak flow rates to the capacity of the downstream facilities and to maintain pre-development flow regime requirements.

Bio-retention systems and/or vegetated overland flow paths shall be provided prior to the entry of all drainage systems into a natural waterway and at any other location where required by the appropriate water body management authority or by the Local Government.

Where road pavements are designed for direct runoff to adjacent swales, a set down should be provided from pavement surfaces to the vegetation level of swales or detention storage areas to allow accumulation of coarse sediments. See Figure 4.7.

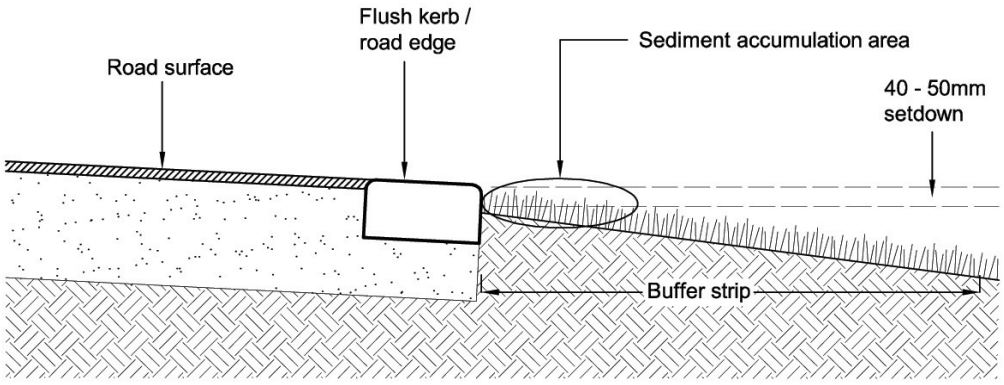


FIGURE 4.7: PAVEMENT EDGE DESIGN FOR VEGETATED OVERLAND FLOW PATHS

SOURCE: Department of Water and Environmental Regulation

Module No. 5

Streetscape Guidelines

5 Module No.5 – Streetscape Guidelines

5.1 General requirements

Streetscape development creates a strong physical image for Local Government and has aesthetic, social and economic value for the community. Streetscapes help reinforce the identity of a place, provide facilities for passive recreation and create an environment for pedestrian activity.

Each Local Government has a range of natural landscapes that have intrinsic natural and cultural value, many of which occur around specific landforms and associations of native plants that form natural communities. Development of streetscapes should, where possible, take account of endemic plant communities and provide for the enhancement of ecological systems through introduction of new landscape development.

A commitment to environmental sustainability including conservation of flora, fauna and water, use of renewable resources and a preference for waterwise designs with optimum ongoing maintenance methods is required. Design of streetscape and landscape features is critical to complement public space in an attractive, functional and cost-effective manner.

For establishment or re-development of verges by private landowners, the *Liveable Neighbourhoods Guidelines* will be used by the WAPC as part of the development approval process (where the verge is being established or redeveloped in conjunction with a development proposal for the adjoining private land), or as a basis for advising landowners of Local Government's requirements (where there is no requirement for a development approval).

For development of road reserves (including footpaths, street lighting, medians and verges) as a part of subdivisional development, the *Liveable Neighbourhoods Guidelines* will be used by the WAPC as a basis for approval of design drawings submitted by developers in accordance with subdivision approval and clearance processes.

5.2 Policies and standards

5.2.1 Policies

The following WAPC policies are predominantly used and apply to subdivision design and assessment:

- Residential R-Codes
  WAPC, Perth (available online).
- *Liveable Neighbourhoods*: 4th edition 2007
  WAPC, Perth (available online).
- Bicycle Planning, Development Control Policy 1.5 (February, 1990)
  WAPC, Perth (available online).
- General Road Planning and Planning Bulletin 18 Development Control Policy 1.7
  WAPC, Perth (available online).
- *Utility Providers Code of Practice*
  released by the Public Utility Services Committee
  WAPC, Perth (available online).

5.2.2 Standards

- Guide to Traffic Engineering Practice, Part 13 – Pedestrians (Austroads);
- Guide to Traffic Engineering Practice, Part 14– Bicycles (Austroads);
- Guidelines for the Design of Bicycle Facilities (Bikewest);
- The Australian National Cycling Strategy 2005–2010 (Austroads 2005);
- The Perth Bicycle Network Plan (DPI Bikewest);
- Design for Access and Mobility (AS1428 Parts 1 and 2);
- Street (Road) Lighting Code AS1158;
- Protection of Trees on Development Sites AS4970.

5.3 Design

5.3.1 Pedestrian and bicycle facilities

5.3.1.1. General

Provision of safe and convenient facilities for pedestrians and cyclists (and in rural or special rural areas, horses and riders) is a prime consideration in designing a road network within a residential, commercial and/or industrial neighbourhood. Pedestrians and cyclists have an important place in the street environment as they do not create the problems of safety, noise, pollution and disturbance caused by motor vehicles.

WAPC policy requires the developer to provide the Local Government with a plan indicating the proposed footpath, bicycle path, or bridle path network for the overall development area. In smaller subdivisions, the hierarchy classification of adjacent roads needs to be assessed in order to determine the necessity for such facilities.

Off-road facilities comprise footpaths, shared paths, bicycle-only paths and pedestrian access way paths. On-road facilities comprise cycle lanes and cycle routes constructed as an integral part of the road pavement.

Integrator roads and neighbourhood connector streets must have footpaths or shared paths on both sides, and constructed to an approved construction standard.

Access streets must have a footpath or shared path on one side. A footpath or shared path may be required on both sides where pedestrian activity is high, (ie. where the path forms part of a pedestrian link, near schools, shops or stations).

Footpaths in streets should be 1.5 metres minimum wide, and be widened to two metres minimum as a shared path in the vicinity (as determined by the Local Government) of schools, shops and other activity centres. Footpaths 1.5 metres wide are offset a minimum of 0.3 metres from the property boundary, or are built at 1.8 metres wide if abutting the property boundary or kerbline, provided the road has low traffic volumes. Pram crossings are required at all intersections and should have a maximum grade of 1:10.

Footpaths should be separated from the street pavement, and usually located against or close to the property boundary. Footpaths may only be located abutting kerbs where site constraints

preclude alternative sites, and where vehicle volumes or road design speeds are low. If footpaths abut kerbs, verges may need to be widened to accommodate trees in locations clear of services. Footpaths should be designed with a maximum grade of 1:14 and located taking into account pedestrian amenity, sun and shade, street lighting, postal deliveries and likely use patterns. Locations of paths must consider tree placement on order for the trees to provide shade during the hottest part of the day.

Footpath and dual use path construction should be continuous across driveways. Shared space for pedestrians, cyclists and vehicles should be designed and detailed to enable pedestrians and vehicles to share the same pavement, particularly in town and neighbourhood centres, with a sense of equal priority. Pedestrian crossings of integrator roads should be provided at-grade wherever practical.

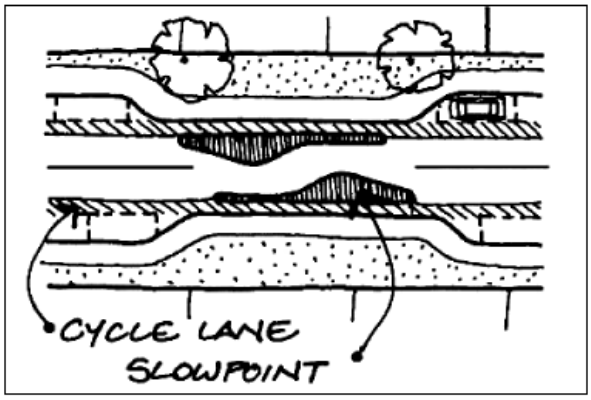
Grade-separated pedestrian crossings should only be used where topography can be used to advantage and is overlooked by adjacent development, or at freeways or other high speed distributor roads. Full height dividing fences must be avoided next to shared paths to improve driver sight lines at driveways. A safe, convenient and legible bike network should be provided for both experienced and less experienced cyclists. The network may comprise both on-road and off-road routes, planned in accordance with any State plan or local walking trail or bike plan and responding to:

- projected bike travel demand;
- expected vehicular traffic volumes and composition;
- linkages between trip attractors such as schools, local centres and other community facilities; and
- safety, security and convenience for users.

The local street network should provide a permeable network of routes for cyclists to promote on-pavement cycling to daily activities. Abutting cul-de-sac heads should have a foot and bike path connection. A continuous local street system for cyclists parallel to integrator streets to supplement paved shoulders and/or cycle lanes and shared paths along integrators should be provided wherever practical. In residential areas where projected traffic volume is less than 3000 vehicles per day, cycling should generally be on-street and shared with cars.

Cycle lanes should be provided on streets with projected traffic volumes of more than 3000 vehicles per day and near schools, stations, centres or where long distance commuter cycling and recreational cycling is likely. Additional shared paths may also be necessary for cyclist safety along streets with higher traffic volumes. Integrator roads should normally incorporate a cycle lane for on-street cyclists.

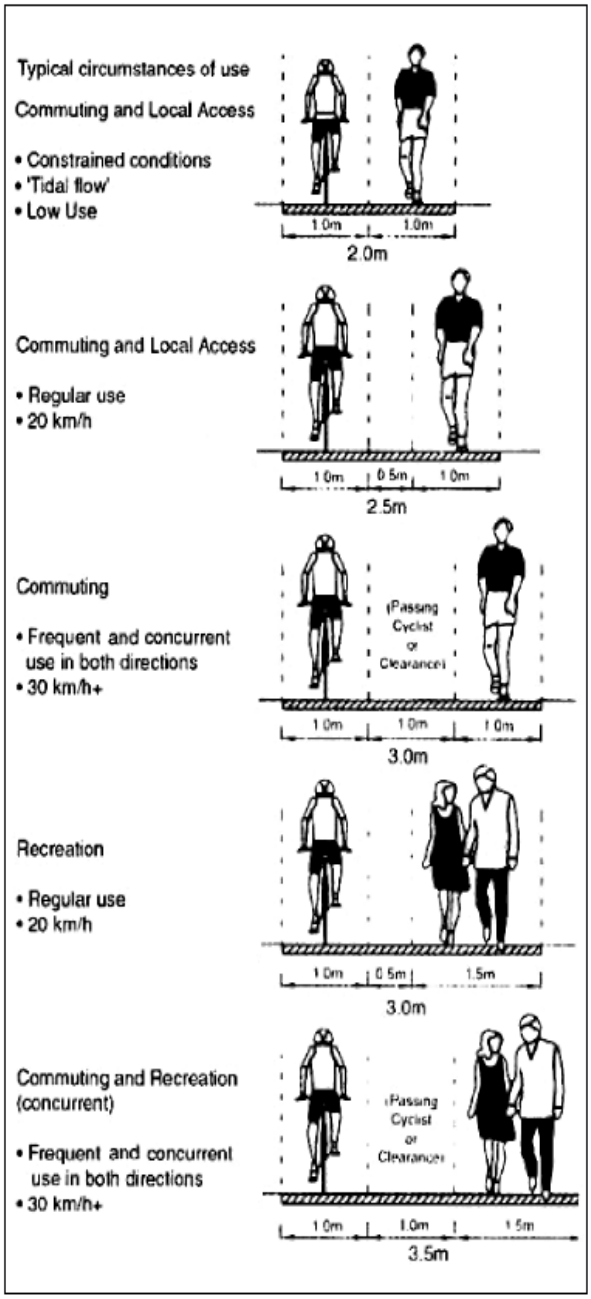
FIGURE 5.1: SLOW POINT DESIGN
Example of slow point to accommodate cyclists



End of trip facilities such as bike racks should be provided at parks, community centres, public transport hubs (train stations or along bus routes), schools and shopping centres and ideally when a subdivision is planned.

Off-street shared paths and bike paths should be designed to take into account the specific requirements of the route (eg. long distance commuter cycling and/or recreational cycling). Paths for the use of pedestrians, wheelchairs or motorised wheelchairs, and cyclists should be constructed in accordance with approved construction standards, and take into account safety requirements of all potential users.

FIGURE 5.2: SHARED PATHS



(Source: Liveable Neighbourhoods, and derived from Austroads Guide to Traffic Engineering Practice, Part 14: Bicycles, Figure 6.6. Shared paths on neighbourhood connectors or integrator routes providing major access to a school should desirably be 2.5 m wide and designated as a shared path in accordance with Austroads as cited above. The above diagram provides indicative dimensional criteria for shared paths.)

Shared paths must be provided with facilities for the separation of pedestrians and cyclists where appropriate (eg. meeting points or junctions on high-use activity areas).

Shared path width and design should cater for projected user types and volumes, and facilitate ease of use by the disabled, aged and the very young. Grade separations can be provided where topography assists or where a direct route is desirable and can be safely achieved.

Footpath and/or shared path construction

Footpaths and shared paths must have a durable, non-skid surface with tactile ground surface indicators at bus stops and traffic signals and at other road crossing points in activity centres, near stations and medical centres where there is high pedestrian usage. The path surface should be flush across crossovers.

Notwithstanding the contents of this clause prior to commencing design the Engineer is to liaise with the Local Government in order to:

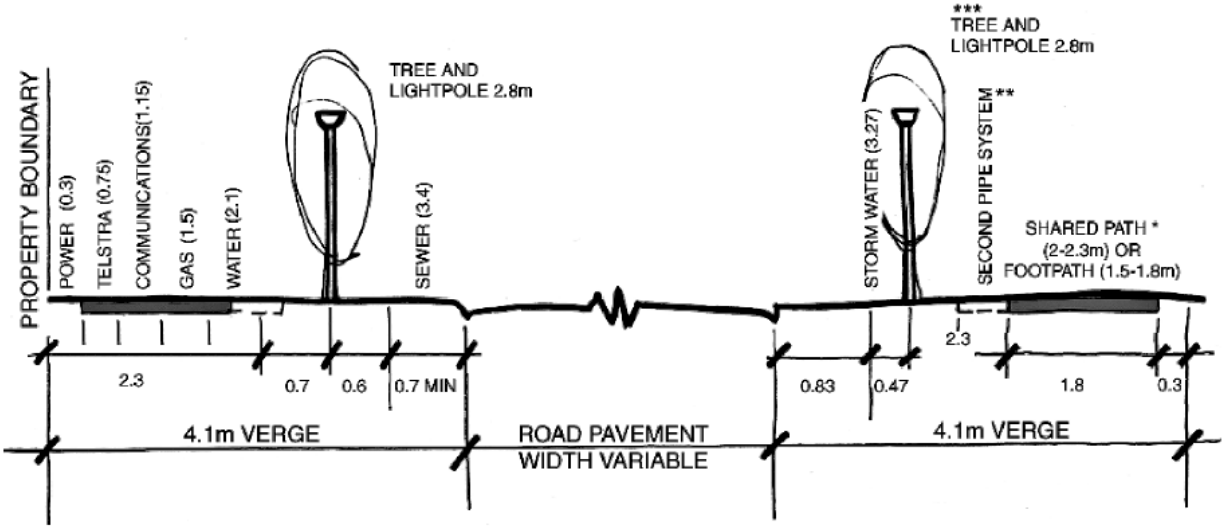
- obtain where available the Local Government's approved pedestrian and bicycle facility plan;
- resolve the location of any Multi-Use Trails required by the Local Government;
- identify if any local variations to alignments are appropriate due to terrain, vegetation adjacent public open space or special circumstances;
- agree on construction medium for pedestrian and bicycle paths;
- agree on design parameters for pedestrian and bicycle facilities located in POS including:
    - whether commuter or recreational use;
    - vertical alignment taking into account the steepness and length of grades;
    - changes of grade;
    - sight distances;
    - lighting standards;
    - the nature of specific stormwater drainage facilities to be provided where the free drainage of stormwater onto the natural surface of the POS without ponding is not practical; and
    - pram Ramp installation in accordance with AS1428.

5.3.1.2. Urban areas

Local Government requires developers to provide facilities for pedestrians and cyclists in all new subdivisional developments in accordance with an overall network plan.

Paths and cycleways shall be designed in accordance with Australian Standards.

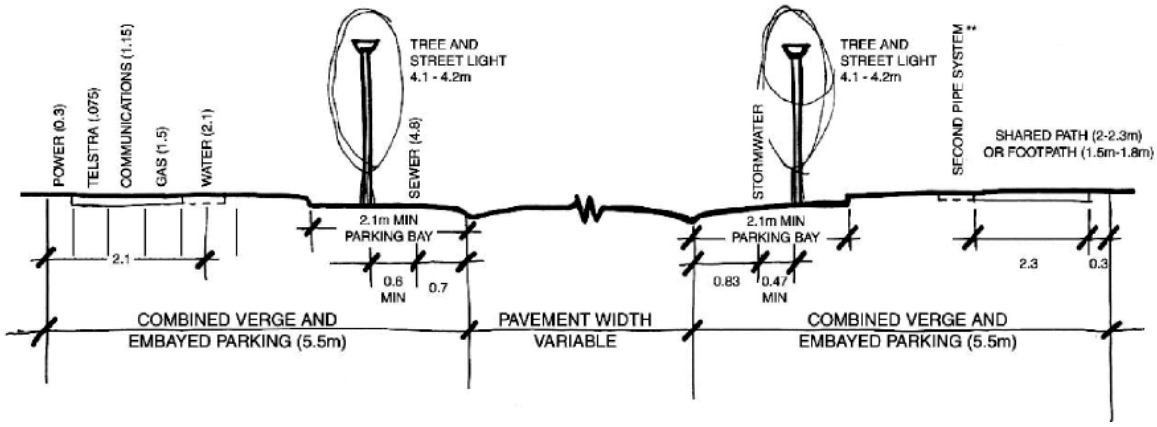
FIGURE 5.3: TYPICAL SERVICES, TREE AND PATH LOCATIONS IN 4.1-METRE VERGE



* In specific cases, wider shared paths maybe required, and the verge width will need to be widened accordingly
** Possible second pipe alignment
*** Trees maybe located at 2.4 metres from property boundary where there is no shared path
Note Local Government reticulation or rising main to be located beyond the 3 metres alignment.

SOURCE: Liveable Neighbourhoods

FIGURE 5.4: TYPICAL SERVICES, TREE AND PATH LOCATIONS IN 5.5-METRE VERGE INCORPORATING INDENTED PARKING



* In specific cases, wider shared paths may be required and the verge width will need to be widened accordingly.
* Possible second pipe alignment

Notes:

1. 0.3 metre clearance required to property boundary for minimum footpath width of 1.5 metres and minimum shared path of two metres. The footpath or shared path may be paved to the property boundary in addition to minimum width.
2. 0.5 metre clearance required between shared path and tree.
3. Setbacks shown to property boundary only. Road pavement may vary.
4. Trees and light poles are typically located three metres from property boundary in the minimum width verge of 4.1 metres.

SOURCE: Liveable Neighbourhoods

Walkable catchments, sometimes referred to as ‘pedsheds’, are maps showing the actual area in a five minute walking distance from any centre, or ten minutes from any major transport stop such as a railway station. The centre could be a neighbourhood or town centre.

The walkable catchment is simply a technique for comparative evaluation of how easy it is to move through an urban area in order to get to and from these centres or facilities. These maps are the best estimates of workability, and as such are an indication of energy efficiency.

Where approval is given for a cycleway to be an on-road facility on either a local or district distributor road, it shall be designed and constructed homogeneously with the road pavement. Where such facilities are provided for cyclists, a footpath shall be provided for pedestrians.

The developer may construct an approved path in a distributor road reserve with no frontage access, provided written assurance is supplied by the utility providers that services have been installed in the road reserve. It is the responsibility of the developer to obtain such assurances from the various utility providers.

5.3.1.2.1. Pedestrian access way

Pedestrian access ways shall be paved with approved materials as specified above and in accordance with the following:

- where the pedestrian access way is up to and including three metres wide, the paved section shall be the full width between the two front property lines, narrowing to two metres for the section between the property line and the kerb line;
- where the pedestrian access way is wider than three metres, the paved section shall be a minimum of two metres wide for the full length between kerb lines. Any unpaved section within the access way shall be protected against erosion in an approved manner by the Local Government;
- designed to include adequate passive surveillance and clear sightliness to ensure Crime Prevention Through Environmental Design. Pedestrian access ways enable connectivity within an area and encourage active transport. Adequate lighting is required at night;
- vehicle barriers shall be installed at the entrance and exit to all pedestrian access ways as per Australia Standards, as they must not reduce accessibility or cause hazards for shared path users – especially gophers, bicycles, prams and wheelchairs;
- in deciding the locations and design of footpaths, cycleways and shared paths, the ultimate safety of pedestrians and cyclists shall be considered at all times; and
- all paths in pedestrian access ways and public open space shall be constructed at the time of subdivision by the developer. All public utility services shall be installed prior to the paving of the pedestrian access way.

Generally, footpaths and shared paths within the road reserve will be constructed prior to building development within the subdivision. Where it is not practicable to complete footpath or dual use path construction prior to the endorsement of the diagram of survey, the developer may obtain release of the subdivision by lodging a bond with the Local Government as part of Bonding Outstanding Works. Alternatively, the developer may pay to the Local Government the estimated cost of the paths for construction at a later date.

5.3.1.3. Rural areas

Footpaths and shared paths may be required in some rural or special rural developments in accordance with the WAPC and Local Government policies. Generally, urban area guidelines

are applicable to rural developments. Bridle paths shall form part of an overall network located within the road reserve or in specifically designated reserves. The fire management plan for the development may utilise the reserves for fire breaks and access for fire fighting equipment. In addition, the Local Government may require provision of bridle paths in some special rural developments.

Specifications for materials, construction and the location of bridle paths should be confirmed with the Local Government prior to lodgement of detailed design drawings.

5.3.2 Footpaths and shared paths in rural developments

Footpaths and shared paths may be required in some rural or special rural developments in accordance with the WAPC and Local Government policies. Generally the urban area guidelines are applicable to rural developments. Bridle paths shall form part of an overall network located within the road reserve or in specifically designated reserves. The fire management plan for the development may utilise the reserves for fire breaks and access for fire fighting equipment. In addition the Local Government may require the provision of bridle paths in some special rural developments.

Specifications for materials, construction and the location of bridle paths should be confirmed with the Local Government prior to the lodgement of detailed design drawings.

5.3.3 Street name plates and community signs

The developer is responsible for the supply and erection of all street name plates in accordance with *AS 1742.5 Part 5: Street Name and Community Facility Name Signs and Section 4.16 Street Name Plates*.

Street name plates shall be of a design and colour scheme as determined by the Local Government and where applicable house numbers provided eg. '150–176'.

Street name plate sizes shall be in accordance with the road classification as follows:

- District Distributor B or higher – 200 mm deep with 150 mm lettering;
- Rural roads – 200 mm deep with 150 mm lettering;
- Local distributor or lower – 150 mm deep with 100 mm lettering.

Street name signs shall be erected at all intersections and junctions as shown on the drawings and shall include the names of both streets. Where two or more signs are affixed to one post, the signs shall be at two different levels.

Generally, individual signs indicating a street higher in the road hierarchy shall be installed above those of roads of a lower classification.

A 'No Through Road' sign plate shall be affixed below the street name plate where applicable.

5.3.4 Street and public area lighting

Lighting of streets, car parks, public transport stops, major pedestrian and bicycle links and public areas (including pedestrian access ways) that are likely to be well-used at night to assist in providing safe passage for pedestrians, cyclists and vehicles shall be provided to appropriate standards.

Street lighting shall be provided in all new developments to the requirements of the relevant categories of *AS1158: Road Lighting* and other specific requirements detailed herein.

Design proposals submitted must demonstrate compliance with *AS1158.1: Road Lighting – Vehicular traffic (Category V and P) lighting – Performance and installation design requirements* and Part 12 of Austroads guide to Traffic Engineering Practice and be designed by a suitably qualified lighting designer.

The recommended preference is for standard Western Power street lights however the Local Government may be prepared to consider non-standard light poles and luminaires from the Western Power's Street Vision Decorative Lighting series.

Alternative decorative street lights may be considered however the Local Government should ensure an appropriate replacement stock of the decorative light pole and luminaires is provided by the developer for future maintenance, the street light design complies with AS1158 and an appropriate defects liability period is applied.

Where a proposed subdivisional road extends from an existing road, the street light pole and luminaire shall be consistent. Street light selection shall consider existing street light networks on surrounding roads.

Plans and specifications for all road and public area lighting shall be submitted to both Western Power and the Local Government for consideration and approval.

5.3.4.1. Responsibilities

Responsibility for decorative or non-standard roadway or public area lighting, unless otherwise agreed in writing, is as follows:

Developer

- The developer is responsible for providing all work and associated costs for the design, supply, installation, connection, commissioning and maintenance of the entire lighting installation until the subdivision is cleared.
- The developer is responsible for ensuring compliance with all relevant standards and public utility requirements and obtaining the necessary approvals.
- At practical completion of the installation of non-standard street lights, the developer shall provide to the Local Government the comprehensive Maintenance and Operating Handbooks.

Local Government

- The Local Government shall be responsible for all energy costs from the approved date of practical completion.
- Public lighting should be designed with regard to energy efficient practices and technologies.
- Obtrusive and upwards waste lighting should be minimised in accordance with AS 4282 (1997).

5.3.4.2. Equipment locations

All equipment including pole foundations, poles, conduits, switchboards, luminaries and cable pits shall be located to prevent obstruction or interference with other constructed elements,

services or utilities. All roadway lighting services shall be installed within the road reserves. Street lighting and tree alignment shall be as detailed in the *Utility Providers Code of Practice*.

Coordination and approvals shall be obtained from all relevant service authorities. Public area lighting shall be designed and located to prevent hazards to motor vehicles or injury to pedestrians as approved by the Local Government.

5.3.5 Bus shelters and seating

Detailed consultation with the Department of Planning, Lands and Heritage, the Public Transport Authority and transport providers should occur at the structure planning stage. Attention needs to be given at the urban structure stage of development that will support public transport. New urban areas should facilitate significantly improved transit usage relative to conventional urban development.

Bus routes are generally to be located on integrators and neighbourhood connectors, which should provide a direct and convenient route through a neighbourhood. Consultation with the Public Transport Authority and/or bus operator at structural planning stage of design is recommended. The Authority's 2004 Design and Planning Guidelines for Public Transport Infrastructure Manuals are also relevant. However, approval from the Authority is not required unless it is making a funding contribution.

Location of bus stops is also an important issue to consider in the design of neighbourhoods. These need to be located in places with good pedestrian access, have clear site lines from nearby buildings, and located at key destinations. In addition, bus stops need to be located where there are safe pedestrian crossings to and from stops.

Design detailing of bus stops should make them a feature in the local area, such as providing identity (eg. by providing each stop with a name), and providing seats and shelters and bus embayments where applicable. Bus shelters and seats are required to meet universal access standards. Sufficient room is required to allow shared path users to pass the bus stop without bus stop infrastructure and bins creating a hazard. Developer contributions are encouraged as bus routes are often developed once the area is developed. (Bus stops are generally placed so the maximum distance a resident needs to walk is 500 metres to reach the closest bus stop).

Design of streets for buses should consider the comfort of passengers, and the efficiency of the route. In neighbourhood connectors and many integrator roads, buses will normally stop in the roadway, at extended kerbs, rather than in embayments. This ensures that the bus has priority in the traffic, and also enables the bus to provide a periodic traffic-calming function.

Developer contributions may be required as provided for in the WAPC's *Development Control Policy 1.7 General Road Planning* and *Planning Bulletin 18 Developer Contributions for Infrastructure (as amended)*.

5.3.6 Street trees and landscaping

Landscaping should provide attractive streetscapes which reinforce important functions of a street, and valuable public places that add value to the amenity of adjacent housing and developments. Street trees should be considered as part of the road construction.

Landscaping enables roads and verges to perform their designated functions in the street network, and the streetscape needs to be designed to discourage speeding vehicles.

Special attention needs to be given for the setback distance to trees from a moving travel lane.

These distances have been specified taking into account a range of factors. The design environment for urban streets is to create an environment of care, and the traffic-calming benefits of street trees relatively close to the pavement is an integral part of this. These clearances are therefore different to those typically specified for rural roads or urban highways and freeways where clear zones are established to cater for errant single vehicles at high speeds.

Setbacks need to comply with MRWA policy and the *Utility Providers Code of Practice*.

Species and types of trees need to meet Local Government requirements that take into account existing plants and trees and Local Government policy.

5.3.6.1 Rain gardens / biofilters

The design and planting must be in accordance with best practice and agreed to by the Local Government.

5.3.6.2 Entry statement

Developers must seek approval to install temporary or permanent estate entry statements.

Structures and garden beds provided as entry statement shall comply with both local and state legislation.

5.3.7 Banner poles

Provision of banner poles is subject to the consideration and approval of the Local Government. Where their installation has been agreed, banner poles need to be constructed and located to meet Australian Standards.

5.3.8 Streetscape maintenance bond

Where the developer arranges for landscaping to take place, it shall be supported by a maintenance and watering period of at least two summer periods after planting to ensure that the vegetation is properly established. This condition shall be guaranteed by way of a bond in the form of cash or guarantee from a financial institution acceptable to the Local Government. The bond will be returned when the maintenance period has been satisfactorily completed. The amount of bond is detailed in Module 1, section 1.20: Bonding Outstanding Works.

5.4 Specifications

5.4.1 Footpath and/or shared path construction

Footpaths and shared paths must have a durable, non-skid surface with tactile ground surface indicators at bus stops and traffic signals and at other road crossing points in activity centres, near stations and medical centres where there is high pedestrian usage. Any crossing points such as pram ramps and crossovers should be smooth and flush from the path to the road surface to reduce trips and falls by all path users.

The sub grade shall be compacted to not less than 95% of the maximum dry density in accordance with AS1289-2003: Method of Testing Soils for Engineering Purposes (pt.2.1).

Paths may be constructed in concrete, asphalt, brick or block paving as approved by the Local Government with a minimum thickness as outlined below:

- concrete paths shall have a minimum thickness of 100 millimetres;
- asphalt paths shall have a minimum base course thickness of 150 millimetres with an asphalt thickness of 25 millimetres. Iron oxide and/or gravel mix asphalt is recommended where vision separation is required; and
- brick or block pavements shall incorporate bricks or blocks of minimum thickness and laying procedures in accordance with the manufacturers' recommendations.

Paths shall generally follow the longitudinal grades of the road and be laid with a minimum crossfall of two per cent towards the road carriageway.

Footpaths within POS areas are to be constructed to crossfall toward the areas designed to receive and treat surface flows. These grading requirements are to prevent ponding of stormwater over the path areas and to maintain pedestrian access in wet conditions.

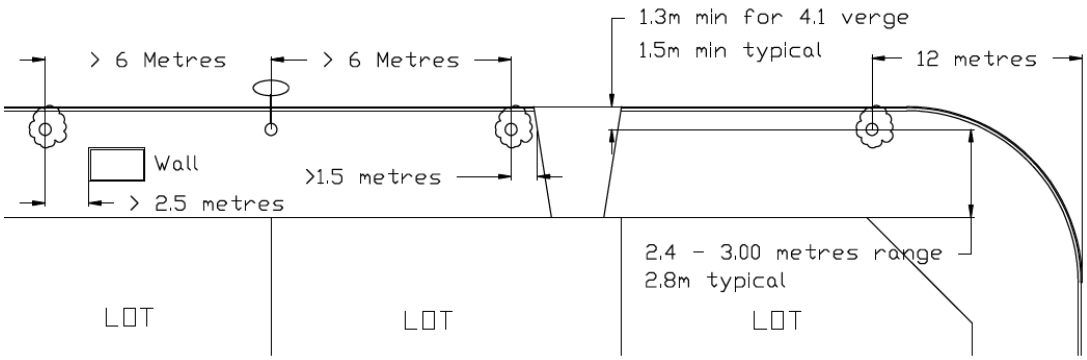
5.4.2 Street trees

Street trees need to be chosen to reflect the local character and conditions and provide attractive streetscapes and public amenity in the form of shade, improved micro-climate, ecological linkage and landscape amenity, and to ensure that trees do not interfere in the future with lighting, paving or other public infrastructure. In general:

- street tree species need to be approved by the Local Government. Alternatively the Local Government can provide the name of appropriate tree species for streetscapes;
- street trees should be spaced appropriately for the species selected. Species are to be selected and approved by the Local Government to ensure appropriate separation from crossovers and property boundaries. Street trees should not obstruct visibility at intersections or screen street lights. Generally one tree per property frontage is recommended and two or three trees per side verge subject to width and length of verge;
- as a general guide, street trees shall be planted greater than six metres from a street light, unless otherwise approved;
- consideration should be given for the size of the mature canopy of the street tree in relation to the street light;
- street trees shall generally be planted a minimum of 1.3 metres (for a slow speed road environment) but ideally 1.5 metres or greater from the front of the road kerb or crossover with a minimum of 2.5 metres from structural elements (ie. walls and foundations);
- street trees shall generally be planted on the 2.8 metres alignment but can be in a range of 2.4 metres to three metres depending on the verge width. This is set out in the *Utility Providers Code of Practice*. Greater clearance from property boundaries can be achieved in wider road reserves;
- adequate root protection needs to be provided unless justification is provided where root protection is not required;

- for corner properties, trees shall not be permitted within 12 metres of the intersecting kerb alignments. At major intersections this clearance may need to be increased to comply with sight distance requirements. Depending on the speed and type of road and tree, the Local Government may be receptive to reducing the street tree spacings; and
- tree plantings in roads controlled by MRWA shall comply with its standards.

FIGURE 5.5: STREET TREE INDICATIVE LOCATIONS



5.4.3 Lighting categories for roadways and public areas

The following table is used to identify the lighting category applicable for each public area or roadway.

TABLE 5.1: LIGHTING CATEGORIES FOR ROADWAYS AND PUBLIC AREAS

ROAD/AREA	AS/NZS1158 CATEGORY	TYPICAL EQUIPMENT & GEOMETRY (LAMP/HEIGHT/SPACING/WIDTH
Primary and District Distributor Roads >20,000vpd	V3	250 W HPS / 10.5m / 55m / 2 lanes 250 W HPS / 9m / 40m / 2 lanes
Primary and District Distributor Roads 6,000 - 20,000vpd	V5	150 W HPS / 10.5m / 55m / 2 lanes 150 W HPS / 9m / 40m / 2 lanes
Primary		
Local Distributor Roads (3,000 - 6,000 vpd)	P3	70 W MH / 7.86m / 40m / 20m road reserve 70 W MH / 6.5m / 60m / 20m road reserve
Access Roads (<3,000 vpd)	P4	70 W MH / 7.86m / 80.5m / 20m road reserve 70 W MH / 6.5m / 60m / 20m road reserve 42 W CF/6.5m / 60m / 20m road reserve
PAW's Laneway (<300 vpd)	P4 P5	LED / 70 W MH / 6.5m / 60m / 3m - 5m laneway LED / 42 W CF/6.5m / 60m / 3m - 5m laneway
Intersections Distributor Road Access Road Isolated intersection & bends	V3/V5 P3 P4	250 W HPS / 10.5m 70 W MH / 6.5m 70 W MH / 6.5m
Local Area Traffic Management Devices	DR 03284	3.5 lux, or 25% spacing

Car Parks	P11 P12 (disabled)	LED/42 W CF or LED/70 W MH/6 m/15 m X 17 m LED/150 W MH/6 m/15 m X 17 m

Note:

HPS = High Pressure Sodium, MH = Metal Halide, MV = Mercury Vapour, CF = Compact Fluorescent, LED = Light Emitting Diode.
20,000 vpd selected but could be 15,000 vpd. Pedestrian/vehicle conflict and presence of heady vehicles also influences selection of V3/V5
Busy PAW's P4, quiet PAW's P5

Module No. 6

Public Open Space Guidelines

6 Module No.6 – Public Open Space Guidelines

6.1 General Requirements

Local Government requires land suitable for public use as public open space.

6.2 Policies and standards

6.2.1 Policies

The following WAPC and DWER policies are predominantly used and apply to subdivision design and assessment:

- State Planning Policy 2.9 Water Resource
- *Liveable Neighbourhoods*:
- Better Urban Water Management Guidelines Western Australia Stormwater Management Manual.

6.2.2 Standards

The following standards are relevant:

- Decision process for stormwater management in Western Australia, Department of Water and Environment Regulation
- Department of Water and Environment Regulation 2007, Interim Position Statement: Constructed lakes.
- Design in Urban Areas – Open Access Drainage Facilities.
  AS 4685.1–2004, General Safety requirements and test methods.
- AS 4685 SET: 2014, Playground equipment and surfacing Set.
- AS/NZS 4422:1996, Playground surfacing – Specifications, requirements and test method.
- AS/NZS 1158 Set:2010, Lighting for roads and public spaces Set.
- AS 1170.2:2011, Structural design actions - Wind Actions.

- AS 1428 (Set) 2010,Design for access and mobility Set.
- AS/NZS 4486.1:1997, Playgrounds and playground equipment - Development, installation, inspection, maintenance and operation.
- AS 4970:2009, Protection of trees on development sites.

6.3 Design

6.3.1 General

Liveable Neighbourhoods has provision to apply subdivision conditions for the development of open space to a minimum standard. If applied, this may include full earthworks, basic reticulation, grassing of key areas, pathways that form part of an overall pedestrian and/or cycle network and maintenance for two summers. This is a new subdivision condition and to date is not routinely applied.

Any development of public open space should be carried out in accordance with the standards and policies stated in 6.2.1 and 6.2.2 respectively to produce a landscape plan first approved by the Local Government. Any special public open space requirements and entry statements will need to be approved by Local Government. The WAPC may not require development of public open space where land is in a fragmented ownership, where it is restricted use public open space, or where climate variations do not require such development.

Passive surveillance of parklands by residents is of high importance especially where children's play equipment is located. This should be delivered through appropriate structure and design. Good visual amenity is also required to minimise the potential of vandalism. The public open space design also needs to consider future maintenance costs.

Mowing strips should be utilised at the base of walls and ease of mowing should be considered in the design.

Residential fencing abutting a public open space shall have visual permeability, conforming to the Residential Design Codes.

The public open space design and associated infrastructure shall conform to *AS1428 (set) – 2003: Design for Access and Mobility Set*.

Provision of landscaping in distributor road reserves by developers at the time of subdivision is encouraged, and the design shall incorporate considerations for cost effective long-term maintenance.

Where required by the WAPC as a condition of subdivision, or where agreed between the Local Government and the developer, public open space and other recreational reserves within the development shall be sustainably designed in accordance with the objectives in section 6.3.2.

6.3.2 Objectives

The guidelines provide a set of performance criteria and standards for provision of public space with a number of prime objectives being to:

- provide a consistent process for review and approval of designs in keeping with specific requirements and Local Government policy;

- ensure the design process takes into account local character and existing conditions;
- encourage the retention and enhancement of endemic vegetation and other natural features;
- provide for the needs of the community by ensuring that public space is functional, accessible and safe for its intended purpose;
- encourage provision of high quality designs that contribute to the built and natural environment and the special character of a place in a sustainable, amenity enhancing and cost-effective manner;
- encourage the use of endemic plant species, drought-tolerant exotic species and waterwise garden designs; and
- minimise requirements for irrigation and fertilisers.

Design and development of public open space should take into account the objectives of water-sensitive urban design and water balance as indicated in section 4.3.

Variations from these guidelines need to be justified on the basis that the design meets the intent, objectives and principles set out in the guidelines.

6.3.3 Public open space

6.3.3.1. Clearing

Where there is no approval for the subdivision of land, the clearing of significant vegetation may require a clearing permit from the Department of Biodiversity, Conservation and Attractions and Conservation under the *Environment Protection Act* and the Native Vegetation Clearing Regulations, unless an exemption applies. Local Government engineering staff should liaise with their Local Government environmental officers or Department of Biodiversity, Conservation and Attractions officers for clearing permit advice.

6.3.3.2. Development in reserve areas

6.3.3.2.1. Management plan

Where required by the WAPC or otherwise specified by Local Government as a condition of subdivision or development, or where agreed between the Local Government and the developer or landowner, open space or reserve areas within the development shall be developed, rehabilitated or constructed in accordance with the Local Government's specifications. A management plan may be required in areas of natural vegetation or environmental sensitivity.

An overall concept development and management plan of development for the open space or reserve area shall be submitted to the Local Government for approval in principle prior to submitting detail working drawings.

Design plans shall show the following details:

- cadastral boundary of the site;
- existing services;
- survey marks;

- fences;
- significant vegetation and trees;
- existing and proposed contours;
- existing or proposed buildings;
- proposed access roads and parking areas;
- pedestrian and cyclist facilities;
- disabled access facilities;
- existing or proposed stormwater or drainage management facilities;
- playground equipment;
- proposed irrigation system;
- other features pertinent to the development of the public open space;
- Areas and details of native vegetation proposed to be removed; and
- Street Furniture.

The design drawings shall include a schedule of trees, plants and grass types suitable to the area.

Consultation with adjoining property owners and residents is required before commencement of the works. In the case of dispute or objection, the matter shall be referred to the Local Government.

6.3.3.2.2. Development process

The process for the development of public open space is as follows:

- the developer shall prepare and submit for approval a landscape master plan and relevant management plans;
- the developer shall prepare and submit for approval detailed landscape drawings prior to construction at the time of submitting civil design drawings;
- construction can commence only upon approval of the detailed landscape plans;
- on completion of the works, the developer shall arrange a practical completion inspection and where required, payment of the landscape maintenance bond;
- the developer is required to maintain the public open space reserve for a minimum two (2) year period from practical completion;
- three months prior to expiration of the maintenance period, the developer shall contact the Local Government to initiate the handover process, which shall commence with a joint inspection of the public open space. This should also include transfer of bore licenses, power accounts, maintenance tasks and legal responsibilities arising from these guidelines;
- once the Local Government is satisfied the public open space meets these guidelines, the Local Government shall accept responsibility for maintenance of the public open space;
- the developer is to comply with all requirements of the Department of Water and Environment Regulation in respect of bore installation and licensing; and
- the developer may negotiate with the Local Government for water budgets.

6.3.3.3. Landscape maintenance agreement

The long-term maintenance cost is an important factor in the design of Local Government facilities to minimise ongoing costs to the community. Landscape maintenance may also include monitoring.

The design of public open space should reflect features that provide for a safe, aesthetically pleasing and functional facility that can be maintained by the community at a sustainable cost.

A maintenance agreement based on the management plan shall be entered into by the developer with the Local Government as part of the approval.

The agreement shall be legal in nature and be prepared at the cost of the developer.

6.3.3.4. Landscape maintenance bond

All plantings shall be supported by a maintenance and watering period of at least two summer periods to ensure full establishment. This condition shall be guaranteed by way of a maintenance bond in the form of cash or guarantee from a financial institution acceptable to the Local Government.

The landscape maintenance bond can be expected to equal five per cent of the contract value for landscape works (excluding GST) as acceptable to the Local Government to be held in trust until handover of the public open space.

The bond will be returned when the maintenance period has been completed satisfactorily.

6.3.3.5. Power supply

The developer shall make provision for adequate power connection points for all public open space at the time of the initial power installation to allow for future anticipated lighting, building and/or irrigation requirements to satisfy the ultimate development of the facilities as established in the planning of the structure plan. This development outline shall be negotiated between the developer and the Local Government at or prior to subdivision or structure planning stage.

6.3.3.6. Planting

Plant species lists of the most common natural and other native species are available from the Local Government. The recommended working drawings and specifications to be approved by the Local Government shall include a schedule stating type, species, number, size of pot, seeds, trees, shrubs, ground-covers, herbs and grasses to be planted. The plan shall show the location and density of planting the specifications shall show detail on how the plants are to be planted, fertilised watered and protected.

6.3.3.7. Playground equipment and play opportunities

Playground equipment may be installed with the approval of the Local Government in each public open space development irrespective of active or passive use. Consultation, where applicable, will take place with adjoining land owners regarding the location and type of equipment.

All equipment and its installation shall meet AS 4685.1–2004 and the *Occupational Safety and Health Act* and Regulations. Play spaces that use natural elements such as wet/dry creek beds, mounds and slopes, sand and mud pits, sensory plants and trees for swinging and climbing should be encouraged to need children's needs for play, learning and fun.

6.3.3.8. Lake areas

Any proposal for a constructed lake shall conform to the requirements of the *Interim Position Statement: Constructed Lakes, Department of Water and Environment Regulation July 2007* and be approved by the Local Government.

Lake areas (including floodwater storage areas with resident water for greater than 96 hours) constructed in public places shall conform to the following requirements:

- constructed lake banks, where practical, shall have barriers to delineate reeded sloped banks from grassed areas. The barriers will preferably consist of footpaths or kerbing;
- lake banks are not to be steeper than one in eight above the low water mark and extend for a distance of at least 10 metres. Below the low water mark, in order to provide a safe recovery zone, the slope shall preferably be one in eight, and shall not exceed one in six for a distance of five metres measured horizontally from the low water mark, and one in four thereafter. This is for public safety and to allow local reeds to establish;
- where slopes in excess of one in eight are unavoidable in the vicinity of a drainage structure, a fence shall be provided. The fence shall be 1.2 metres high and of open mesh construction, extending from the top of the bank to the low water mark on both sides of the structure;
- the banks up to five metres from the low water mark shall be reasonably firm to prevent persons sinking into soft mud. Suitable fill may need to be imported to achieve the necessary compaction of the banks;
- all slopes shall be seeded or planted to obtain stabilisation as quickly as possible; and
- excavation for 'in principle' approved irrigation lakes are not to intrude into the tree root preservation zone (for trees identified for retention). This zone is identified as a one metre radius for every 100 millimetres trunk diameter.

6.3.3.9. Use of reserves for drainage and floodwater storage purposes

Provision of piped drainage outfalls and flood storage areas is difficult in many areas due to flat grades, high groundwater tables or soil types and restrictions imposed by the Department of Water and Environment Regulation and the Department of Biodiversity, Conservation and Attractions with respect to the quantity and quality of stormwater being discharged into river and wetland systems. There is an expectation that development sites accommodate their drainage on site.

The use of proposed open space areas for drainage in new subdivisions will be determined by the WAPC at the time of subdivision, in accordance with *Liveable Neighbourhoods*.

Small rainfall events, up to the 1-year ARI event, are to be managed in defined areas, such as vegetated garden beds, to prevent the active grassed areas from being inundated during small rainfall events.

In existing urban areas where drainage infrastructure upgrading or infill development is occurring, the Local Government may consider proposals to incorporate stormwater or drainage quantity and quality management measures within proposed or existing public open

space, subject to the agreement of the landowner – which may be Local Government or private owners.

Such applications should have regard to the following:

- the proposal to use the recreation area for drainage is approved by Local Government and the relevant government agency with management responsibilities (if not Local Government);
- in the case of a developer, providing a written undertaking to develop the reserve as required and specified by the Local Government;
- the drainage purpose does not impact on current and planned recreational functions of the reserve unless authorised by the Local Government;
- mosquito management is addressed; and
- the drainage facility is not detrimental to the use of the reserve or to flora and fauna.

6.3.4 Tree planting

All plants proposed shall have an emphasis on local endemic species, due to their drought tolerance, low maintenance and ability to withstand local climatic conditions. The developer shall refer to the Local Government 'recommended plant lists' for selection of appropriate trees and to the "not permitted plant species" list for the '**not recommended'** plants.

6.3.4.1. Trees in paved areas

Trees in the urban environment are subjected to stress. It should be assumed that feeder roots are concentrated in the top 500 to 600 millimetres of soil and extend to the drip-line of the tree canopy. Paving should be at least 20 per cent porous for this distance or a substantial area of exposed soil should be left to at least three (3) times the expected diameter of the tree. The area at the base of the tree should be able to be watered by run-off or trickle irrigation for at least the first two (2) summers or until established.

Protection of the exposed area is essential (use mulch or tree grates) to prevent soil compaction. Alternatively, removal and replacement of the surface paving with a metal tree grate and/or the application of mulching material is recommended.

Where possible, opportunities for natural infiltration of water and air should be maintained. That is, porous paving material (eg. brick and sand) should extend at least beyond the expected canopy area of the tree at maturity. The expected canopy should not interfere with lights, roofs, traffic or pedestrians.

Radial brick patterns provide bigger spaces between bricks than rectangular patterns, which will help reduce the likelihood of tree roots distorting the pavement.

Root shields may be used for intrusive types of trees to protect structures or piping.

6.3.4.2. Protection of trees from excavation works

It is likely that new structures built in close proximity to existing trees, will damage or destroy tree root systems and may lead to a reduction in the ability of a tree to withstand high winds.

Buildings built close to trees may create higher wind speeds through wind tunnelling. Buildings built close to existing trees can stress the trees through an increase in reflected light and heat. An arboriculturist should be engaged to provide guidance on how to treat trees retained close to new buildings. This may be compensated by thinning or reducing the top of the tree by a corresponding amount during the coolest time of the year and by the use of substantial amount of watering.

Where structures are to be built close to trees, it may be possible to construct breaks in the foundations to save roots from being destroyed.

To prevent roots from damaging new work, it is essential to use appropriate pipes. Pipes laid near trees must have sealed joints and be flexible. Alternatively, pipes should be ductile or cast iron with a minimum of joints. The pipes should be strong enough to withstand the pressures of root growth.

When excavations are made for water, sewerage lines and service facilities, the trenches should be directed away from the trees. If it is impossible to locate the trenches away from the drip-line area, the best alternative is to excavate a tunnel, usually with a high-powered soil auger, under the trees' root system rather than to the sides. A further alternative is the use of root shields. Backfilling should be carried out as soon as practically possible.

If raising of the pavers or pavement is required, a coarse porous wall of material such as stones or gravel topped with mulch should surround the tree so that water and air can penetrate to the original ground surface level.

If lowering of the pavers or pavement is required, the soil should be retained by either a battered slope or retaining wall with weep-holes left at the new surface to allow water to drain into the tree. If roots are cut, the tree should be pruned back, as the cutting of anchor roots can lead to windrow.

Trees growing in clay soils require the same amount of water. They may have smaller root systems due to reduced porosity in clay soils. Smaller root systems can make trees in clay soils more vulnerable to heat stress.

When planting in heavy to medium clay sub-soils, backfill the hole with a porous soil mixture and provide for drainage to prevent a sump forming. The addition of gypsum to clay soils will improve soil structure and improve drainage, if several applications are made over a two to three year period.

Introduction of a slotted-corrugated-PVC-agricultural field drain placed in the base of a tree pit prior to back filling can also be considered. A pump inserted into this pipe can drain or pump out tree pits to prevent logging for extended periods during the trees' establishment period. Such drains may also be of use for hand watering on clay soils during drought periods.

Over-watering of heavy textured soils leads to water-logging which reduces plant growth and can lead to tree losses. It should be noted that some trees can tolerate heavy soils and/or high water tables. Success will depend on species selection.

6.3.5 Foreshore areas

6.3.5.1. General

Foreshore areas require special attention and need to be determined in accordance with the Department of Water and Environment Regulation's Operating Policy: Identifying and establishing waterway foreshore areas, 2012. Foreshore areas are generally more vulnerable to natural and human drainage. The objective of this section is to provide an outline of the

salient points required of a coastal beach, dune, or waterway management plan to cover both the developer's land and adjacent public lands. Local Government or WAPC referral and approval is required for works on foreshore reserves, other than rehabilitation and maintenance. Foreshore reserves should generally not contain drainage.

6.3.5.2. Guidelines for construction of access to beaches

Erosion of beaches resulting from wave and wind action is a natural process. In some areas, after periods of erosion, reasonable stability is normally regained through the operation of natural forces. As development occurs and human influence becomes more evident on foreshore and coastal areas, accelerated erosion of beaches is likely to occur. Denuding vegetated frontal dunes by foot traffic and/or grazing results in wind transport of sand in an inland direction. This movement decreases the amount of sand in the 'sand cycle' between bay, beach and dunes, and can result in accelerated wave erosion due to the lowering in level of the beach and dunes. Structures such as walls and groynes may then be required to protect the shore. Development setbacks are applied to reflect the ability of the coast and coastal protection structures to protect the shoreline.

Natural frontal dunes can be stabilised against wind erosion by vegetative measures or where erosion and resultant damage is extreme by engineering structures such as seawalls. Vegetative stabilisation is the cheaper and more natural type of dune stabilisation. Where this type of stabilisation is used, the points of access to the beach are susceptible to wind erosion. Fencing is usually required to direct access to the appropriate areas.

6.3.5.3. General requirements for beach access tracks

Effective access over a secondary and frontal dune system must comply with the following specific requirements (including river, estuary and wetland foreshores):

- access must be conveniently placed, so that it will be used by the public;
- where the access traverses sand, the sand surface must be so treated that it is not susceptible to wind or 'human' erosion. This usually entails surfacing of the tracks with compacted limestone gravel and bitumen, board and chain walkways, mulch, or steps;
- access tracks should be located over existing dunes and not through them. Care should be taken to ensure that dune height is not reduced to less than 2.5 metres Australian Height Datum. Location in this manner will help prevent the ocean overtopping the dune and the formation of blowouts along the track, or excessive accumulation of sand. It will also simplify vegetative stabilisation of the areas alongside the access tracks;
- provision should be made in the case of gravelled and sealed access tracks to minimise or prevent water erosion. This can be done by preventing excess run-off water on to the tracks, and by shaping the surface of the track to prevent concentration of water and enabling it to shed heavy rainfalls quickly;
- access tracks should be sited and aligned so that sand blown from the beach does not accumulate in them to any great extent. The tracks should be aligned to be at 45° from the most destructive winds – south west and north west. Width should not be less than 1.5 metres, and up to three metres where emergency vehicle access is required and the maximum slope should be 15 per cent; and
- tracks should be completely fenced off to prevent damage to the vegetation and to encourage use of the track with suitably worded and prominently placed signs.

6.3.6 Verge treatments

Plants for verge treatments to be undertaken as part of a POS development are to be selected in consultation with the Local Government.

Road reserve plantings especially at intersections shall be selected so as not to restrict road users and pedestrian sight distance and access.

6.3.7 Conservation Reserves

Where an area of a development (the area) is required as a conservation area or for the retention of existing native vegetation the developer is to undertake the following:

- remove all noxious weeds from the area;
- construct fire breaks in accordance with the fire management plan;
- fence the reserve prior to subdivision works to a standard specified by the Local Government;
- prepare a Reserve Management Plan for future maintenance; and
- maintain the area for a period of two years from the date of practical completion.

6.4. Specifications

6.4.1. Clearing

Site plans shall be annotated to clearly show areas 'to be cleared'. Where approved, all standing timber, scrub and other vegetation, including roots to a depth of 300 millimetres, are to be removed and disposed of in accordance with Local Government requirements. Any trees designated for retention shall be protected from damage to roots and trunks. 100 millimetres of topsoil from all cleared areas to be earth-worked, shall be stripped and stockpiled for later respreading as directed by the Local Government.

Rehabilitation of disturbed or previously degraded areas will generally be required as a condition of approval for clearing or reserve development, or as a condition of development approval.

Some clearing may require the Department of Biodiversity, Conservation and Attractions approval as per legislation in Module 1.

6.4.2. Land or form – earthworks

Change to the land or form of reserves requires Local Government or WAPC approval. Once approved, the site shall be worked to the levels and grades shown on the approved drawings, suitable for the designated type of recreation activity or purpose, ie. active, passive or conservation.

6.4.3. Compaction

Fill, where applicable, shall be placed in layers not exceeding 300 millimetres in thickness, be watered and rolled to achieve a minimum compaction of the surrounding natural soil.

6.4.4. Irrigation

Design plans for irrigation of the public open space shall contain a list of approved sprinklers, valves, bore, electrical switch gear and other equipment used by the Local Government. Water quality will be acceptable to the Local Government or water treatment provided to improve water quality to a suitable level.

The design shall specify identical or compatible equipment in the design of the irrigation system. A plan of the proposed irrigation system shall form part of the design drawings and requires approval by the Local Government.

All fixed sprinkler systems shall overlap centre to centre.

Pipe classes shall be strictly in accordance with the manufacturer's recommendations for the design pressures within the system; however, no PVC pipe of class lower than Class 12 shall be used.

An ‘as construction’ plan of the irrigation system is required.

6.4.4.1 Design and specification

Irrigation designs are to conform to the Local Government’s irrigation requirements. The developer shall design and construct all systems to be compatible with the Local Government control system requirements.

6.4.5. Watering systems in paved areas

6.4.5.1. Watering systems for trees in paved areas

An adequate watering programme can be provided manually, provided there is sufficient surface area to absorb a quickly delivered volume and provided a water source is available. A coil of flexible, slotted agricultural piping can be laid in a ‘corkscrew’ fashion around the root ball when planting, leaving a length (150 millimetres with cap) protruding above the soil level which can conveniently be filled manually.

Reliance on rain falling on paved surfaces and being directed into or past the exposed soil area round each tree is effective as a supplement. Where new paving is being constructed, gentle cambers and/or dish drains should be located appropriately. Use of porous paving such as bricks or concrete pavers laid on sand with a permeable membrane will also allow some water to filter through. Wetting agents may be required to ensure water penetration.

Drip irrigation, micro-irrigation and trickle irrigation systems are the modern approach to applying specific volumes of water to trees. They are water-efficient, as moisture is distributed by pipe to each tree and released through one or more drippers or trickle heads.

6.4.5.2. Basic guidelines for water system operation

Water should be delivered up to twice per week in the warmest weather, at a rate of 10 to 20 litres each application, or as varied to suit local conditions. In winter, natural rainfall should be adequate.

When adjusting the amount of watering in different seasons and weather, the frequency rather than the volume should be altered.

Young trees can be adequately watered by a single or double trickle outlet positioned about 500 millimetres from the trunk.

6.4.6. Post and rail fencing and bollards

Where so specified, the perimeter of reserves adjoining roads or where barriers are to be used on reserves of any public space for protection of vegetation or access control, are to be fenced with CCA-treated pine post bollards or post and rail fencing or other appropriate fencing in accordance with the following:

- nominal post diameter is not less than 150 millimetres;
- rail (where used) diameter is 100 millimetres to 150 millimetres, where required. The top of the rail shall be nominally 50 millimetres below the post top;
- seven millimetre diameter galvanised fixing round head bolts being used. Nuts and protruding bolts thread shall be countersunk and recessed;
- post spacing is to be 2.4 metres where rails are required, and rail length is to be 3.6 metres, and the gap between end of rails is to be 600 millimetres;
- post spacing is to be not greater than 1.5 metres between centres where bollards only are required;
- alternative materials including recycled materials can be used, provided they are approved by the Local Government;
- typical length for post and rail is to be 1200 millimetres, set 450 millimetres in the ground with 200 millimetres concrete to 100 millimetres below ground level for post and rail, and 900 millimetres above the ground. Bollards shall be 1200 millimetres to 1600 millimetres long. Where placed near car parks or road edges, bollards shall be 1100 millimetres above ground and 900 millimetres below. At park edges, bollards shall be 750 to 900 metres above ground and 450 to 600 millimetres below ground. An alternative to concreting posts into the ground is fixing an anchor to the bottom of the post to prevent withdrawal; and
- post tops and rail ends shall be chamfered.

Fencing requirements may vary depending on the Local Government.

6.4.6.1. Private property and reserve boundary fencing

Where private property adjoins a reserve fencing shall be as specified by the Local Government.

The Local Government is not responsible, under the *Dividing Fences Act 1961*, for the cost of fencing boundaries of any reserve including public access way and road reserves adjoining private property. This is the responsibility of the adjoining landowner.

6.4.6.2. Vegetation protection fence

The standard minimum protection fence for vegetation is a three-strand plain wire white PVC coated and logged fence, set at the edge of vegetation. Posts 75–100 millimetres in diameter shall be spaced at not greater than four metres with strainers 150–175 millimetres in diameter,

strutted and not greater than 100 metres spacing. Strainers shall be provided at each opening. Other fences may be approved as variations on the standard.

6.4.7. Specifications for access tracks

6.4.7.1. Base and surface

Access tracks should comply with the following:

- on sand 150 millimetre thickness or on gravel 100 millimetre thickness compacted fine gravel or fine crushed limestone base;
- light seal of fine aggregate and bitumen emulsion;
- 2–5 per cent cement stabilisation can be used on some gravels to reduce base depth or to strengthen the base in poor foundation soils;
- heavy layer of medium coarse mulch – mixed bark chip and leaves may be used for informal, low use paths;
- asphalt seal with moderately high bitumen content 25 millimetre thickness in limestone and 20 millimetres in gravel;
- boarded walk; and
- rubber mats, chained slats or sleepers.

6.4.7.2. Cross-section

Cross-sections for access tracks should be graded for drainage, one way two per cent crossfall, or with crown two per cent crossfall.

Module No. 7

Standard Drawing Guidelines

7 Module No.7 – Standard Drawing Guidelines

7.1. General requirements

The following sections outline details and general aspects that a developer and the consultant should supply when submitting drawings for development.

7.2. Policies and standards

7.2.1. Standards

The following standards need to be applied to subdivisional development drawings with all levels to be shown in Australian Height Datum unless specifically otherwise approved.

- AS 110 Drawing Standards;
- AS 1100.101–1992 – Technical drawing – General principles;
- AS 1100.101–1992/Amdt 1–1994 – Technical drawing – General principles;
- AS 1100.401–1984 – Technical drawing – Engineering survey and engineering survey design drawing;
- AS 1100.401–1984/Amdt 1–1984 – Technical drawing – Engineering survey and engineering survey design drawing;
- AS ISO 128.1–2005 – Technical drawings – General principles of presentation – Introduction and index;
- AS ISO 128.21–2005 – Technical drawings – General principles of presentation – Preparation of lines by CAD systems; and
- AS ISO 128.23–2005 – Technical drawings – General principles of presentation – Lines on construction drawings.

This list is not exhaustive and other publications may also give rise to drawing standards and specifications.

7.3. Design

7.3.1. Drawings

Design drawings shall show the following details:

- cadastral boundaries of the existing site and future subdivisional lots;
- existing and proposed services;
- fences;
- significant trees and vegetation;
- existing and proposed contours;
- existing and/or proposed buildings;
- proposed access roads and parking areas;
- pedestrian and cyclist facilities;
- disabled access facilities;
- existing or proposed drainage management facilities, including sub-soil drainage systems

In addition to the details listed, the following items shall also be included in the submitted drawings;

- typical road cross section, including pavement, seal, kerb and verge shape;
- stormwater drainage structures;
- footpath and dual path details;
- kerbing details;
- ramp and grab rail details;
- street name signs and street furniture;
- retaining walls (a building licence is required);
- all survey reference marks required by the Local Government; and
- public transport facilities.

Drawings should be numbered and include revision numbers and signed / approved by a suitably qualified person.

The following section gives examples of the different aspects of design drawings and forms a set of drawing specifications which are suggestions only. There are several forms of drawing specifications and these should be discussed with the consultant and the Local Government.

7.3.1.1. Drawing lines and sets

Drawings may be prepared in colour, but must remain legible if photocopied and/or faxed in black and white.

The drawing number, title, revision letter, north point arrow, bar scale and scale at a nominated paper size shall all appear on every drawing. The Local Government's logo may also be required.

Sets of drawings shall be listed on a contents page at the same size and format as the drawing set.

7.3.1.2. Layer naming and layer discipline

All drawing layers produced by the consultant should be named commencing with the consultant's initials. Following the consultant's initials, all layers shall commence with one of the following prefixes:

- L (for line)
- H (for hatch)
- I (for image)
- T (for text).

These words should indicate the type of object on each layer respectively.

Following the object type, layers should describe the element represented on that layer. This should be as succinct as possible. For example:

- trees
- kerbs
- footpath
- buildings
- walls
- roads
- furniture
- drainage.

Following each element name, any specific quality of that element may be used to differentiate it. For example:

- trees proposed
- kerbs barrier
- footpath concrete
- buildings demolished
- walls retained
- roads asphalt
- furniture bench
- drainage.

The layer labelled 'LA L Trees Proposed' will therefore appear adjacent to 'LA Line Trees Felled', enabling all lines describing similar elements to be identified and grouped together in the layer control pane. The creator of each layer will also be clear by the use of initials, and all layers created by a single author will appear adjacent to each other.

Prior to issue each layer should be checked by the consultant using the layer isolate command on each layer in turn. Objects that appear on an inappropriate layer during this process should be moved to their correct layer.

7.3.1.3. Viewports

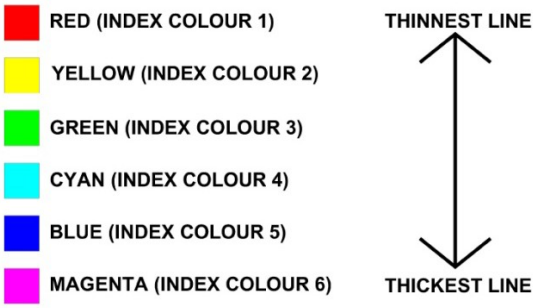
All viewports shall be locked, with the non-printing symbol checked on the layer control pane, and located on a layer described as 'VP'.

PSLTSCALE command setting shall be set at 0.

All layers shall be switched on in model space; unwanted layers in viewports shall be removed through viewport freezing. This allows all objects to be visible when the file is viewed in model space, avoiding the impression of information being lost on frozen or 'off' layers when the drawing is viewed in model space.

7.3.1.4. Plot styles

The plot style shall use the order of the colours in the default index colour bar to describe the gradual thickening of lines on the finished print. For example;



Line thickness shall be nominated by the author to suit the size and format of the drawing when printed (note the requirement for legibility at A3 pertains to this issue).

7.3.1.5. Hatching

Solid hatches shall be in non-index colours to allow expression of the colour in the printed document.

Non-solid hatches shall be in index colours so that they appear black when printed.

Text within hatched areas or overlying photographs shall employ a background mask to aid legibility of text when reproduced in black and white.

7.3.1.6. Raster images

Image frames shall be switched off prior to issuing drawings.

7.3.1.7. XRef files

XRef files shall not be greater than 4MB. To reduce file sizes, drawings may use XRef 'base' drawings to allow emailing to and from the City's officers. XRefs may be emailed separately and reinserted upon receipt of the drawing.

7.3.1.8. Coordinates

Ensure all 'Z' coordinates on 2D drawings are set at 0 to avoid errors in taking off quantities and errors in drafting (note that many topographical surveys are routinely made in 3D).

7.3.1.9. Polylines

Ensure all fragmented lines intended to be one object are joined, and all polygons are closed, by auditing the drawing with the properties manager prior to issuing the drawing.

7.3.1.10. Annotations and dimensions

All annotations and dimensions shall comply with the Local Government's style guide, and shall be inserted onto paper space. Dimensions shall be generated using the dimension command, and scaled in the dimension manager to suit the scale of the viewport.

7.4. Submission of documents for approval

Prior to commencement of construction of any subdivisional works, the developer shall submit the documents listed below to external government agencies and the Local Government for approval (eg. sign and linemarking plans by MRWA and street lighting plans by Western Power).

This is required to satisfy engineering conditions imposed in the letter of conditional approval of the subdivision by the WAPC and as required under section 170 of the *Planning and Development Act 2005*. The following documents shall be submitted where appropriate or required:

- geotechnical investigation report;
- subdivision pre-calculation plan;
- earthworks grading plan;

- services plan (electricity, water, telecommunications, gas and sewer);
- roadworks and drainage layout plan, including service crossings;
- roadworks and drainage longitudinal profile drawings;
- roadworks typical cross section drawings;
- stormwater catchment and management plan;
- stormwater drainage calculations;
- standard drawings and details;
- landscape master plan;
- landscape,irrigation, operation, maintenance and management plans for public open space;
- Environment Protection Authority site classification assessment chart for dust control;
- soil stabilisation strategy;
- construction cost of the works;
- project schedule (including all works eg. water, sewerage, power, landscaping);
- specification for the works;
- traffic management plan;
- environmental management plan;
- emergency management plan;
- plan of existing significant vegetation;
- plan showing location, elevation and structural details of retaining walls, bridges and other similar structures;
- locality plan;
- street lighting plan;
- fire management plan;
- dilapidation survey;
- vibration management plan;
- pavement design calculation; and/or
- urban water management plan.

All documents shall be submitted in duplicate. The Local Government will return one set to the consulting engineer either endorsed 'Approved', or with any modifications detailed. If significant modifications are required, the consulting engineer shall resubmit the documents incorporating the required modifications.

On final approval of the design, one set of approved drawings and specifications will be returned to the consulting engineer accompanied by a letter of approval indicating any conditions with respect to the drawings or specifications. One set will be retained by the Local Government.

No construction shall commence until all documents have received approval (ie. WAPC conditional approval has been received and the Local Government has approved the subdivisional engineering design documents and drawings).

The consulting engineer shall, in submitting the documents for approval, allow a reasonable time for the initial examination of the documents. The Local Government will be able to advise the consulting engineer of the general adequacy of the submission and approximate time required for full assessment. A reasonable time for an initial assessment of adequacy and time frame for a full assessment is 10 working days. Refer to section 1.12 for information on the approval process.

All drawings shall show a north point.

All plans for earthworks, road works and drainage works shall be certified by a practicing experienced Civil Engineer.

All plans for bridge works, retaining walls and/or other structures shall be certified by a practicing experienced Structural Engineer.

7.5. Information to be shown on drawings

7.5.1. Scales for drawings

DRAWING		SCALE
Locality plan		1:5000
Pre-calculated plan		1:1000
Re-contouring and earthworks layout		1:1000
Overall layout plan		1:1000
Road, drainage plan, including services	*Preferred* *Minimum*	1:500 1:1000
Road profile	*Horizontal* *Vertical*	1:1000 1:100
Road cross-sections		1:250
Intersections		1:250
Traffic management devices		1:250
Culs-de-sac		1:250
Drainage plans	*Horizontal* *Vertical*	1:500 1:50
Standard drawings	Various as appropriate	
Stormwater catchment plan		1:1000
Landscape master plan		1:1000
Landscape and irrigation plans for public open space		1:500
Environment Protection Authority site classification assessment chart for dustcontrol		1:1000

Where applicable or where such drawings will allow better information for approvals the turning movements for appropriate vehicles can be submitted for assessment of traffic management and turning movement details.

7.5.2. Locality plan

The locality plan shall (where appropriate) show:

- existing roads including distributor roads;
- new roads;
- locality areas;

- service corridors;
- any other significant features; and
- Limit of works and immediate surrounds.

7.5.3. Pre-calculation plan

The pre-calculated plan shall (where appropriate) show:

- lot numbers;
- areas and dimensions of lots;
- road reserve widths;
- road names;
- truncations;
- drainage easements; and
- utility provider road widening requirements.

7.5.4. Re-contouring and earthworks layout plan

The re-contouring and earthworks plan shall (where appropriate) show:

- all existing and proposed road and property boundaries;
- all existing and proposed contours with maximum intervals of 1 metre. However, there may be a need to reduce the interval to 0.25 metres at intersections;
- detailed areas of cut and fill;
- total earthworks or re-contoured area;
- levels along existing roads and property boundaries adjacent to the re-contoured area;
- details of ties to existing levels;
- details of existing vegetation and extent of clearing and vegetation protection;
- all trees with trunk diameters greater than 150mm;
- location of all existing and proposed retaining walls;
- levels and contours of shaped sub-grade / impervious layer where applicable; and
- spot heights.

Note: the horizontal distance between minor contours should be no more than 5mm (critical for flatter sites).

7.5.5. Layout plan

The layout plan shall (where appropriate) show:

- existing and new streets and roads with allocated street names;
- pavement widths;
- lots with lot numbers;
- existing and proposed street drainage and allotment drains where required with any necessary easements;
- services and fence lines (where applicable);
- traffic management devices;
- footpaths, shared path, cycle paths and bridle paths (where applicable);
- survey and bench marks;
- operating speed for all new roads;
- bus embayment's, parking bays, street furniture and tree locations;

- street lighting;
- retaining wall locations; and
- waterways and water bodies.

7.5.6. Road plans

Each road to be constructed shall be drawn in plan and profile and cross sections shall (where appropriate) be provided.

7.5.6.1. Street plans

The plan of the street shall (where appropriate) show:

- width of all pavements, verges and medians;
- distances and stations along the centre of the road;
- existing services;
- street lighting;
- horizontal curve data;
- existing and proposed levels;
- existing and proposed street drainage including manholes and gullies;
- lots facing onto the street;
- proposed traffic management devices;
- existing and proposed services in the road reserve (where applicable);
- footpaths, footways, cycle paths and bridle paths (where applicable);
- location of street signs;
- full details of stormwater drainage connections from and to adjoining developments;
- long section profile, including road gradients, vertical curves, and crossfalls;
- cross sections;
- on-street parking; and
- any other relevant information.

7.5.6.2. Longitudinal profile

The longitudinal profile of the road shall (where appropriate) show:

- a running distance along the centre line of the road;
- natural surface levels along the road centre line and both property lines;
- design pavement levels along the centre line and both channels. Levels shall be at a maximum of 20-metre intervals on straight grades, and alignments and shall be at 10-metre intervals on vertical and horizontal curves. Levels shall also be shown at horizontal curve tangent points and any other salient locations;
- lengths of grade lines with grades expressed as a percentage;
- intersection and tangent points at change of grades;
- length of vertical curves; and
- transition and superelevation details.

7.5.6.3. Cross-section details

Cross-section details shall (where appropriate) show the offset from the road reserve centre line and levels of the following points:

- road centre-line;
- toe and top of kerb;
- any change in crossfall;
- road reserve boundary.
- street tree alignments;
- street lighting alignments; and
- underground services.

7.5.6.4. Plans of other features

Plans of intersections, cul-de-sac heads, roundabouts and any other traffic management device(s) shall (where appropriate) include the following information:

- all adjacent lot boundaries;
- geometric details;
- design levels at appropriate points;
- drainage and other services (where applicable);
- specific features such as kerbing, pathways, signs, ramps, paving and so forth;
- existing and proposed services;
- paths and cycleways;
- island and median details;
- signage and line marking as approved by MRWA;
- ramps and tactile paving areas; and
- design contours.

7.5.6.5 Utility plans

The public utility plans shall (where appropriate) include:

- water reticulation layout;
- sewer reticulation layout;
- power supply layout (including street light locations);
- Telstra cable locations; and
- Reticulated gas layout.

7.5.6.6 Path network plan

The path network plan shall (where appropriate) include;

- existing and proposed pathways;
- ramp and grab rail locations;
- path widening;

- widths of paths;
- construction requirements;
- location of above ground infrastructure and features (i.e. light poles/trees); and
- signage and line marking of shared paths.

7.5.6.7 Intersections and other features

Plans of intersections, roundabouts, cul-de-sacs, temporary turn arounds, slow points etc shall be drawn at 1.250 minimum.

The following information shall (where appropriate) be shown:

- all lot boundaries;
- footpaths and shared paths;
- island and median details;
- kerbing details;
- ramp and grab rail details;
- drainage details;
- existing trees and proposed landscaping;
- streetlights; and
- signage and line marking (approval by MRWA required if regulatory).

7.5.7. Drainage plans

The stormwater drainage plans shall accurately reflect the content of the Local Water Management Strategy and the Urban Water Management Plan for the development area and must clearly address its recommendations.

All drainage lines shall be drawn in plan and profile, without compromising legibility, on the same drawing and where practical, on the same plan as the road longitudinal plan and profile.

Drainage plans shall (where appropriate) show:

- existing and proposed drainage lines detailing channel flow cross-sectional area, pipe sizes, invert levels, hydraulic grades and top water levels, lengths, junction pits, gullies, sub soil drainage, other drainage structures and whether the pipes are slotted or solid;
- upstream and downstream levels on all existing drainage and outfalls to which connections are being made;
- existing and proposed sewer lines and any other services which may affect the drainage works;
- existing and proposed contours and spot levels;
- streets, street names and lot numbers;
- existing and proposed drainage easements including their description and width;
- stormwater connection points and the design discharges from lots where property drainage is applicable;
- basins, open drains, table drains, outlets and overflow structures, headwalls and siphons; and
- physical pipe grades and identify pipe type, class and size;
- service crossing clearance data, clearly marked hydraulic gradeline on profiles;
- subsoil drainage and flush out points;
- re-vegetation of drainage basins works; and
- the top water level to AHD for the 10 year and 100 year storm events in drainage basins and swales and storage volume.

Longitudinal section

The longitudinal section shall (where appropriate) show:

- all pipe sizes and grades, the type and class of pipe and whether the pipe is solid or slotted;
- existing natural and finished surface levels on the pipe route;
- invert levels of the pipes and the depth to the invert from the finished surface;
- running distance and the distances between gullies, junction pits and other drainage structures;
- location and levels of other services, especially sewer line crossings;
- details of all junction pits, gullies and other structures; and
- longitudinal section – showing bedding details, HGL's, tailwater, etc..

In some cases it may be more efficient to show drainage profiles on the road profile drawings, and this is acceptable.

7.5.8. Landscaping plans

Landscaping plans shall (where appropriate) show:

- cadastral boundaries of the existing site and future subdivisional lots;
- existing and proposed services;
- fences;
- significant vegetation and trees;
- existing and proposed contours;
- existing and/or proposed buildings;
- proposed access roads and parking areas;
- pedestrian and cyclist facilities;
- disabled access facilities;
- existing or proposed drainage management facilities, including sub-soil drainage systems;
- significant environmental areas such as wetlands;
- playground equipment;
- proposed irrigation system;
- other features pertinent to the development of the public open space
- schedule of trees and other vegetation to be planted which indicates the botanic name (genus, species and cultivar), pot sizes and quantities;
- design and specification of play equipment;
- seating, shelters and barbecues;
- retaining walls (may require a building licence – refer BCA); and
- signage.

Where landscaping drawings are required, they shall include a schedule of trees suitable to the area, other vegetation to be planted and grass types.

7.5.9. Drawings of standard details

Standard drawings shall show the following information:

- pavement and seal cross section;
- kerb cross-sections;
- street signs and name plates;

- pipe bedding and laying details;
- drainage structures, including side entry pits, junction pits, headwalls, acquifer recharge structures, detention basins, bubble-up pits, scour protection details and gross pollutant traps;
- fencing guide post locations;
- brick paving;
- sub-soil drainage;
- footpaths and dual use paths;
- lot connection pits where appropriate; and
- any other standard details appropriate to subdivisional works or details within the design area.

7.5.10. 'As-constructed' drawings

Prior to the release of the subdivision, the developer shall provide the Local Government with a full set of 'as-constructed' engineering drawings in hard copy and digital format. These drawings shall be in a reproducible form, clearly marked 'As-constructed' and be certified by a licensed surveyor, as follows:

- details of any alterations made during construction of the road network;
- drainage drawings and grades against the design lines, levels and grades of the drainage network;
- street lighting and confirmation of luminaire; and
- any other infrastructure information and specifications required by Local Government for their asset management systems.

Module No. 8

Construction Guidelines

8. Module No.8 – Construction Guidelines

8.1. General requirements

This module is to apply as the minimum specifications for subdivision works in the Local Government area.

Where a particular construction technique is required for use in subdivision works but is not covered in this module the consulting engineer shall submit an alternative to the Local Government for approval.

8.1.1. Noise Management

Noise emissions from the subdivision works shall comply with the Environmental Protection (Noise) Regulations 1997. An assessment of the noise anticipated to be caused by subdivisional works to determine whether a Noise Management Plan is needed must be undertaken by the consulting engineer using a suitable qualified and experienced person prior to the works commencing. The Noise Management Plan is to be in accordance with the Local Governments Noise Management Guidelines. The Noise Management Plan requires approval prior to commencing works.

8.1.2. Vibration Management

Vibration due to subdivision works must be managed in accordance with the provisions of the Local Governments Vibration Management Guidelines. The Vibration Management Plan requires approval prior to commencing works.

8.1.3. Traffic Management

Where work on existing roads is approved as part of a subdivisional development a traffic management plan shall be prepared and signed by an accredited traffic management professional and submitted for approval.

Traffic shall be managed in accordance with MRWA Traffic Management for Road Works Code of Practice and AS 1742.3 Manual of Uniform Traffic Control Devices: Part 3 Traffic Control Devices for Works on Roads.

The traffic management plan shall be developed to minimise the impact of the works on traffic flows, pedestrians, cyclists, access to existing private properties, and emergency vehicles, while ensuring the safety of employees and the public.

8.1.4. Road Closures

Where it becomes necessary to close an existing road to traffic to carry out approved construction works, the developer shall apply to the Local Government for approval to close the road at least 21 days before the closure is required.

The application for a road closure shall include the following details:

- Location of closure
- Reason for closure
- Period of closure
- Route proposed for traffic detour (if any)
- Significant facilities affected by the closure (e.g. schools, hospitals, etc)
- Method of advertising the closure
- The Traffic Management Plan for the closure

The developer shall advise all emergency services and owners and occupiers affected by the proposed closure once the Local government approval has been obtained. The developer shall comply with any conditions placed on the road closure approval.

If a closure is likely to exceed 7 days, public consultation is required, in which case the developer shall make application at least 28 days before the closure is required. For closure in excess of 7 days a suitable Public Notice is to be placed in the local newspaper circulating in the area.

8.1.5 Sediment and erosion control

Sediment and erosion control measures (including dust control) must be provided and maintained during construction.

8.2. Acts and Standards

The following acts and standards may be considered as the minimum consideration of the infrastructure within a sub-development.

8.2.1. Acts

- *Bush Fires Act 1954*;
- *Environmental Protection Act 1986*;
- *Mines Regulation Act 1946* and
- *Explosives and Dangerous Goods Act 1961.*

8.2.2. Standards

- AS 2734: Asphalt (Hot-mixed) Paving – Guide to Good Practice;
- AS1160: Bituminous Emulsions for Construction and Maintenance of Pavements;
- AS 2758.1: Concrete Aggregates;
- AS 3600: Concrete Structures;
- AS 3959: Construction of buildings in bush-fire prone areas;
- AS2157: Cutback Bitumen;
- AS 2188: Explosives – Relocatable Magazines for Storage;
- AS 2187: Explosives – Storage, Transport and Use;
- AS 1712: Fibre Cement Pipes;
- AS 2419: Fire Hydrant installations;
- AS 1744: Forms of Letters and Numerals for Road Signs;
- AS 1761: Helical Lock-seam Corrugated Steel Pipes;
- AS 1762: Helical Lock-seam Corrugated Steel Pipes – Design and Installation;
- AS 2150: Hot mix asphalt;
- AS 1289: Methods of Testing Soils for Engineering Purposes;
- AS 2566 Plastic Pipe laying Design;
- AS 3972: Portland and Blended Cement;
- AS 4058: Precast Concrete Pipes (Pressure and Non-Pressure);
- AS 2008: Residual Bitumen for Pavements;
- AS 1597.1: Small Culverts;
- AS 1379: Specification and Supply of Concrete;

- AS 1302: Steel Reinforcing Bars for Concrete;
- AS 1303: Steel Reinforcing Wire for Concrete;
- AS 1742.5: Street Name and Community Facility Name Signs; and
- AS 1304: Welded Wire Reinforcing Fabric for Concrete;

8.3. Specifications

8.3.1. Construction requirements

8.3.1.1. Codes and other applicable documents

Materials, workmanship, construction procedures and tests shall conform with the relevant Australian Standards and Codes published by Standards Australia. These documents shall apply generally as appropriate whether specifically referenced or not.

8.3.1.2. Survey preparation

The works shall be set out and constructed in accordance with the alignments, levels, grades, road chainages, distances and cross-sections shown on the approved drawings.

The works shall be set out, using appropriate survey equipment, from the pegs and bench marks given and these shall be used constantly during the progress of the works to check accuracy. Care shall be taken not to disturb any survey pegs, survey recovery pegs or survey marks.

Where it is necessary to cover a survey peg, it shall have a substantial stake (suggested 25 x 25 millimetres) driven beside it and this stake shall extend at least 75 millimetres above the finished surface and be appropriately marked to identify it. The developer shall be responsible for the accuracy of the setting out works.

Any State survey mark affected by the works shall be identified and reported to the Department of Planning, Lands and Heritage Administration for replacement or relocation.

The Contractor shall be responsible for any reinstatement of survey pegs, survey recovery pegs or survey marks. Suitably qualified personnel shall complete such reinstatement works.

8.3.1.3. Clearing

Clearing of all shrubs and trees shall be completed only to an extent sufficient to facilitate the construction works. Natural vegetation shall be retained where possible. Precautions to protect and prevent damage to native vegetation to be preserved during subdivision works must be put in place as agreed with the Local Government.

All tree roots, boulders and other deleterious material shall be totally removed to a depth of 600 millimetres below the natural surface or finished cross-sectional levels of the road, whichever is the greater. Stumps shall be completely removed.

All holes and depressions resulting from clearing and grubbing shall be backfilled with approved material and compacted to at least the compaction of the surrounding undisturbed soil. Where the road passes close to a tree that is to be retained, consideration should be given to the road level to match the existing ground level at the base of the tree. Excavation shall be minimised within the root zone of retained trees.

The contractor shall take adequate precautions to prevent damage to trees, shrubs, fences,

all services and other improvements outside the designated areas. Any resultant damage shall be made good by the Contractor at their expense.

No material from clearing is to be pushed beyond the limits of the development site. Burning of cleared vegetation and timber or other combustible material is not permitted except in extraordinary circumstances and this material shall either be removed from site or disposed of in an approved manner (eg. chips or mulch for soil stabilisation).

Cleared vegetation burned for disposal on land development sites in a prescribed area of the Perth metropolitan area is prohibited under *Environmental Protection Regulations 1987*, Part 7A, Regulation 16B.

The developer shall be responsible for suppression and control of dust, sand drift and smoke pollution from development sites in accordance with "A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities". (Department of Biodiversity, Conservation and Attractions March 2011).

Clearing shall occur to the extent described on approved plan of subdivision. All other vegetation shall be protected and retained with fencing and notices as specified. Natural features and cultural artifacts and facilities identified for retention on the drawing shall be fenced off and sign posted as specified.

8.3.1.4. Topsoil

Any topsoil stripped from the site should be stockpiled for re-spreading. Topsoil shall only be re-spread if the geotechnical report for the site indicates that it is suitable for such use. Often, this is not suitable in areas with highly plastic soils and high natural groundwater levels. It is also not suitable in areas of medium to high-risk acid sulphate soils.

Topsoil stockpiles should be a maximum 1.5 metres in height. Stockpiles should be hydromulched with sterile cereal rye to prevent wind blow and suppress weed growth. Topsoil stockpiles should be fenced off, sign posted and protected from compaction and pollution by waste materials.

Stockpiled topsoil should be kept weed-free and mulched to prevent wind erosion and movement.

When earthworks have been completed, the topsoil should be re-spread to a maximum compacted depth of 100 millimetres over all areas of earthworks to match approved finished surface levels.

Where excavated material is classified as unsuitable for use as topsoil by the Geotechnical Report it shall be disposed off-site in an approved manner.

8.3.1.5. Earthworks

8.3.1.5.1. General

Earthworks shall be completed to the requirements detailed in these guidelines, with tolerances set out and detailed on the drawings. Where there is existing infrastructure, the Local Government may require a dilapidation report to identify and measure any damage. Also refer to Module 1, section 1.2.2.1 and Module 2, section 2.2.1.1.

Roads shall be cut to the grades and cross-sections indicated on the approved drawings.

All fill shall be clean, 8.3.1.5.2 granular material obtained from general and roadwork excavations and shall not be contaminated with roots or other impurities. Fill for roadworks shall be placed in even layers not greater than 300 millimetres thick and each layer shall be compacted to 95 per cent of the modified maximum dry density when tested in accordance with *AS 1289: Methods of Testing Soils for Engineering Purposes* and *AS 3798 – 2007 – (Incorporating Amendment 1) – Guidelines in Earthworks for Commercial and Residential Developments*. Depending on the location and compaction equipment used, greater layer thicknesses may be approved by the Local Government.

Where filling is under public open space and paths, the compaction can be reduced to 90 per cent and 95 per cent respectively of the modified maximum dry density when tested in accordance with *AS 1289: Methods of Testing Soils for Engineering Purposes* and *AS 3798– 2007 – (Incorporating Amendment 1) – Guidelines in Earthworks for Commercial and Residential Developments*.

Earthworks shall be trimmed to a neat finish to a tolerance of ±50 millimetres so that the surface shall be even and conform to approved finished levels.

Surplus material to be removed from the site unless otherwise approved.

Where fill is required to be imported the material shall be certified as "Dieback" free.

8.3.1.5.2. Lot filling

Where filling of lots is required as part of development, the fill area shall be cleared and stripped of all organic material and debris, and the filling placed and compacted to approved design levels. Tolerances on lot filling shall be ±50 millimetres.

All fill material shall be clean and non-cohesive, sand should be free draining and free of all silty, organic or other deleterious materials, and which contains not more than five per cent by weight of soil fractions finer than 0.075 millimetres, with a zero plasticity index (ie. non-plastic). Where required by the Local Government, these properties should be confirmed through testing by a geotechnical laboratory certified by the National Association of Testing Authorities.

All filling shall be compacted and tested in accordance with *AS 3798 – 2007 – (Incorporating Amendment 1) – Guidelines in Earthworks for Commercial and Residential Developments and Amendment No. 1* – 8 May 2008.

Requirements for stabilisation, dust control and sand drift shall be as detailed in section8.3.1.5.5.

For urban subdivisions on a clay subgrade, the clay surface shall be sloped at a minimum grade of 1:100 towards a subsoil drainage line and covered with a minimum fill of 300mm of clean sand over the entire site. Clay being used as fill to achieve a uniform graded surface shall be compacted to 90% of the modified maximum dry density when tested in accordance with AS1289.

8.3.1.5.3. Limestone and rock

All cuttings through limestone and rock shall be excavated to a depth of 100 millimetres below sub-grade level and 200 millimetres below the verge finished level.

If trees and plants are to be planted and these depths of excavation are followed, it may be necessary to negotiate with the Local Government as to the required depths for plants and

trees to survive in an appropriate cover material depth. This depth will need to take into account required depths for root systems of plants and trees as well as possible waterlogging of root systems in wet weather.

Increases in cover depths may be required where irrigation systems are to be installed for purposes of watering vegetation and similar.

Limestone or rock excavated shall be placed at the bottom of fills. No stone larger than 300 millimetres shall be placed in compacted fill. Large rock pieces shall be stockpiled where directed or disposed of at an approved disposal site.

8.3.1.5.4. Blasting

Excavation in rock or hard soil may be carried out by blasting, and a blasting permit can be obtained from the Local Government.

All explosives shall be stored and handled in accordance with requirements of the *Mines Regulation Act 1946*, the *Explosives and Dangerous Goods Act 1961*, *AS 2187: Explosives – Storage, Transport and Use* and *AS 2188: Explosives – Relocatable Magazines for Storage*.

Blasting shall only be carried out by a person holding a current Western Australian Mines Department Shot Firer's Permit. The shot-firer shall be responsible for repair of damage, legal liability or anything that may arise from blasting operations. Appropriate screens, shields and matting necessary to prevent rock, stones, earth, debris or other material from scattering or blowing from the immediate site of blasting, shall be provided.

Blasting may be prohibited if geotechnical and other data demonstrate adverse effects as follows:

- vibration damage to existing developments;
- vibration may damage substrata weakening foundations for future development;
- damage to substrata may affect groundwater location and quantities;
- noise may disturb wildlife species protected within the area; and
- dust suppression may not be contained so as not to interfere with adjacent developments.

8.3.1.5.5. Soil stabilisation

The developer shall be responsible for the satisfactory control of dust, sand and soil drift or erosion from the development site.

Stabilisation of topsoil, sand or other material or matter subject to movement over or near the subdivision shall generally be carried out in accordance with *A Guideline for the Prevention of Dust and Smoke Pollution from Land Development Sites in Western Australia* (Department of Biodiversity, Conservation and Attractions, November 1996) both during the construction stages and upon completion of the subdivisional works.

Where initial stabilisation is carried out and subsequent works associated with the subdivisional works cause deterioration of effective stabilisation of the area, the affected area shall be restabilised appropriately as agreed by the Local Government. The developer shall effect a varying method of restabilisation should initial stabilisation be unsuitable.

Stabilisation disturbed by works other than subdivisional works shall be the responsibility of persons responsible for disturbance of stabilised areas (eg. builders, private lot owners and utility providers).

To avoid dust nuisance to adjacent owners, earthworks including stripping or replacing of topsoil, shall not be carried out when a wind is blowing towards the surrounding properties, which will cause sand drift or dust to reach these properties. All measures necessary shall be used to prevent the generation of dust from all such earthworks by watering cut and fill areas and stockpiles at intervals and times as required. A water tanker and spray equipment suitable for this purpose shall be available on site at all times.

Where adjacent occupied homes or trafficked roads are adversely affected by sand drift from construction works, a sand trapping fence shall be erected fronting the developed area, with the contractor retaining full liability for damages.

Where possible, effects of erosion and soil drift shall use as little water as possible and preferably only bore water where possible. Hydromulching and other soil stabilisation methods are preferred where little repeated disturbance of the earthworks will take place.

8.3.1.6. Sub-grade

The formation shall be excavated in conformity with profiles, dimensions, camber and depths shown on the approved drawings.

Tolerance for sub-grade width shall be ±100 millimetres.

The finished levels of sub-grade shall be within +0 to –30 millimetres of design levels.

The sub-grade shall be compacted to not less than 95 per cent of the maximum dry density when tested in accordance with *AS 1289: Methods of Testing Soils for Engineering Purposes*.

The sub-grade shall be approved by the Local Government before any sub-base material is placed.

Sub-grade strength shall be tested to determine sub-grade CBR values. Depending on the results additional works may be required to ensure a satisfactory pavement.

8.3.1.7. Sub-base

The tolerances to levels permitted for the various stages of road construction shall be -25mm to +10mm.

8.3.1.7.1. Materials

The sub-base shall be constructed of limestone or a material complying with the requirements of the specification detailed in section 3.4.2 – Crushed Limestone, unless otherwise approved.

Materials other than limestone may be used, particularly in rural areas where limestone is not necessarily available. The only criterion for alternative materials is that their performance complies with the specification or mechanistic characteristics suiting the specification.

8.3.1.7.2. Spreading

The sub-base shall be placed so that the compacted sub-grade is not disturbed or broken up

and the specified even thickness is achieved. Sub-base materials shall not be spread upon a waterlogged sub-grade.

The sub-base shall be laid in one layer and constructed to the design width within a tolerance of + 200mm to – 0mm.

8.3.1.7.3. Compaction

The sub-base shall be watered to optimum moisture content and compacted by rolling to a density not less than 95 per cent of the maximum dry density when tested in accordance with *AS 1289: Methods of Testing Soils for Engineering Purposes*.

The depth of sub-base after compaction shall be as specified on the approved drawings with a tolerance of +5 to –10 millimetres.

Where damage to adjoining properties may result, use of vibrating rollers will be permitted with care and by negotiation with the Local Government to ensure all measures are taken to protect adjacent properties.

It may be necessary to formulate a vibration plan in conjunction with the Local Government. The vibration plan would need to address vibration nuisance, potential damage and be approved by the Department for Environmental and Conservation, the consulting engineer and Local Government.

8.3.1.7.4. Acceptance

All irregularities in the longitudinal grade and cross-section and any imperfections or failures detected in the surface of the sub-base shall be corrected in an approved manner until the road sub-base is brought to a uniformly compacted, smooth and even surface. Unsatisfactory material shall be removed from the site and replaced with material as specified.

The sub-base construction shall be approved by the Local Government prior to the placement of the base course material.

8.3.1.8. Base course

8.3.1.8.1. Materials

The base course shall consist of either emulsion stabilised limestone, laterite gravel, recycled ferricrete or fine crushed rock (unless otherwise approved) complying with the following specifications:

- Section 3.4.3 – Bitumen emulsion
- Section 3.4.4 – Bitumen stabilised limestone
- Section 3.4.5 – Gravel
- Section 3.4.6 – Fine crushed rock (road base)
- Section 3.4.7 – Ferricrete
- Section 3.4.9 – Recycled materials for base course construction.

8.3.1.8.2. Spreading

Prior to laying of base material, all utility service crossings beneath roadways shall be installed. All road crossings shall be backfilled and compacted according to requirements for sub-grade and sub-base construction.

Base material shall be placed so that sub-base material is not disturbed or broken up and an even thickness as specified is obtained.

Base material shall be spread to the required compacted thickness by means of an approved mechanical spreader or by grading from continuous stacks deposited on the sub-base.

8.3.1.8.3. Compaction

Base course material shall be watered, compacted and cut to grade and crossfall specified in the approved drawings. Each course shall be rolled until it is compacted to a firm, even surface by appropriate self-propelled steel-wheel and pneumatic tyred rollers. The use of the pneumatic tyred roller is essential for the final passes to achieve compaction of immediate surface material. Where damage to adjoining properties results, use of vibrating rollers are not permitted.

Grading of loose material over a hard surface and/or compaction in a thin layer is not permitted. The base course shall be compacted to not less than 98 per cent of the maximum dry density when tested in accordance with *AS 1289: Method of Testing Soils for Engineering Purposes*.

Thickness of the base course after compaction shall be as specified on the approved drawings with a tolerance of +10 to 0 millimetres.

8.3.1.8.4. Acceptance

The surface course shall be tested for shape and level, and any irregularities greater than 10 millimetres, when tested with a straight edge three metres long, shall be made good by addition or removal of material and further rolling and cutting to grade until the specified cross-section is obtained.

Any imperfections or failures detected in the surface of the base course shall be corrected in an approved manner. Unsatisfactory material shall be removed from site and replaced with material as specified.

Before sealing the base course, the moisture content shall comply with the dry back moisture requirements (85% or less of moisture content.

Base course construction shall be approved by the Local Government prior to the application of a primer seal.

8.3.1.9. Primer sealing of pavements

8.3.1.9.1. General

The surface of the base course shall be primer-sealed in accordance with *Guide to Pavement Technology Part 4K: Seals* (Austroads, 2009) prior to application of the wearing course.

8.3.1.9.2. Preparation

The surface of the base course shall be swept free from loose stones, dust, dirt and foreign

matter so as not to damage the finished surface of the base course prior to application of the binder.

Sweeping shall be completed immediately before the application of the primer. All sweepings shall be completely removed from the road and disposed of in an approved manner.

8.3.1.9.3. Binder

Bitumen emulsion

Bitumen emulsion in accordance with *AS1160: Bituminous Emulsions for Construction and Maintenance of Pavements*, shall be uniformly and evenly sprayed onto the existing surface at a rate determined by design in accordance with table 4.3 of the Guide to Pavement Technology.

Hot cut-back bitumen

A medium curing cut-back bitumen in accordance with *AS2157: Cutback Bitumen*, shall be applied at a rate determined by the design in accordance with table 4.3 of the Guide to Pavement Technology.

The primer shall be applied by an approved mechanical sprayer which has been tested in accordance with *Testing of Mechanical Sprayers of Bituminous Material* (Austroads).

Where direct use of a mechanical spray is impracticable, the binder may be sprayed using a hand lance supplied from the mechanical sprayer.

Kerbs shall be protected from bitumen overspray at all times by adequately covering the kerbs with polythene sheeting or similar approved material. Any kerbing marked by bitumen overspray shall be made good by the contractor at the contractor's expense.

8.3.1.9.4. Aggregate

Immediately after spraying, the primer shall immediately after spraying be covered with five or seven millimetres of diorite, granite or basalt to the specification detailed in section 3.4.11 – Road Sealing Aggregate, so that all sprayed areas shall be completely covered within a period of 15 minutes.

The aggregate shall be dry and free from dust and other deleterious material and be spread by means of an approved aggregate spreader capable of spreading a uniform layer of aggregate.

Rate of application shall be determined by design but shall not exceed 150 m^2 per cubic metre of metal, controlled so that only a sufficient amount is applied to give a uniform dense mat one stone thick. Additional aggregate may be added by hand spreading to any bare or insufficiently covered areas to produce the required uniform cover.

Within five minutes of application of the aggregate, rolling shall commence using self-propelled steel wheel and pneumatic tyred rollers and continue until the aggregate is well embedded in the binder and a uniform surface obtained.

8.3.1.10. Hot sprayed bitumen seal

8.3.1.10.1. General

This section covers application of a single coat aggregate wearing course seal to either a bitumen emulsion stabilised limestone base course or surface primer sealed. The application shall be designed and carried out in accordance with *Bituminous Surfacing Volume 1, Sprayed Work (Austroads, 1989).4.10.2 – Surface Preparation*.

The surface shall be lightly swept free of all loose stones, dust, dirt and foreign material. Any sections of the surface which are loose or damaged shall be repaired and finished to the approved level.

8.3.1.10.2. Materials

The binder and medium curing cutting oil shall comply with *AS2008: Residual Bitumen for Pavements*, *AS2157: Cutback Bitumen* and the specification detailed in section 3.4.9 Bitumen.

The proportion of medium curing cutting oil to be added to the binder is dependent on the anticipated road temperature at the time of spraying but shall not exceed eight per cent.

The aggregate shall consist of crushed diorite or granite stone of 10 or 14 millimetres nominal size to the specification detailed in section 3.4.11 Road Sealing Aggregate.

Bitumen laminated paper of sufficient width and strength to prevent overspray and spillage during removal, or other suitable protective material, shall be applied to start, finish and taper operations.

8.3.1.10.3. Binder

The developer shall give the Local Government at least 48 hours notice of intention to apply the binder, and approval shall be obtained before any spraying proceeds. The surface to be sealed shall be dry and no binder shall be applied whilst the pavement temperature is less than 25°C or during wet or rainy conditions, or when adverse weather conditions may prevail at any time during such work.

The binder shall be applied by an approved mechanical sprayer which has been tested for uniformity of transverse distribution and calibrated for overall rates of application in accordance with *Testing of Mechanical Sprayers of Bituminous Material* (Austroads).

Where direct use of the mechanical sprayer is impracticable, the binder may be applied by using a hand lance supplied from the mechanical sprayer.

Binder application rates shall be determined by design, but should generally fall within the range of 1.6–2.6 litres residual bitumen per square metre measured at 15°C for 14 millimetres diorite and granite aggregate.

The binder shall be sprayed at the design application rate for the full length of each run, including start and finish lines. Appropriate precautions shall be taken to ensure no binder is applied beyond the start and finish lines or beyond other limits of the works. Bitumen laminated paper and any spilt bitumen shall be removed and disposed of in an approved manner.

The binder edge shall not deviate from the desired edge lines by more than 50 millimetres. The rate of deviation of the binder edge from the desired edge lines shall not exceed 1:400. All necessary precautions shall be taken to prevent the binder from adhering to any existing

structure. Any damage or defacement shall be made good immediately after sealing in that section has been completed and no payment will be made for the cleaning work.

Kerbs shall be protected from bitumen overspray at all times by adequately covering the kerbs with polythene sheeting or similar approved material. Any kerbing marked by bitumen spray shall be made good by the contractor at the contractor's expense.

8.3.1.10.4. Aggregate

The aggregate shall be dry and free from dust and other foreign material at the time of application (pre-coated where necessary) and shall be uniformly spread over the sprayed area by means of an approved mechanical spreader.

All sprayed areas, with the exception of approved lapping strips, shall be covered with aggregate within 10 minutes of spraying the binder.

Additional aggregate may be applied by hand spreading to any bare or insufficiently covered areas to produce the required uniform cover.

Rate of application of the aggregate shall be determined by design, but shall not exceed 100 m^2 per cubic metre of 14 millimetres diorite or granite aggregate, controlled so that only sufficient is applied to give a uniform dense mat one stone thick.

The spread aggregate shall immediately be rolled into the binder using approved equipment and continued until the aggregate is well embedded in the binder and a uniform surface is obtained.

Any loose aggregate not incorporated in the seal after the completion of rolling shall be lightly swept from the surface in a manner that will not disturb the embedded aggregate and disposed of in an approved manner.

8.3.1.11. Two-coat seal

Application of a consecutive two-coat aggregate wearing course seal may be approved on submission of a fully detailed specification.

8.3.1.11.1. Measurement and recording of application rates

Binder

All loads of bitumen shall be sampled in accordance with the following Australian Standards:

- AS 1160: Bitumen Emulsions for Construction and Maintenance of Pavements;
- AS 2008: Residual Bitumen for Pavements; and
- AS 2157: Cutback Bitumen.

The following records shall be kept of all spray runs:

- spray width;
- start distance – finish distance;
- side of road (left or right);
- road temperature;
- bitumen temperature;
- volume of bitumen used; and
- average bitumen application rate.

Aggregate

The actual application rate of cover aggregate shall be calculated from the measured volumes spread and the actual area measured on site, and expressed as the number of square metres per cubic metre of aggregate.

8.3.1.12. Asphalt seal

8.3.1.12.1. General

Material for the wearing course shall be asphalt consisting of a combination of course aggregate, fine aggregate and mineral filler, uniformly coated and mixed with bituminous binder. The course shall be composed of materials to the specification detailed in section 3.4.12 – Asphalt and laid in accordance with IPWEA/AAPA specification.

8.3.1.12.2. Preparation of surface

Surface preparation, which includes sweeping, chipping and burning off rich fat areas, shall be carried out immediately before applying the tack coat. No asphalt shall be placed upon any area which contains an excess of binder in such quantity that there is any possibility of the binder coming to the surface of the new work.

8.3.1.12.3. Tack coat

The tack coat shall be laid in accordance with *AS 2734: Asphalt (Hot-mixed) Paving – Guide to Good Practice*. The bituminous emulsion shall comply with requirements of *AS 1160: Bituminous Emulsions for Construction and Maintenance of Pavements*. Anionic or cationic bitumen may be used depending on the site conditions and the time of the year. The application rate shall generally be sufficient to fully coat the surface with a residual binder content of 0.1 litres per square metre. The application rate may be varied or even omitted to satisfy particular conditions.

No asphalt shall be laid on the tack coat until the emulsion has broken and the water has substantially evaporated.

Any pools of tack coat which may have formed in surface depressions shall be brushed out. No traffic other than trucks delivering the asphalt shall be permitted to travel over the tack coat.

8.3.1.12.4. Placing of asphalt

Asphalt shall be laid upon a base which is clean and dry and in dry weather conditions with the atmospheric temperature above 10°C.

Prior to the delivery of asphalt to the construction site, the prepared base shall be cleaned of all loose or foreign material. The mixture shall be delivered on site in accordance with requirements of *AS 2150 – Hot Mix Asphalt* and *AS 2734 – Asphalt (Hot-mixed) Paving – Guide to Good Practice*, unless otherwise approved.

The mixture shall be spread to such line, level and camber detailed in the approved drawings in a single layer and compacted to give the average compacted thickness specified.

Thickness tolerance shall be +5 to –2 millimetres.

Spreading shall be by an approved self-propelled paver unless otherwise approved.

Mixing and placing asphalt will not be permitted when the surface of the road is wet, or cold winds chill the mix to the extent that spreading and compaction are adversely affected. The surface on which the asphalt is to be laid shall be free from ponding water.

The temperature of the mix when it is tipped into the spreader shall not be less than 135°C. Spreading shall proceed without undue delay and initial rolling of the mix shall commence at a temperature of not less than 120°C.

Uniform compaction to the required density shall be achieved before the temperature of the mix falls to 80°C.

The contractor shall ensure that the complete operation from mixing to final compaction is maintained within the specified temperature ranges.

8.3.1.12.5. Joints

Asphalt shall be spread in such a manner as to minimise the number of joints in the surface, and unless otherwise specified, the layout of joints shall conform to the following requirements.

Transverse joints

In any individual layer, transverse joints in adjoining paver runs shall be displaced longitudinally by not less than two metres.

Transverse joints in any layer shall be longitudinally displaced from any transverse joints in the underlying layer by not less than two metres.

Transverse joints shall be at right angles to the direction of spreading and cut to a straight vertical face for the full depth of the layer.

Longitudinal joints

Longitudinal joints shall be continuous, parallel and coincident within 150 millimetres of line of change of crossfall.

Longitudinal joints shall be offset by at least 150 millimetres from joints in underlying layers and located away from traffic wheel paths. Where feasible, longitudinal joints should be located beneath proposed traffic line markings.

Special care shall be taken in the forming of longitudinal joints at all intersections to avoid joint layouts and an appearance that would tend to misdirect traffic from the design travel paths.

Longitudinal and transverse joints shall be made in a careful manner, be well-bonded and sealed. Joints between old and new pavements, or between successive paver runs, shall be carefully made to ensure a thorough and continuous bond between old and new surfaces. The edge of the previously laid course shall be cut back to its full depth so as to expose a fresh surface, after which the hot mixture shall be placed in contact with it and raked to the specified depth and grade. Hot smoothers or tampers shall be employed to heat up the old pavement sufficiently without burning to ensure an effective bond.

Before placing the mixture against surfaces of longitudinal joints, kerbs, gutters, headers, junction pits or other surfaces, the contact surfaces shall be painted with a thin uniform coating of hot or cutback bitumen.

Where asphalt is required to match an existing surface, road or other fixture, the contractor shall place the material in such a manner as to provide a smooth riding surface across the junction.

8.3.1.12.6. Compaction of asphalt

The density of the asphalt as specified in section 3.4.12 shall be achieved using approved equipment and techniques and in accordance with *AS 2734: Asphalt (Hot-mixed) paving – Guide to Good Practice*.

The surface of the finished course shall be free from depressions exceeding five millimetres as measured with a three-metre straight edge.

8.3.1.12.7. Acceptance of asphalt seal

Testing

Asphalt testing shall be undertaken by a laboratory approved by the National Association of Testing Authorities. All tests shall be made on a single test lot which consists of one sample of loose asphalt extracted on site and six random core samples taken from the compacted asphaltic mat. A test lot may be a day's paving on the subdivision, the entire subdivisional stage or a selection of suspect pavement surfaces. All tests shall be carried out in accordance with the current Australian Standard and/or MRWA standards.

Grading and bitumen content

Where the in situ job mix (aggregate grading, bitumen content and film thickness) fails to meet specification requirements, the work may be rejected; alternatively, with the agreement of the Local Government, the contractor shall provide to the Local Government, a five-year guarantee of asphalt performance from the date of paving. The contractor shall remove and replace or overlay the entire area should the surface show signs of distress during the guarantee period.

When the results of an individual audit test or field testing shows that the mix does not meet requirements of the specification, the contractor's process control records shall be considered before a decision is made on an appropriate course of action.

Marshall characteristics

The Marshall characteristics (stability, flow and quotient) of a test lot, when tested in accordance with the current Australian Standard and/or MRWA standards, shall form part of the determination for asphalt quality level.

The Marshall Quotient is the calculated ratio of stability to flow which represents an approximation of the ratio of load to deformation and may be used as a measure of the asphalt's resistance to permanent deformation under load.

If stability and flow are both within or equal to specification parameters, the asphalt is deemed conforming to specification and is acceptable.

If the stability or flow is less than the minimum specified value, the mix shall be deemed non-conforming.

Where flow exceeds the maximum value and the stability of the mix is high, the mix shall be considered conforming – providing the minimum Marshall Quotient value is met, and the flow

does not exceed the maximum specified value by more than one millimetre.

Where the mix is non-conforming, the contractor shall arrange, at the contractor's expense, for the test lot to be removed and replaced with fresh asphalt and retested. Removal shall be carried out so as not to damage underlying layers or any road fixtures, such as gully gratings. Any such damage shall be repaired at the contractor's expense.

Density

When tested in accordance with Clause 9.4 of *AS 2734: Asphalt (Hot-Mixed) Paving – Guide to Good Practice*, the Characteristic Percent Marshall Density (Compaction) for any test lot of a minimum of six Marshall Density tests shall be deemed to be conforming if they attain the minimum value required for the mix type as shown in Table 8.1.

TABLE 8.1: DENSITY REQUIREMENTS

Marshall Blows	Characteristic Marshall Density (Rc percentage)
35	95.0
50	94.5
75	94.0

Asphaltic mat voids

Asphaltic mat voids is the relationship between maximum density and the mean core density of a sample test lot. It is calculated as follows:

$$AMV = \left(\frac{MD - CD}{MD} \right) \times 100$$

Where:

AMV = Asphaltic mat voids
MD = Maximum density of a test lot
CD = Mean core density of a test lot

In the case of 35 blow mixes where the asphaltic mat voids is greater than or equal to 2.5 and less than or equal to 10.0, it shall be deemed as conforming.

In the case of 50 blow mixes where the asphaltic mat voids is greater than or equal to 3.5 and less than or equal to 10.0, it shall be deemed as conforming.

In the case of 75 blow mixes where the asphaltic mat voids is greater than or equal to 3.5 and less than or equal to 11.0, it shall be deemed as conforming.

Where for any individual core the asphaltic mat voids is less than 3.0 for 75 blow mix or 2.5 for 50 blow or 2.0 for 35 blow mixes, additional testing shall be carried out to determine the extent of unstable asphalt. This asphalt shall be removed and replaced at the contractor's expense.

Thickness

When tested for thickness, any test lot of a minimum six core samples shall be deemed to be conforming if the mean core thickness is greater than the minimum specified thickness less 15 per cent.

Should any one of the six core samples be less than the minimum thickness specified by more than 20 per cent, then additional cores may be taken at the contractor's expense to establish that an area of thin pavement exists. Cores shall be taken at locations halfway between existing random cores and/or additional thickness determining cores to determine the extent of the thin pavement.

The contractor shall arrange, at the contractor's expense, to have the area of thin pavement overlaid or removed and replaced with fresh asphalt, and retested. Where it is necessary to overlay or remove and replace asphalt, the absolute minimum overlay or layer thickness shall not be less than 2.5 times the aggregate Average Least Dimension (ALD). Removal shall be carried out so as not to damage the underlying layers or any road fixtures, such as gully gratings. Any such damage shall be repaired at the contractor's expense.

Shape

Where the base pavement conforms with the appropriate standard, the shape shall conform to the values for freeways and highways as detailed in Table 9.1 of *AS.2734: Asphalt (Hot-mixed) Paving – Guide to Good Practice*.

8.3.1.13. Interlocking segmental pavements (block paving)

When segmental paving is proposed, the brick or concrete block colour, shape or laying pattern is to be approved by the Local Government.

8.3.1.13.1. General

Work covered by this section comprises construction of brick or segmental concrete pavement surfaces. Preparation of the sub-grade, sub-base and base courses shall be as detailed in sections 2.3.1, 3.4.2 and 3.4.6 respectively. Pavement design for sub base and base course shall be based on soaked CBR values.

8.3.1.13.2. Segmental paving blocks

Concrete paving units

Concrete paving units shall comply with the Concrete Masonry Association of Australia Specification for Segmental Paving Units (MA20).

Clay paving units

Clay paving units shall be fired at high temperature with exposed faces of an extruded, wire-cut or pressed finish and shall comply with the specification detailed in section 3.4.13 – Clay Paving Units.

8.3.1.13.3. Edge restraint

All interlocking segmental pavements shall be constrained on all edges by the construction of extruded concrete kerbing.

Extruded Concrete Kerbing. Edge restraints which separate interlocking block pavement from adjacent flexible pavement shall be flush with the top of the pavements and reinforced.

8.3.1.13.4. Bedding sand

The bedding course is the layer of sand between the base course and the paver. Bedding sand shall conform to sieve gradings in Table 8.2 below.

TABLE 8.2: BEDDING SAND

SIEVE SIZE	PERCENTAGE PASSING
9.52 mm	100
4.75 mm	90–100
2.36 mm	80–100
1.18 mm	50–90
600 microns	30–60
300 microns	10–30
150 microns	5–15
75 microns	0–5

The sand shall be non-plastic and shall not contain stones, clay lumps, organic matter, soluble salts, any other deleterious materials or any contaminants which can cause, or contribute to, efflorescence. The bedding sand shall have a uniform moisture content of between four and eight per cent by weight.

The bedding sand shall be spread loosely to a uniform depth and screeded to the nominated design profile with sufficient surcharge to allow for compaction to a uniform thickness of 30 millimetres, with a tolerance of ±5 millimetres.

Bedding sand shall be screeded slightly ahead of the laying face and protected from pre-compaction. Any pre-compacted, water saturated or pre-screeded sand (left overnight) shall be removed and replaced with fresh loose sand.

8.3.1.13.5. Laying segmental paving blocks

All paving shall be laid by competent contractors accredited with proper quality control practices to ensure that their work is completed in accordance with the specified requirements.

Pavers shall be laid on uncompacted bedding sand and shall be placed so that units are not in direct contact with each other. Pavers shall be laid with a two millimetre (minimum) to three millimetre (maximum) gap between pavers. This two to three millimetre gap is an essential feature of the interlocking pavement.

All rectangular interlocking pavers shall be laid in a 45° herringbone configuration.

Full pavers shall be laid first and gaps at the pavement edge shall be neatly filled by saw cutting pavers to fit. Only full bricks or blocks shall be laid against all edge restraints.

8.3.1.13.6. Segmental paving block compaction

Immediately after laying, the pavers shall be compacted and brought to design level by not less than three passes of a vibrating plate compactor. The plate shall have sufficient area to simultaneously cover 12 pavers and pavers shall be protected from damage by the placement of a suitable pad between the vibrating plate and the pavement. Pavers damaged during compaction shall be immediately replaced. Compaction shall continue until a smooth surface is produced.

The top of compacted paving shall finish five to eight millimetres above abutting drainage inlet structures.

8.3.1.13.7. Joint filling

Immediately after compaction is completed and prior to acceptance of traffic, the two to three millimetre gaps between pavers shall be filled with dry joint filling sand which conforms to the following sieve grading:

TABLE 8.3: JOINT FILLING

SIEVE SIZE	PERCENTAGE PASSING
2.36 mm	100
1.18 mm	80–100
600 microns	65–90
300 microns	30–70
150 microns	10–35
75 microns	0–10

Joint filling sand shall be free of all soluble salts and contaminants likely to cause efflorescence.

Pavements subject to stormwater run-off, gutter flow or any other movement of water shall be protected from scouring. Scour protection shall be provided by means of dry cement grouting of the paver joints for a width of 300 millimetres from the edges of interlocking pavements. The joint filling grout shall consist of a 4:1 mix of 1.18 millimetres sieve dry sand and dry cement. The joint filling grout and the pavement shall be dry to ensure that the pavement is not stained by the grout.

The pavement shall receive one or more passes of a plate compactor and joints shall be completely refilled with sand in accordance with the previous sections.

8.3.1.13.8. Daily finishing of pavements

At the end of each day's laying of pavement, the total area of laid pavement shall be compacted and sanded in accordance with Sections 8.3.1.13.3 and 8.3.1.13.6 to ensure interlocking of the total pavement area. Suitable signage and barricades shall be erected to ensure that no traffic uses the area until compaction and sanding has been completed as specified.

8.3.1.13.9. Minimum paver size

Where pavers form part of the general surface and are not part of the border paving, the minimum size of a paver should be not less than one-third (1/3) of the size of a normal block. This applies to the standard paver size; however, where large sized pavers are used, the minimum size should be no less than a size that will not crack, break into smaller segments or chip on the edges. It may also be relevant to ensure that pavers are of a size enabling them to lock into position without cementing in place.

8.3.1.13.10. Permeable paving

General pavers (even clay pavers) in an interlocking pattern are not to be considered as being permeable. With time, it is possible that joints become less permeable and surface prevents water infiltration.

There are specific pavers that can be used as a permeable surface and assist with drainage and reduction of run-off of water from paved surfaces. Generally, corners have a 20 by 20 millimetre chamfer to allow for infiltration.

8.3.1.13.11. Acceptance of interlocking segmental pavements

The completed pavement shall satisfy the following criteria prior to acceptance:

- the completed pavement surface shall be constructed in accordance with design profiles and shall drain freely;
- pavers shall not be cracked, damaged or distorted;
- a maximum of one per cent of spalled pavers may be accepted;
- surface texture shall be uniform and shall be free from abrasion or wear;
- colour of the pavement shall be uniform and any colour variations in batches of pavers shall be eliminated by batch mixing to produce a uniform colour grading;
- the pavers shall be laid such that the maximum deviation from the bottom of a 3 metre straight edge shall be 10mm and the level of adjacent pavers shall not differ by greater than 2 mm; and
- during the defects liability period, the stability of the pavement to be such that creep movements by the bricks do not create joints greater than 4mm in width nor affect the location or stability of the kerbing or adjacent bituminised pavements. The sand filter should be stable so as not to be eroded under normal conditions. Rotation of bricks to be minimal with no other detrimental effects permitted.

8.3.1.14. Extruded concrete kerbing

8.3.1.14.1. General

The developer shall be responsible for the provision of extended concrete kerbing in accordance with the approved drawings.

8.3.1.14.2. Materials

The kerbing shall be constructed using pre-mixed concrete complying with *AS 1379: Specification and Supply of Concrete and the following requirements:*

TABLE 8.4: KERBING CONSTRUCTION

Item	Value
Compressive Strength	Minimum 32 MPa at 28 days
Aggregate Size	Maximum 10 mm
Slump	Maximum 90 mm at delivery

Where flush kerbing is to be used which could carry loadings on a regular basis from traffic, the strength should be to 32 MPa at 28 days with steel reinforcing.

8.3.1.14.3. Preparation and placement

The road surface shall be thoroughly swept clean of all loose material prior to the kerb being extruded to ensure the maximum bond between the kerb and pavement material.

Road kerbing shall be constructed of extruded concrete kerbing using an approved extrusion machine equipped with an automatic levelling device. Kerbing to small radii that cannot be placed with the extrusion machine shall be cast in situ to the same cross-section as the extruded kerbing.

The finished alignment shall conform to requirements of the approved drawings.

The first 150 millimetres of any new pour shall be cut away and removed. Any gap between the old and new work shall be filled by hand-placing, rodding and shaping of the concrete until a uniform shape and finish has been obtained.

8.3.1.14.4. Tolerances

The finished product shall be true to the dimensions specified and shall be to a smooth finish. Tolerances for kerbing shall be in accordance with the following requirements:

- the top surface of the kerb shall be parallel to the ruling grade of the pavement and free from depressions exceeding five millimetres when measured with a three-metre straight edge;
- level ±5 millimetres;
- line ±10 millimetres to face of kerb or gutter line; and
- cross-section dimensions ±5 millimetres.

8.3.1.14.5. Contraction joints

Contraction joints shall be constructed at 2.5-metre intervals along the new kerbline. Contraction joints shall be five millimetres wide and shall be cut through the kerb above the road surface level with an approved tool immediately after extrusion. Care shall be taken to avoid disturbing joint edges, with any disturbance made good immediately.

Where the kerb adjoins a footpath the contraction joints are to coincide with the footpath joints where possible.

8.3.1.14.6. Expansion joints

Not less than 24 hours after kerb placement, expansion joints shall be formed by completely cutting through the kerb with a suitable cutting wheel at five-metre intervals along the new kerbline, at sides of drainage gullies, at tangent points of all small radius horizontal curves and at junctions with existing kerbing. Expansion joints shall be a minimum of 10 millimetres wide.

Each expansion joint shall be filled with an approved butyl mastic compound filler and foam or polyurethane backing.

All joints should be cut prior to the laying of asphalt unless the Local Government has approved designs where the kerbing is laid on the asphalt running surface.

Where the kerb adjoins a footpath the expansion joints are to coincide with the footpath joints where possible.

8.3.1.14.7. Curing

Within two hours of surface finishing, all exposed faces of the completed kerb shall be protected from moisture loss for a period of not less than four days after extrusion by covering with plastic sheeting or spraying with an approved curing compound.

In the event of defacing or damage to the kerb, from the time of its construction until the practical completion stage, the kerb shall be removed and replaced at the Contractor's expense where in the opinion of the Local Government repairs would detract from the finished product.

8.3.1.14.8. Backfilling

Backfilling to the kerbing shall be placed after curing the concrete and acceptance of the kerbing. Backfill material shall be free draining sand or a similar material to the local topsoil, free from debris and compacted to a thickness not less than that of the surrounding natural surface.

8.3.1.14.9. Keyed kerbing

Where keyed kerbing is specified on approved drawings, excavation of the base shall be by an approved method. The primed road surface beyond the line of the face of kerb shall not be disturbed.

Provision shall be made in the base key for extension of the expansion joint through the complete kerb section.

8.3.1.15. Concrete footpaths and shared paths

8.3.1.15.1. General

The developer shall be responsible for the construction of footpaths or shared paths in accordance with the approved drawings.

8.3.1.15.2. Materials

The pavement shall be constructed using pre-mixed concrete complying with *AS 1379: Specification and Supply of Concrete*, and the following requirements:

TABLE 8. 5: PATH CONSTRUCTION

Item	Value
Compressive Strength	Minimum 25 MPa at 28 days
Aggregate Size	Maximum 20 mm
Slump	Maximum 75 mm at delivery

High early strength additive in accordance with *AS 1478: Chemical Admixtures for Concrete*, may be used. No other additives or admixtures of any kind shall be used without written approval.

8.3.1.15.3. Preparation and placement

The excavation, fill, backfill and trimming shall be carried out to required levels and grades and surplus materials resulting from the works shall be removed and disposed of in an approved manner.

Earthworks shall be carried out in accordance with approved design alignments, grades and levels.

The sub-grade shall be evenly graded and free of rocks, organic matter and any other deleterious material. The sub-grade shall be compacted so as to provide even compaction to a depth of 450 millimetres. Compaction shall be not less than 95 per cent of maximum dry density when measured in accordance with *AS 1289: Methods of Testing Soils for Engineering Purposes*. Alternatively, it should be 7 blows per 300mm with a calibrated Perth sand Penetrometer.

Before placement of concrete, the boxed-out alignment shall be watered to provide a thoroughly moistened, but not flooded, sub-grade.

The concrete pavement shall be consolidated using a mechanical vibrating screed spanning the width of the path and supported by rigid side forms.

After consolidation, the concrete shall be screeded perpendicular to the side forms to provide a straight surface between forms and a smooth, even surface profile along the path alignment.

To prevent premature drying of the surface of screeded concrete in hot weather conditions, addition of water to the surface of the screeded concrete using a fog spray may be permitted. Approval of the addition of water in this manner is conditional upon the integrity of the mix being maintained in accordance with its specification.

The finished concrete pavement shall have a non-slip, broomed surface. The broomed grooving (approximately two millimetres deep) shall be aligned at 90° to the edge of the pavement.

For dual use paths, transverse lips or ridges of concrete, such as may be formed during jointing works, are not permitted and the broomed finish surface shall be maintained at joints.

Dry cement shall not be added to the surface of the pavement.

8.3.1.15.4. Expansion joints

Transverse expansion joints shall be installed in accordance with the local government's standard drawing. The joints shall be 10 millimetres wide and extend the full depth and width of the pavement, and be filled with approved expansion joint filler. The joint filler shall not exude bituminous material when compressed in hot weather. The following materials are approved:

- Non-Porite – Bitumen impregnated by cold solvent process
- Expandite – Flexicell
- Meljoint – Melcann.

Other expansion joint fillers may be approved such as lock joints. Expansion joints shall be installed where the pathway abuts kerbing, utility service structures, drainage pits and/or existing crossovers.

Expansion joints are to coincide with kerb joints and vice versa where possible.

Expansion joints to be at changes in direction or width or where adjacent to a solid object, otherwise at maximum spacing of 40m.

Joints to be Lock Joint or other similar type, as approved by the Local Government.

8.3.1.15.5. Contraction joints

Transverse contraction joints shall be installed in accordance with the Local Government's standard drawing and equally spaced between expansion joints. The contraction joint shall be aligned at 90° to the pavement alignment and be a minimum of five millimetres deep, and provide a vertical plane of weakness through the pavement. The joint shall be made in plastic concrete by depressing an approved grooving tool into the surface of the pavement.

Contraction joints are to coincide with kerb joints and vice versa where possible.

8.3.1.15.6. Edge treatment

Edges of the footpath shall be polished smooth and rounded using an edger of radius 10 millimetres. Edges shall be free from irregularities of alignment and/or level. Edges of the dual use path shall retain the non-slip broom finish surface and shall not be rounded.

8.3.1.15.7. Protection

The contractor shall provide and maintain protection of pavement against damage of every kind during the period of setting and curing of the concrete.

The contractor shall be responsible for appropriate signage and public safety.

Responsibility for the repairs shall be by negotiation between the Contractor and the Local Government.

8.3.1.15.8. Backfilling and reinstatement of the verge

The verge shall be backfilled to the established grading from the top of kerb to the road reserve boundary and flush with the edges of the pavement using material excavated from the boxed-out alignment of the pathway which is free of foreign material. Residual and unwanted material shall be removed off site in an approved manner.

The contractor shall reinstate all existing verge features and treatments to their original condition.

Backfill to be compacted to the satisfaction of the Local Government.

8.3.1.16. Asphalt pathways

8.3.1.16.1. General

Shared paths using an asphalt wearing course shall be constructed to the lines, levels and pavement design as detailed on the approved drawings. Generally asphalt should be utilised for long distance shared paths.

8.3.1.16.2. Sub-grade

The sub-grade shall be boxed out and compacted to provide even compaction to a depth of 450 millimetres. (Compaction shall not be less than 95 per cent of maximum dry density when measured in accordance with *AS 1289: Methods of Testing Soils for Engineering Purposes)*.

8.3.1.16.3. Base course

Crushed limestone rubble shall be laid in accordance with section 3.4.2 or fine crushed rock in accordance with section 3.4.6. Minimum thickness shall be 150 millimetres and width shall extend 200 millimetres beyond the edge of the asphalt wearing course. Generally asphalt should be utilised for long distance shared paths.

8.3.1.16.4. Wearing course

A 30 millimetre thick wearing course of seven millimetres nominal aggregate asphalt shall be laid in accordance with section 3.4.12.

8.3.1.16.5. Edge restraints

A 100-millimetre wide and 150 millimetres deep concrete edge restraint shall be constructed to the outside edges of asphalt pavements in areas subject to soil erosion and weed intrusion (public open space and reticulated verges). The surface of the edge restraint shall be non-slip broomed finish and shall be flush with the surface of the asphalt pavement.

Use of alternative edge restraints such as paving blocks or similar materials may be approved.

8.3.1.17. Street name plates

8.3.1.17.1. Location

Street name plates shall be erected at all road junctions and intersections as indicated on approved drawings and in accordance with *AS 1742.5: Street Name and Community Facility Name Signs*.

8.3.1.17.2. Dimensions

Street name plates shall be extruded 'I' sections constructed from non-corrosive aluminium not less than three millimetres thick. Plates shall have a minimum depth of 150 millimetres and a minimum length of 500 millimetres. Minimum letter height shall be 100 millimetres.

8.3.1.17.3. Colour

Plate colours shall be in accordance with the Local Government's colour requirements. Background colour application shall be reflectorised and applied so as to cover the entire plate surface.

8.3.1.17.4. Legend

Plate legend lettering and numerals shall be in accordance with *AS 1744: Forms of Letters and Numerals for Road Signs*.

8.3.1.17.5. Mounting

Mounting brackets shall be adjustable clamps, fixed to both top and bottom of the name plates and suitable for attachment to approved structures.

8.3.1.17.6. Post colour and fixing

The street name plate support pole shall be 57 millimetres Outside Diameter galvanised unless otherwise approved. The galvanised steel post may be either retained as galvanised or painted in accordance with the Local Government's colour requirements.

The post shall be set vertically and located on the 2.75-metre street alignment (boundary offset distance).

The lowest part of the street name plate shall be a minimum of 2.7 metres and a maximum of three metres above the prevailing verge ground level.

The post shall be set into a concrete footing of sufficient dimension and in such a manner as to ensure rigidity of the post and prevent rotation.

8.3.1.18. Stormwater drainage

8.3.1.18.1. General

Drainage shall be set out and constructed in accordance with alignments, levels and grades shown on the approved drawings.

8.3.1.18.2. Materials

Pipes

Drainage pipes within the road reserve shall be reinforced concrete pipes unless otherwise approved by the Local Government.

All pipes shall conform to the appropriate Australian Standards:

- AS 4058 Precast Concrete Pipes (Pressure and Non-Pressure);
- AS 4139-2003 Fibre Reinforced Concrete Pipes and Fittings;

- AS 1761 Helical Lock-seam Corrugated Steel Pipes;
- AS 1762 Helical Lock-seam Corrugated Steel Pipes – Design and Installation;
- AS 2566 Plastic Pipe laying Design;
- AS 2439.1 – 2007 Perforated plastics drainage and effluent pipe and fittings – Perforated drainage pipe and associated fittings.

Sub-soil drainage pipes shall conform to the above standards, and the Local Government's standard drawing and except in the case of reinforced concrete pipes, shall have 250 x 5 millimetre slots cut through the pipe on alternate sides at 100°, so that total length of slots is approximately half that of the pipe.

Reinforced concrete pipes shall be of spigot and socket type unless otherwise approved.

Strength class for reinforced concrete and fibre-reinforced cement pipes shall be Class 2 unless otherwise approved.

Concrete

Concrete used for in situ work shall conform to *AS 3600: Concrete Structures*, and be provided either by a pre-mix concrete supplier conforming with *AS 1379: Specification and Supply of Concrete*, or mixed on-site, using materials and equipment as approved.

Concrete for pits, headwalls, end walls and keels shall have a minimum compressive strength of 20 MPa at 28 days.

The slump shall not exceed 70 millimetres or be less than 30 millimetres.

Maximum size of aggregate shall be 20 millimetres.

Cement

All cement used shall be Portland cement in accordance with *AS 3972: Portland and Blended Cement*, and obtained from an approved manufacturer.

Cement shall be delivered to the site fresh and in sealed bags and stored in a weatherproof shed until such time that it is to be used. Any bag showing signs of deterioration or setting shall be rejected.

Concrete aggregate

Fine aggregate shall be well-graded, clean, sharp and free from clay and organic impurities in accordance with *AS 2758.1: Concrete Aggregates*.

Coarse aggregate shall be crushed granite, diorite or basalt clear and free from all impurities and dust in accordance with *AS 2758.1: Concrete Aggregates*.

Water

Water for use in concrete and mortar shall be of potable quality, free from any impurities harmful to concrete, mortar or steel.

Sand

Sand for mortar shall be crushed stone or natural sand – free from all deleterious substances with a uniform grading.

Sand for bedding or backfilling shall be clean sand – free from roots, clay or any deleterious matter.

Steel

Steel-reinforcing fabric and bars for concrete shall comply with the requirements of the following Australian Standards:

- AS 1302 Steel Reinforcing Bars for Concrete;
- AS 1303 Steel Reinforcing Wire for Concrete; and
- AS 1304 Welded Wire Reinforcing Fabric for Concrete.

Bricks

Bricks shall be hard, well-burnt, pressed or wire-cut clay brick in accordance with *AS/NZS 4455: Masonry Units and Segmental Pavers* and *AS 3700: Masonry in Buildings*. The bricks shall have a minimum ultimate strength of 30 MPa, and absorb not more than 10 per cent of their own weight of water when saturated.

Bricks shall be of uniform shape and size, carefully conveyed and unloaded at the site. No chipped or broken bricks shall be used, and pieces of brick may only be used where necessary as closures.

Calibrated aggregate

Calibrated aggregate (granite or diorite) shall be free from roots, clay and foreign material and conform to the following sieve grading:

TABLE 8.6: CALIBRATED AGGREGATE

SIEVE SIZE	PERCENTAGE PASSING
19.0	100
13.2	98–100
9.5	80–90
6.7	53–40
2.4	5–14
0.6	0–3

Junction pit liners

Junction pit liners shall be circular precast concrete liners from approved manufacturers capable of withstanding anticipated design loadings.

Junction pit covers

Junction pit covers located in the carriageway shall be equipped with purpose-built reinforced concrete surrounds a minimum of 150 millimetres thick and fitted with an approved cast iron frame and lid.

Junction pit covers located elsewhere in the road reserve shall be equipped with a purpose-built reinforced concrete surround 150 millimetres thick.

All junction covers shall be equipped with a 600-millimetre square or circular access point with tapered inserts. Both cover and insert shall have approved lifting points installed.

Junction pit covers located in easements shall be of a thickness as determined by design loading but be not less than 100 millimetres.

Grated covers

Grated cover surrounds shall be 150 millimetres thick reinforced concrete with a minimum compressive strength of 20 MPa at 28 days.

The steel insert shall be contained within a steel surround firmly embedded in the concrete and hinged on one side to permit opening with the steel surround protruding above the concrete surround by 25 millimetres.

Grated covers with parallel bars shall be installed with the bars at 90° to the kerbline.

All grated gully covers shall be of heavy duty construction and shall be load tested to full Austroads Highway Loading Conditions 90kN Wheel Load applied as per *AS 1597.1: Small Culverts*. Where there is any likelihood of cycle traffic crossing the road perpendicular to the centreline of the road in the vicinity of gullies, 25 x 3 millimetres mild steel straps shall be welded to the bars at 100-millimetre centres across the full length of the grate or other approved method.

Step irons

Steel step irons shall be installed in the walls of all junction pits over one metre deep at approximately 300-millimetre spacings or at every fourth course of brickwork. Step irons shall be of an approved design with a minimum diameter of 12 millimetres. The surface of these steps shall be adequately protected against rust by galvanising or similar treatment.

8.3.1.18.3. Installation of junction pits and gullies

Junction pits shall be constructed from either circular precast concrete sections with a minimum internal diameter of 1050 millimetres or the square or rectangular equivalent.

All junction pit covers shall overhang the external edge of the liner or walls by a minimum of 100 millimetres. Covers of all junction pits shall be flush with either the pavement level or the finished ground level and set at appropriate crossfalls where necessary.

Junction pits shall be embedded on sand compacted to not less than 95 per cent of the maximum dry density when tested in accordance with *AS1289: Methods of Testing Soils for Engineering Purposes*.

Gullies shall be of either a side entry pit design, a steel grate design or other approved design.

8.3.1.18.4. Headwalls

Where a piped drain interfaces with an open drain, a suitable headwall structure shall be provided to prevent entry of loose material into the pipe and erosion of surrounding ground. In the case of pipes exceeding a 600-millimetre diameter, suitable structures shall be fitted to the inlet of the pipe drainage system to prevent access. A Gross Pollutant Trap may be required

prior to the head wall depending where the stormwater is entering a water sensitive area.

All headwalls shall be constructed using either concrete with 20 MPa compressive strength, mortared stonework or brickwork. The headwall should be designed to aesthetically fir with the surrounding environment.

For mortared stonework, each stone shall weigh in excess of 10 kilograms and the largest dimension of any stone shall not exceed 1.5 times its least dimension.

Headwalls located on outlet pipes exceeding 300 millimetres diameter shall include suitable erosion protection in the form of aprons and edge beams.

8.3.1.18.5. Excavation

The ground shall be excavated to the dimensions and depth required for safe construction and installation of pipe work. Trenches shall be cut to the line, depth and gradient required. If any pipe trench is excavated deeper than required, the extra depth shall be filled with an approved material and compacted to a density exceeding that of the natural surrounding material.

Width of the trench shall be kept to the minimum, consistent with bed width requirements and the need for adequate working space and shoring.

Any excavation carried out on public or private roads shall be arranged so that pedestrian and vehicle access are maintained at all times cause minimum disruption. If work requires road closure, approval of the Local Government shall be obtained.

Excavation for junction pits and gullies shall be completed to the approved depth and to dimensions allowing the use of adequate shoring or battered sides.

Free water in excavations shall be controlled to a level sufficiently low so as not to interfere with construction works. Such control shall be exercised by pumps or a well point dewatering system. Pumps shall be operated in such a manner to cause a minimum of noise disturbance to the local neighbourhood.

8.3.1.18.6. Shoring

Excavation of trenches with irregular shaped sides shall be avoided. Where this occurs or if there is any danger of sides collapsing, approved shoring shall be placed. Approved shoring shall be used where the drain is within two metres, plus drain depth to a building or load bearing structure.

8.3.1.18.7. Blasting

Excavation in rock or hard soil may be carried out by blasting, and a blasting permit shall be obtained from the Local Government.

All explosives shall be stored and handled in accordance with the requirements of the *Mines Regulation Act 1946, the Explosives and Dangerous Goods Act 1961, AS 2187: Explosives – Storage, Transport and Use* and *AS 2188: Explosives – Relocatable Magazines for Storage.*

Blasting shall only be carried out by a person holding a current Western Australian Mines Department Shot Firer's Permit. The shot-firer shall be responsible for repair of damage, legal liability or anything that may arise from the blasting operators. Approved screens, shields and matting are necessary to prevent rock, stones, earth, debris or other material from scattering or blowing from the immediate site of blasting shall be provided.

8.3.1.18.8. Pipe laying and backfilling

No pipes shall be laid on filled ground until such ground has been compacted to a minimum of 95 per cent of its maximum dry density when tested in accordance with *AS 1289: Methods of Testing Soils for Engineering Purposes*.

Extra excavation shall be taken out at the bottom of the trench at all joints, so that pipes will be bearing uniformly on the foundation for their entire length.

Bedding of pipes shall be carried out evenly and thoroughly. Piling, keeling or importation of bedding material may be required. In the case of rock occurring in the bottom of the trench, the trench shall be excavated to a depth of 75 millimetres below the depth required for the pipe. The trench shall be backfilled to grade with approved material and compacted to specification. All pipe bedding shall be in accordance with the Local Government's standard drawings and designed to suit the trench conditions.

During construction, no sand or other material shall be allowed to enter the drainage system. Junction pits shall be covered to prevent this occurring.

No part of the works or any length of pipes or fittings shall be covered until they have been inspected, tested and approved by the Local Government.

All backfilling shall be placed in such a way that no pipes or joints or other works are displaced or damaged.

Backfilling up to 300 millimetres above the top of pipes shall be of approved readily compactable material such as sand or fine gravel, and shall be free from stones retained on a 25-millimetre sieve, clay lumps, building rubbish, tree roots and other vegetable matter.

Backfilling of trenches and excavations shall be carried out as far as possible with excavated material, except that no organic and other materials, articles or substances which might cause uneven settlement or voids shall be used. Former topsoil shall be used as the top layer of backfilling.

Backfilled material in the pipe trench shall be thoroughly rammed and compacted in 150-millimetre layers using appropriate equipment. Required compaction shall be at least the density of the adjoining soil in situ.

Immediately after a trench has been filled, the surface shall be restored and all surplus earth and other materials removed and disposed of in an approved manner.

The surface of fields, grassland and all other similar land shall be restored to the condition in which it was found. Surface soil and sub-soils shall be stored separately and later reinstated to their natural order. All areas disturbed by drainage works shall be stabilised in accordance with section 2.2.1.5.3 Soil Stabilisation.

8.3.1.18.9. Excavation in roadways

Backfilling and interim restoration of trenches in roadways shall be completed immediately after acceptance of drainage work. Material used for backfilling pipe trenches and pits in roadways shall be a clean granular material and compacted to a maximum of 300-millimetre layers to a density not less than 98 per cent of the maximum dry density when tested in accordance with *AS 1289: Methods of Testing Soils for Engineering Purposes*.

For trenches in existing roadways, the top 280 millimetres of trench shall be backfilled with limestone to surface level and compacted to 98 per cent of the maximum dry density tested in accordance with AS 1289. The trench surface shall be kept in safe and reasonable condition for traffic until permanent road reinstatement is carried out. All subsidence shall be made good with fresh approved material. Unless otherwise stated, interim restoration and maintenance of private roads or right of ways shall be carried out as if they were public roads.

Final restoration requires removal of the top 130 millimetres of limestone and replacement of base course material (100 millimetres) and asphalt wearing course (25 millimetres minimum) in accordance with section 3.3.9.

Unless otherwise approved by the Local Government, the minimum depth of cover to pipes at road crossings shall be 600mm.

8.3.1.18.10. Open drains

Open drains shall be formed to lines and levels shown on the approved drawings.

Excavated material from open drains shall be disposed of in an approved manner.

Over-excavation is corrected by filling with material in situ and compacting to a density exceeding that of the natural surrounding material.

8.3.1.18.11. Stone pitching

Surfaces shall be protected by hand-placed pitching stones. Stones shall be hard, sound and durable and generally weigh in excess of 10 kilograms each. The largest size of any stone shall not exceed 1.5 times its least dimension. Geofabric may be used to prevent subsidence or wash-outs.

Stones shall be set on a sand bed in a close fitting pattern, watered and rammed into position.

Where specified as mortared stone pitching, joints between stones shall be raked for their full depth and grouted with three parts sand to one part Portland cement mortar.

8.3.1.18.12. Subsoil drainage

Subsoil shall be set out and constructed in accordance with the alignments, levels, grades and pipe design as shown on the approved engineering drawings.

8.3.1.18.13. Backfilling under crossovers and paths

Backfilling trenches under crossovers and driveways is to be the same as for road crossings detailed in clause 8.3.1.18.9.

Backfilling trenches under footpaths and shared paths shall be generally as detailed in clause 8.3.1.18.9 but trenches may be backfilled to the underside of the path pavement using clean sand or other material approved by the Local Government.

8.3.1.19. Subdivisional materials sampling

Sampling regimes for most subdivisional materials can be assessed using methods suggested by MRWA, which set out sampling a basic testing method for items such as:

- numerical testing methods
- soils
- aggregates
- in situ
- concrete or cement
- bituminous materials or oils
- road making materials
- chemicals.

These methods can be found in the materials engineering section at http://standards.mainroads.wa.gov.au/NR/mrwa/frames/standards/standards

Module No. 9

Glossary, References and Further Reading

9. Module No. 9 – Glossary, References and Further Reading

9.1. Glossary of terms

The following meanings apply to these guidelines.

Western Australian Planning Commission (WAPC)
The agency delegated with powers to approve and impose conditions upon subdivision development within Western Australia, as outlined by the *Planning and Development Act 2005*.

Local Government
The Local Government representing the interests of the local community, when a Local Government is nominated by the WAPC, to administer and clear certain conditions of subdivision imposed by the WAPC.

Subdivider/developer
The subdivider/developer is the owner(s) of, or the company nominated to improve, the land proposed for subdivision and development. The subdivider/developer is responsible for engaging consultants and contractors responsible for investigating, designing and construction of the subdivision.

Planning officer
A planning officer is normally given delegated responsibility by the Local Government. The planning officer is responsible for administering any WAPC subdivision non-engineering conditions and is the coordinating officer for the Local Government on each subdivision approval or clearance.

Engineering Officer
An engineering officer will be an engineering employee or engineering consultant for the Local Government. The engineering officer is responsible for administering subdivision conditions relating to engineering.

The engineering officer will inform the planning officer of progress towards the completion of engineering conditions.

Consulting surveyor
The consulting surveyor is a licensed surveyor engaged by the developer to prepare the deposited plan, for submission when requesting clearance after all WAPC conditions of subdivision have been satisfied.

Consulting engineer
The consulting engineer is a professional employed by the developer to meet the requirement of the Local Government pursuant to the *Local Government Act 1995* and associated legislation.

The consulting engineer is to be eligible for membership of the Institution of Engineers Australia or registration in the National Professional Engineers Register and is responsible to the developer for the detailed investigation and design of the civil engineering works to satisfy the relevant WAPC conditions of subdivision to the approval of the Local Government.

Superintendent
The superintendent is the person employed by the developer to oversee the progress and standard of construction by the contractor. The consultant engineer frequently undertakes the role of superintendent.

The superintendent is responsible to the developer for ensuring that the contractor completes the subdivision works to the approved drawings and specifications.

Contractor
The person employed by the developer to construct the subdivision works in accordance with the approved drawings and specifications.

The contractor is responsible to the developer, and carries out the works overseen by the superintendent. There is no contractual or supervisory relationship between the contractor and the Local Government

Construction commencement date
Construction commencement date is the date on which first stage of construction, which is generally clearing of vegetation for works to be undertaken.

Maintenance bond
Where the developer and the Local Government negotiate that the developer will maintain certain stages or parts of the subdivision for a period, the two parties may agree to a maintenance bond to ensure the developer carries out the maintenance works within the agreed time lines for such works. This type of bond generally applies to landscaping rather than roadworks and drainage works.

Maintenance period
This period is also a negotiated period between the developer and the Local Government for maintaining certain aspects of the works for an agreed period. Again, this generally applies to subdivision where major landscaping or streetscape works have been carried out but need to be maintained to assess the rate of attrition of plants over multiple summers.

Payment in-lieu
Payment in lieu is generally associated with subdivisions where the developer cannot develop if land for public open space was to be given up. This is generally specified in the Department of Planning, Lands and Heritage conditions, so the development can proceed but the Local Government receives a payment in lieu of areas of public open space.

Groundwater
Groundwater may be considered as the natural zone of saturation within the soil matrix occurring at or below the ground surface level. The water table is defined as the upper most limit of the groundwater. The zone varies in depth with sand soils providing relatively free sub-surface movement of water while clay soils (due to the close pore space) provide little movement of moisture. Clay and bound soil types are considered impermeable and can result in perching or elevation of the soil groundwater. The critical water table to be considered for surface drainage is that which occurs nearest to the ground surface level. This may be a perched level or top of seasonal groundwater.

Construction
Construction comprises all cleaning, earthworks, services, stormwater drainage, roadworks, streetlighting, paths, landscaping and all associated and ancillary works required for the development of the subdivision.

Industrial roads
Comprise all roads in areas zoned for "Industry", "General Industry", "Light Industry" or equivalent zonings under the appropriate town planning scheme.

Rural roads
Comprise all roads in rural, special rural and special residential developments.

Outstanding works
Comprises all works defined in **Construction** whether capital or maintenance in nature required to achieve full completion of the subdivision design drawings approved by the Local Government.

9.2. References and additional reading

Module 1 Legal framework and contract administration

- A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities, Department of Biodiversity, Conservation and Attractions, March, 2011.
- Regarding Planning for Bushfire Protection and fire protection standards: FESA Manager Bushfire and Environment.
- Regarding WAPC Policy DC 3.7 and the referral process: FESA Manager Fire Services Planning.

Module 2 Site preparation guidelines

Module 3 Road guidelines

- MRWA, Methods for Sampling and Testing of Asphalt.
- Technical Specification, tender form and schedule for supply and laying of hot asphalt road surfacing (IPWEA and AAPA [WA Branch], April 2002).

Module 4 Drainage management guidelines

- A Blueprint for Water Reform in Western Australia: Final Advice to the Western Australian Government (Water Reform Implementation Committee, Perth Western Australia, 2006);
- Disposal of Water (paper by Geoff Cocks for IPWEA State Conference, March 2007);
- Government's Response to the Report of the Irrigation Review Steering Committee, (Department of the Premier and Cabinet, Perth Western Australia, 2005);
- Guidelines for ecological water requirements for urban water management (in preparation) (Department of Water, Perth, Western Australia);
- Healthy Rivers Action Plan (Swan River Trust, 2008), and the draft SRT/D4 Stormwater Management Policy (Swan River Trust, 2009),

- Peel–Harvey coastal catchment Water Sensitive Urban Design Technical Guidelines 2007 (Peel Development Commission, Mandurah) (available online);
- Peel–Harvey Water Sensitive Urban Design Local Planning Policy 2006 (Peel Development Commission, Mandurah) (available online);
- Protecting Wetlands using Stormwater Management (Department of Environment and Conservation);
- State Planning Strategy (WAPC, Perth Western Australia, 2006);
- Stormwater management manual for Western Australia 2004–2007 (Department of Water, Perth Western Australia);
- The Decision Process for Stormwater Management in WA (Department of Water, Perth Western Australia, 2009).

Module 5 Streetscape guidelines

Module 6 Public open space

AS 1012	Methods of Testing Concrete.
AS 1074	Steel Tubes and Tubular for Ordinary Services.
AS /NZS 1111	ISO Metric Hexagon Commercial Bolts and Screws.
AS /NZS 1112	ISO Metric Hexagon Nuts, Including Thin Nuts, Slotted Nuts and Castle Nuts.
AS 1273	Unplasticised PVC (UPVC) Downpipe and Fittings for Rainwater.
AS 1397	Steel Sheet and Strip Hot Dipped Zinc Coated or Aluminium/Zinc Coated.
AS /NZS 1554	Structural Steel Welding.
AS /NZS 1580	Paints and Related Materials – Methods of Test.
AS /NZS 1594	Hot Rolled Steel Flat Products.
AS 1604	Timber – Preservative Treated – Sawn and Round.
AS 1722	Pipe Threads of Whitworth Form.
AS 1725	Galvanized Rail-less Chain wire Security Fences and Gates.
AS /NZS 1734	Aluminium and Aluminium Alloys – Flat Sheet, Coiled Sheet and Plate.
AS 1742	Manual of Uniform Traffic Control Devices.
AS 1743	Road Signs – Specifications.
AS 1744	Forms of Letters and Numerals for Road Signs.
AS /NZS 1906	Retro reflective Materials and Devices for Road Traffic Control Purposes.
AS 2009	Glass Beads for Road Marking Materials.
AS 2423	Galvanized Wire Fencing Products.
AS /NZS 2433	Plastics – Method for Exposure to Ultraviolet Lamps.
AS 2700	Colour Standards for General Purposes.
AS 3730.14	Guide to Properties of Paints for Buildings – Undercoat – Solvent Borne – Exterior/Interior.
AS 4025.1	Paints for Equipment Including Ships – Solvent – Borne - Interior and Exterior – Full Gloss Enamel.
AS 4049.2	Paints and Related Materials –Thermoplastic Road Marking Materials.

AS/NZS 4049.3	Paints and Related Materials – Road Marking Materials – Waterborne Paint – For use with Drop on Beads.
AS/NZS 4680	Hot Dip Galvanized (Zinc) Coatings on Fabricated Ferrous Articles.
APAS 0041/4	Road Marking Paint, Thermoplastic.
APAS 0041/5	Road Marking Paint, Water Borne.
	Waterwise Land Development Guidelines, Water Corporation.
HB 136:2004,	Safety aspects – Guidelines for child safety.
AS/NZS 4360:2004,	Risk management.
AS 4989–2006,	Trampolines – Safety aspects: http://www.saiglobal.com/Publishing/Shop/Promotions/Child safety Standards.htm – top#top.
AS/NZS ISO 8124.1:2002,	Safety of toys – Safety aspects related to mechanical and physical properties (ISO 8124.1:2000, MOD).

Module 7 Standard drawings guidelines

Module 8 Construction guidelines

AS 2734: Asphalt (hot mixed) Paving – Guide to good practice.

9.3. Abbreviations

Common abbreviations and acronyms used in these Guidelines are listed below.

Abbreviation/Acronym	Detail
AAPA	Australian Asphalt Pavement Association
ARI	Annual Recurrence Interval
AS	Australian Standards
Austroads	Association of Australian and New Zealand Road Transport and Traffic Authorities
ESA	Equivalent Standard Axles
ESL	Emergency State Locations
FESA	Fire and Emergency Services Australia
GST	Goods and services tax
IPWEA	Institute of Public Works Engineering Australasia
MRWA	Main Roads Western Australia
MRS	Metropolitan Regional Scheme
SAT	State Administrative Tribunal
WAPC	Western Australian Planning Commission

Appendices

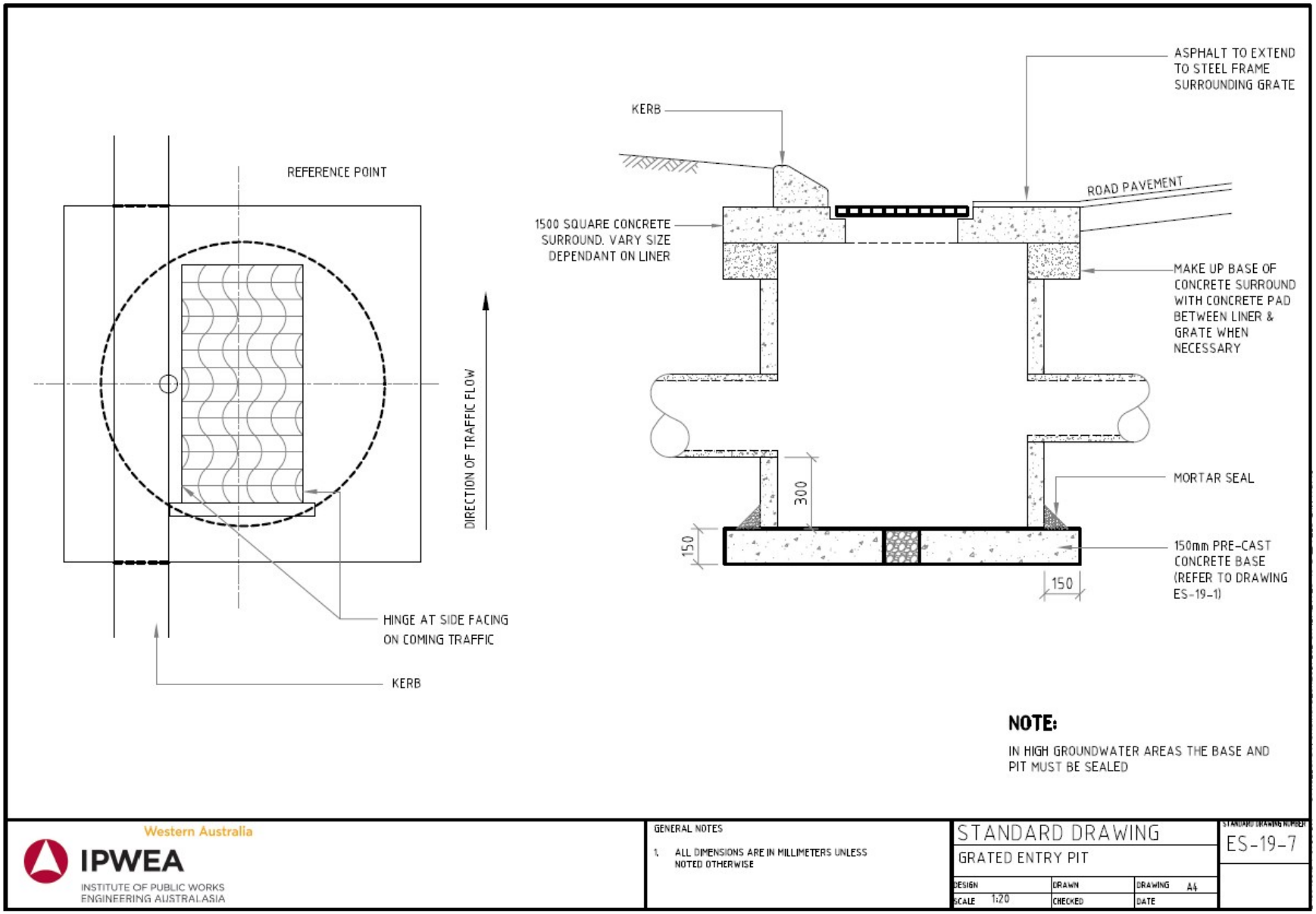
Standard Drawings

10. Appendices STANDARD DRAWINGS

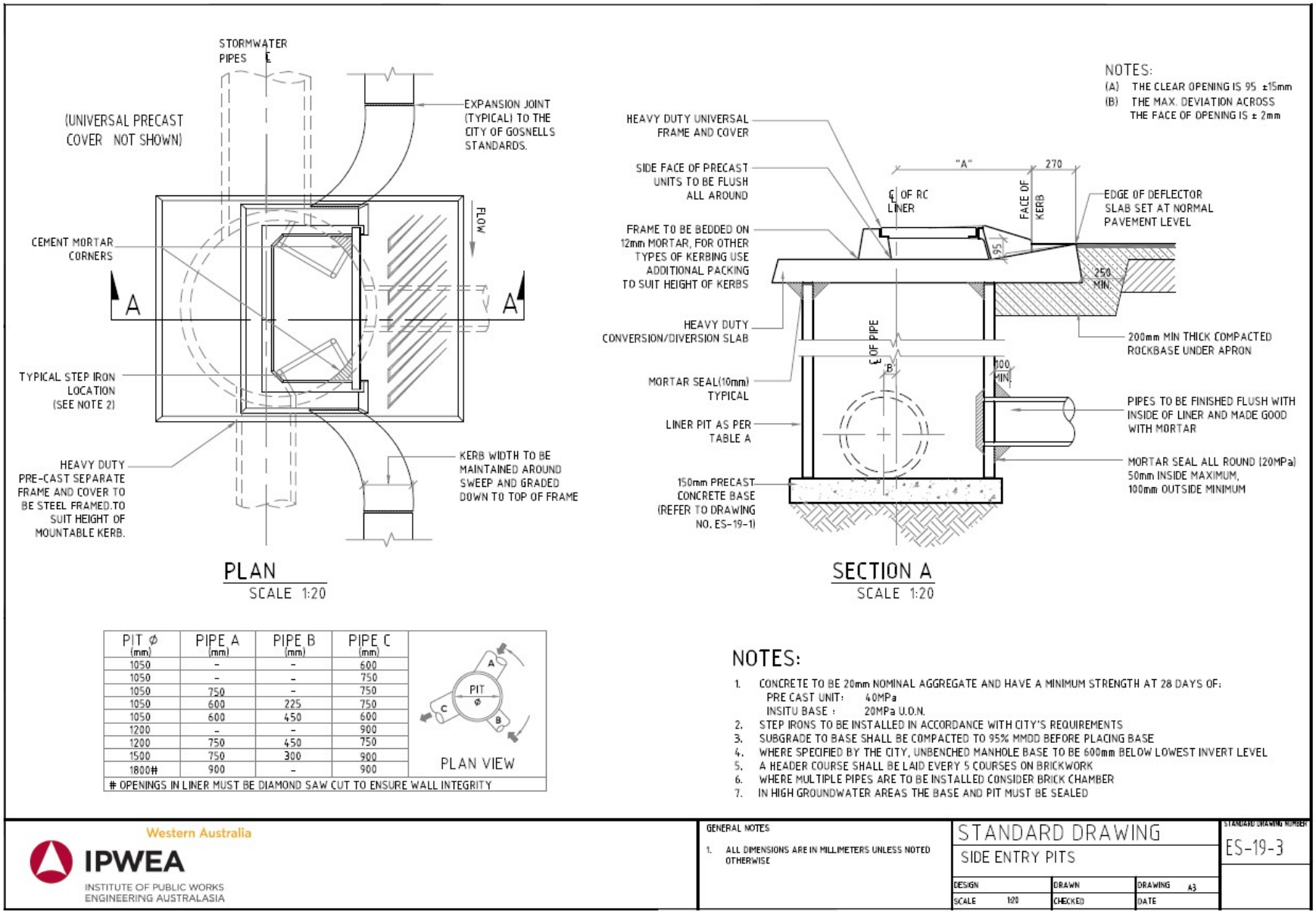
Note: All drawings are at scale when published in A3 format.

CONTENTS

10.1 Grated Gully Pit



10.2 Side Entry Pits



PIT ⌀ (mm)	PIPE A (mm)	PIPE B (mm)	PIPE C (mm)
1050	-	-	600
1050	-	-	750
1050	750	-	750
1050	600	225	750
1050	600	450	600
1200	-	-	900
1200	750	450	750
1500	750	300	900
1800#	900	-	900

OPENINGS IN LINER MUST BE DIAMOND SAW CUT TO ENSURE WALL INTEGRITY

PLAN VIEW

NOTES:

1. CONCRETE TO BE 20mm NOMINAL AGGREGATE AND HAVE A MINIMUM STRENGTH AT 28 DAYS OF:
   PRE CAST UNIT: 40MPa
   INSITU BASE : 20MPa U.O.N.
2. STEP IRONS TO BE INSTALLED IN ACCORDANCE WITH CITY'S REQUIREMENTS
3. SUBGRADE TO BASE SHALL BE COMPACTED TO 95% MMDD BEFORE PLACING BASE
4. WHERE SPECIFIED BY THE CITY, UNBENCHED MANHOLE BASE TO BE 600mm BELOW LOWEST INVERT LEVEL
5. A HEADER COURSE SHALL BE LAID EVERY 5 COURSES ON BRICKWORK
6. WHERE MULTIPLE PIPES ARE TO BE INSTALLED CONSIDER BRICK CHAMBER
7. IN HIGH GROUNDWATER AREAS THE BASE AND PIT MUST BE SEALED

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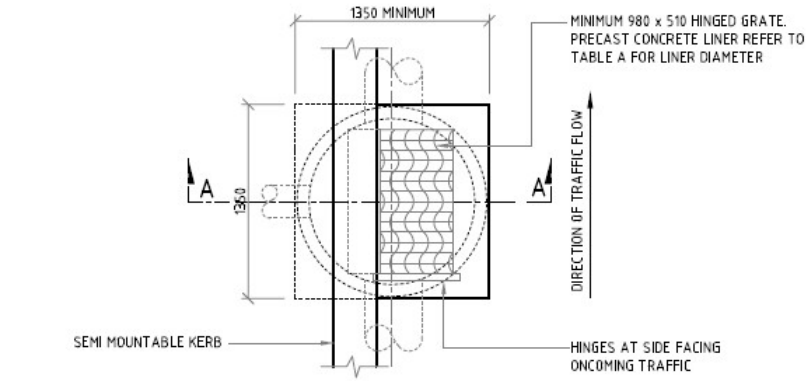
GENERAL NOTES
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

STANDARD DRAWING
SIDE ENTRY PITS

DESIGN	DRAWN	DRAWING A3
SCALE 1:20	CHECKED	DATE

STANDARD DRAWING NUMBER
ES-19-3

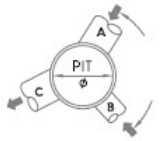
10.3 Combination Entry Pit



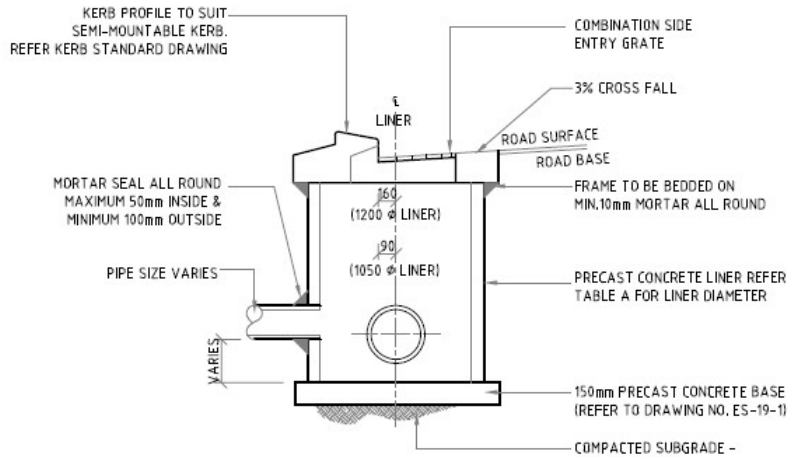
PLAN
SCALE N.T.S

PIT ⌀ (mm)	PIPE A (mm)	PIPE B (mm)	PIPE C (mm)
1050	-	-	600
1050	-	-	750
1050	750	-	750
1050	600	225	750
1050	600	450	600
1200	-	-	900
1200	750	450	750
1500	750	300	900
1800#	900	-	900

OPENINGS IN LINER MUST BE DIAMOND SAW CUT TO ENSURE WALL INTEGRITY



PLAN VIEW



SECTION A-A
SCALE N.T.S

NOTES:

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH OTHER CONSTRUCTION DRAWINGS
2. ALL COVERS ARE TO BE INSTALLED TO MANUFACTURE'S GUIDELINES
3. CONCRETE TO BE 20mm NOMINAL AGGREGATE AND HAVE A MINIMUM STRENGTH AT 28 DAYS OF :
   PRECAST UNIT: 40 MPa
   INSITU BASE: 20 MPa
4. GROUT (MORTAR) TO BE 3 SAND : 1 CEMENT
5. STEP IRONS TO BE INSTALLED IN ACCORDANCE WITH THE CITY OF GOSNELLS' REQUIREMENTS
6. PIPES TO BE FINISHED FLUSH WITH INSIDE OF LINER AND MADE GOOD WITH MORTAR (MAXIMUM PROTRUSION OF 50mm)
7. SUBGRADE TO BASE OF PRECAST LINER AND BACKFILL TO BE COMPACTED TO 95% MMDD BEFORE PLACING BASE
8. IN HIGH GROUNDWATER AREAS THE BASE AND PIT MUST BE SEALED
9. SAND TRAPPING OF LAST JUNCTION PIT PRIOR TO DISCHARGE INTO EXISTING SYSTEM MAY BE REQUIRED. CONFIRM WITH THE CITY OF GOSNELLS
10. USE OF COMBINATION GULLY PITS MUST BE APPROVED BY THE CITY

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GENERAL NOTES
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

STANDARD DRAWING
COMBINATION ENTRY PIT

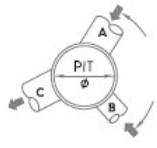
STANDARD DRAWING NUMBER
ES-19-5

DESIGN		DRAWN	DRAWING A3
SCALE	NTS	CHECKED	DATE

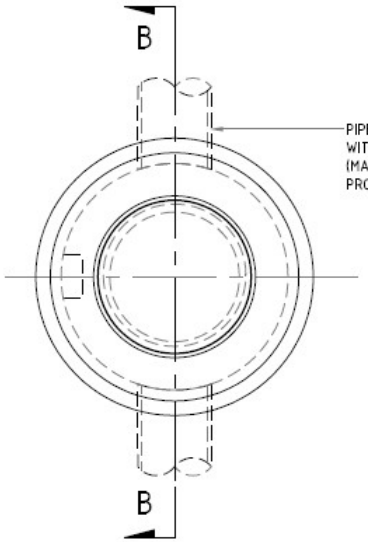
10.4 Junction Pit Detail

PIT Ø (mm)	PIPE A (mm)	PIPE B (mm)	PIPE C (mm)
1050	–	–	600
1050	–	–	750
1050	750	–	750
1050	600	225	750
1050	600	450	600
1200	–	–	900
1200	750	450	750
1500	750	300	900
1800#	900	–	900

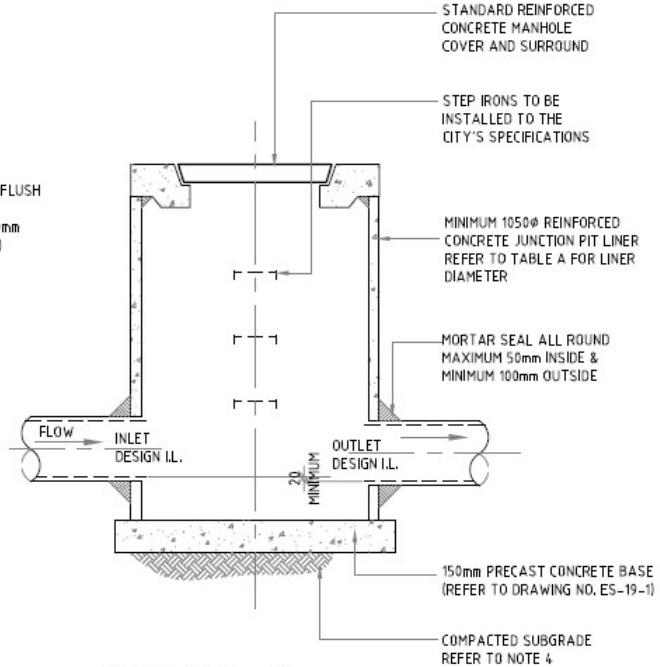
OPENINGS IN LINER MUST BE DIAMOND SAW CUT TO ENSURE WALL INTEGRITY



PLAN VIEW



PLAN
SCALE 1:20



SECTION B – B
SCALE 1:20

NOTES:

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH OTHER ' CONSTRUCTION DRAWINGS
2. STEP IRONS ARE TO BE INSTALLED TO THE CITY'S STANDARDS
3. ALL COMPONENTS SHALL BE DESIGNED TO ACCEPT LOADINGS IN ACCORDANCE WITH AS3725 AND MANUFACTURERS' GUIDELINES
4. SUBGRADE TO BASE SHALL BE COMPACTED TO 95% MMDD BEFORE PLACING BASE
5. IN HIGH GROUNDWATER AREAS THE BASE AND PIT MUST BE SEALED
6. MORTAR TO BE 3:1, SAND:CEMENT MIX
7. PRECAST CONCRETE TO BE 20mm NOMINAL AGGREGATE AND HAVE A MINIMUM 28 DAY STRENGTH OF 40MPa
8. INSITU CONCRETE SHALL HAVE MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 20MPa
9. LINERS SHALL BE INTERLOCKING JOINT AND SPUN REINFORCED CONCRETE LINER TO AS 4058
10. A MAXIMUM OF THREE PIPE OPENINGS ARE ALLOWED IN ANY ONE JUNCTION PIT
11. A MINIMUM WALL WIDTH OF 250mm IS ALLOWED BETWEEN HOLES CUT FOR PIPE OPENINGS
12. THE MAXIMUM OUTSIDE DIAMETER OF A PIPE CONNECTED TO THE JUNCTION PIT SHALL NOT EXCEED 30% OF THE INTERNAL DIAMETER OF THE JUNCTION PIT
13. HOLES FOR PIPES ENTERING JUNCTION PIT WALLS ARE TO BE MACHINE CUT OR MADE BY DRILLING 10mm HOLES AT 20mm CENTRES AROUND A CIRCLE MARKED ON THE INSIDE WALL AND THEN BREAKING OUT THE CONCRETE
14. RUBBER RING JOINTS TO BE INSTALLED IN ACCORDANCE WITH AS3500
15. PIPES TO BE FINISHED FLUSH WITH THE INSIDE OF THE LINER AND MADE GOOD WITH MORTAR (MAXIMUM PROTRUSION OF 50mm)
16. MINIMUM PIPE DIAMETER 300mm
17. LINER DIAMETER TO BE A MINIMUM 1050mm.

Western Australia
IPWEA
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

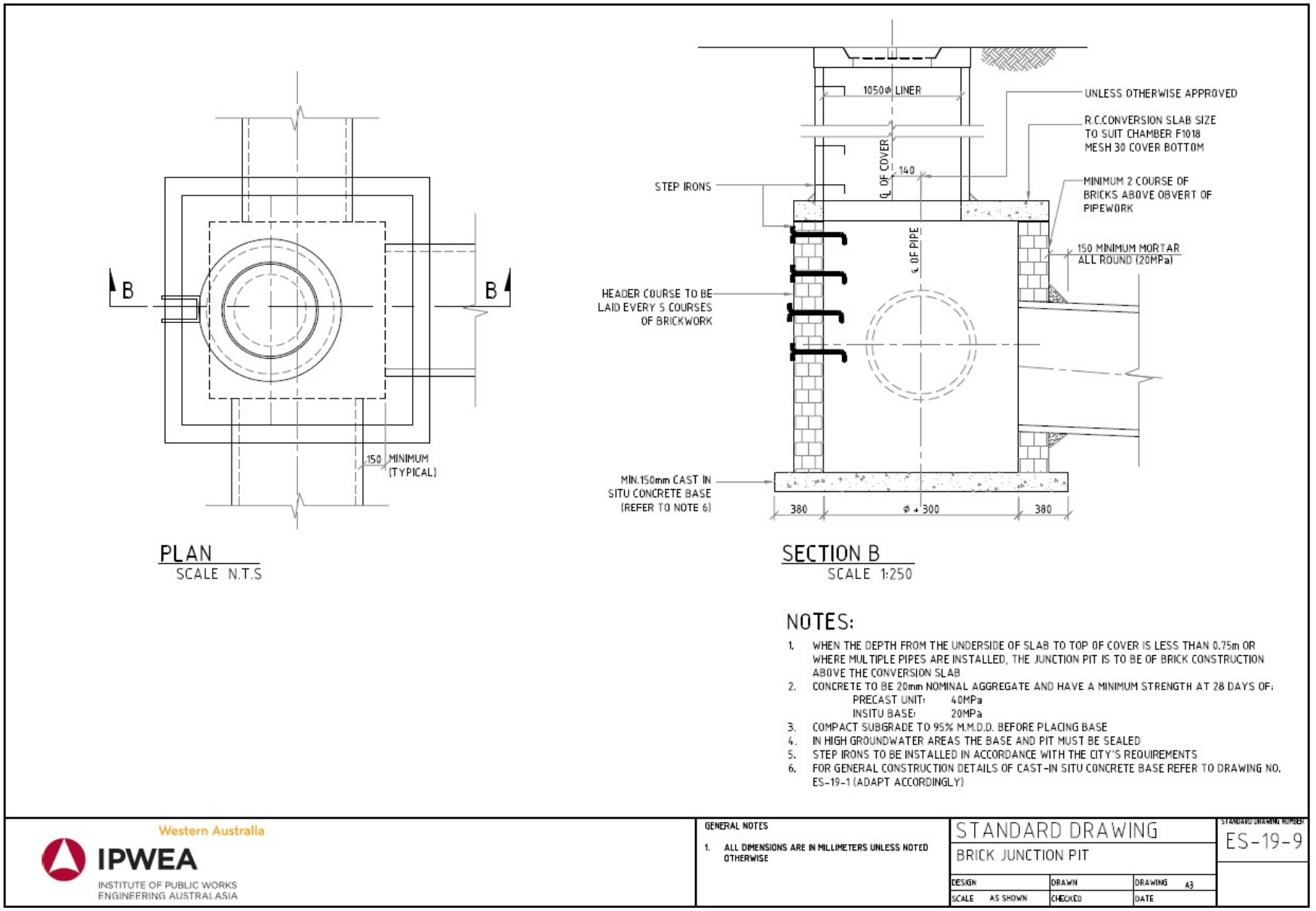
GENERAL NOTES
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

STANDARD DRAWING
JUNCTION PIT DETAIL

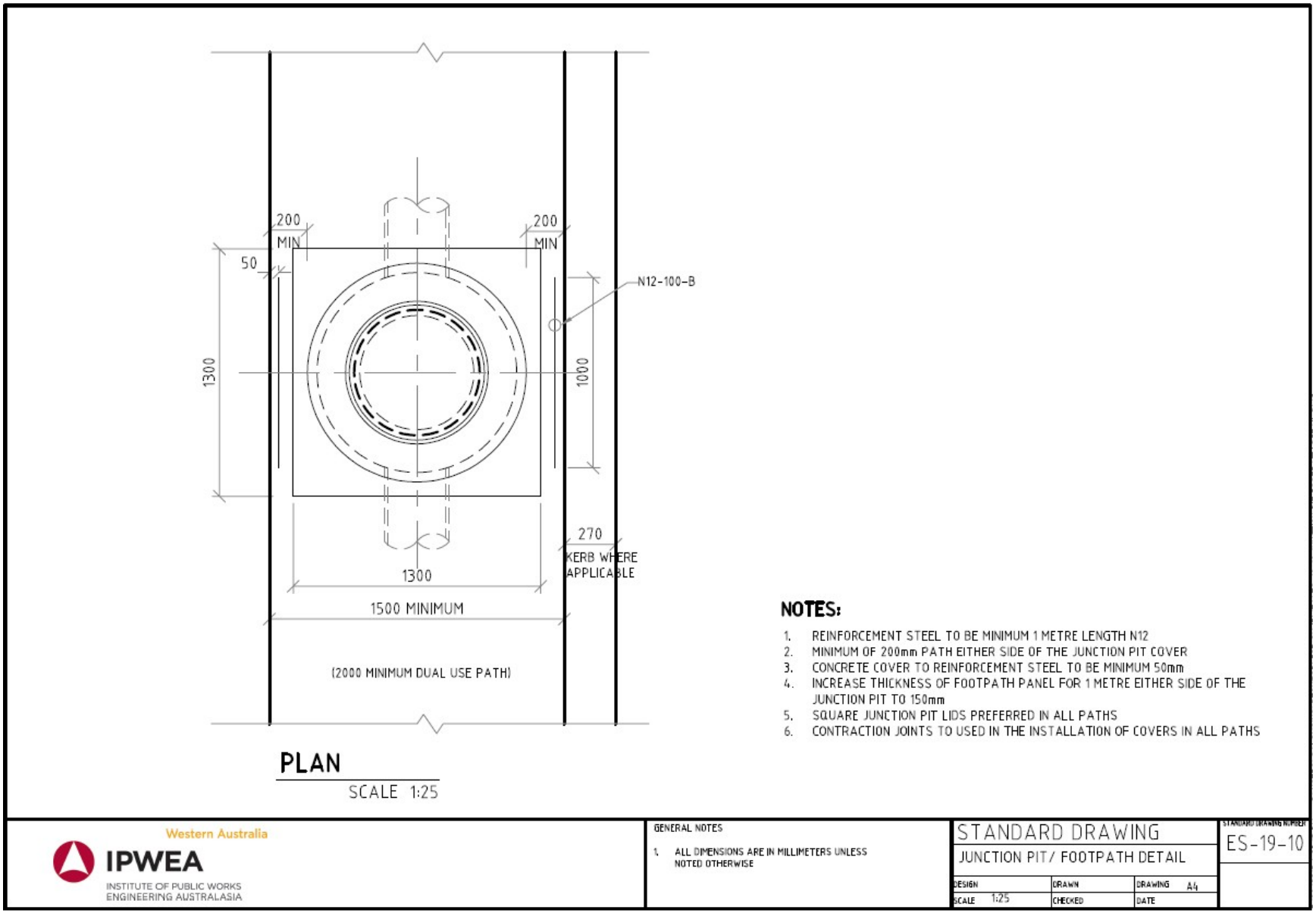
DESIGN		DRAWN	DRAWING A3
SCALE	1:20	CHECKED	DATE

STANDARD DRAWING NUMBER
ES-19-8

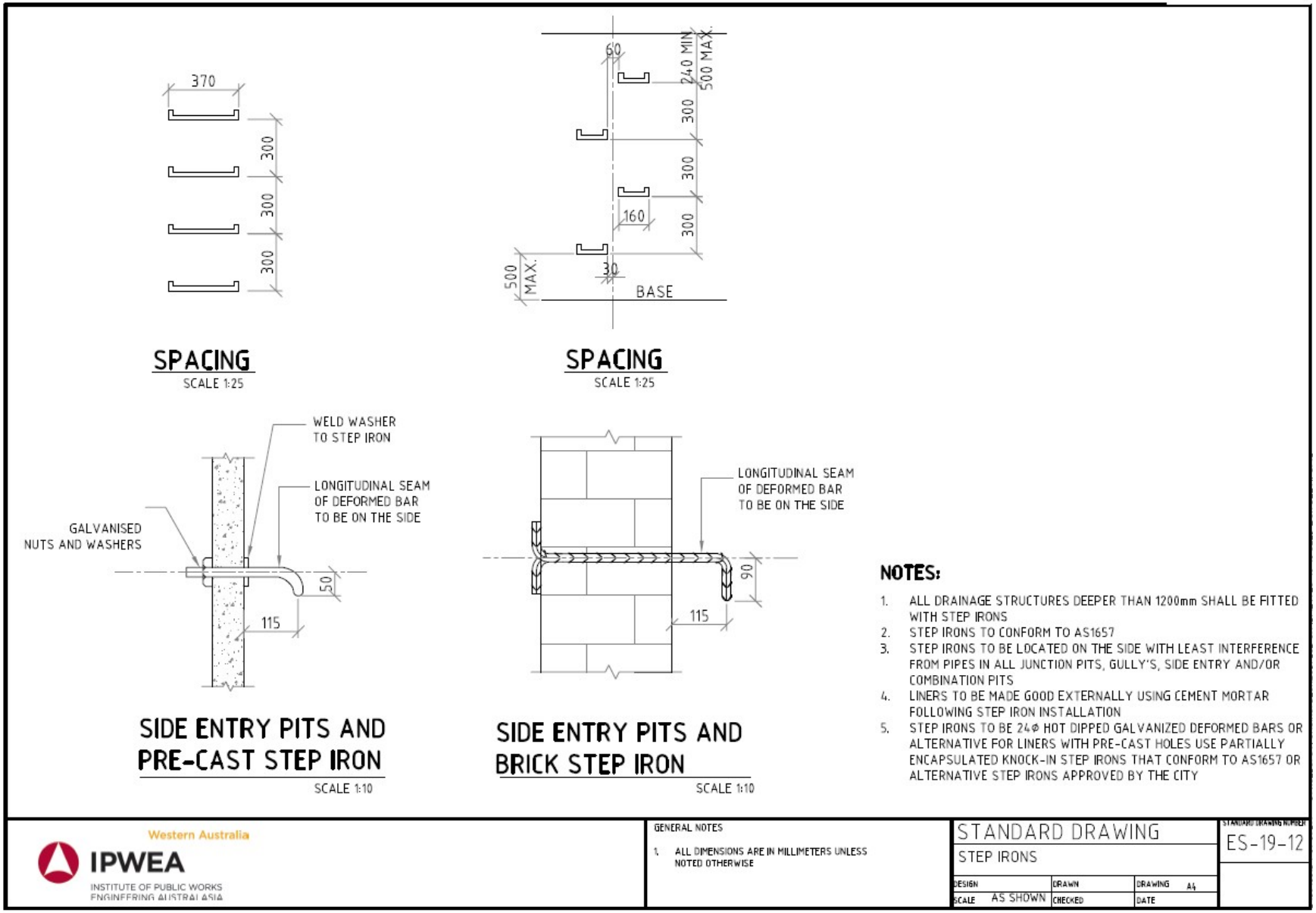
10.5 Brick Junction Pit



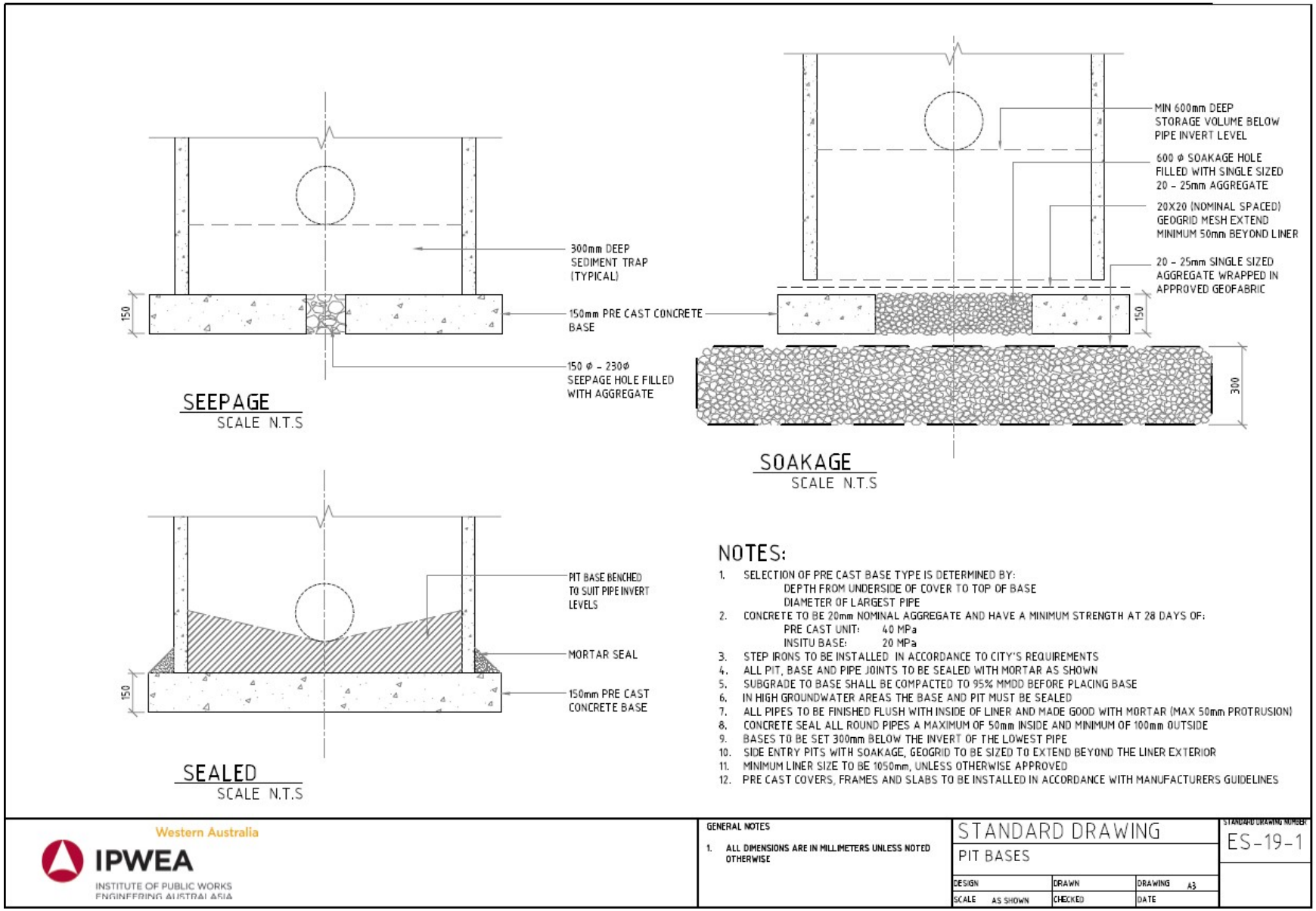
10.6 Junction Pit / Footpath Detail



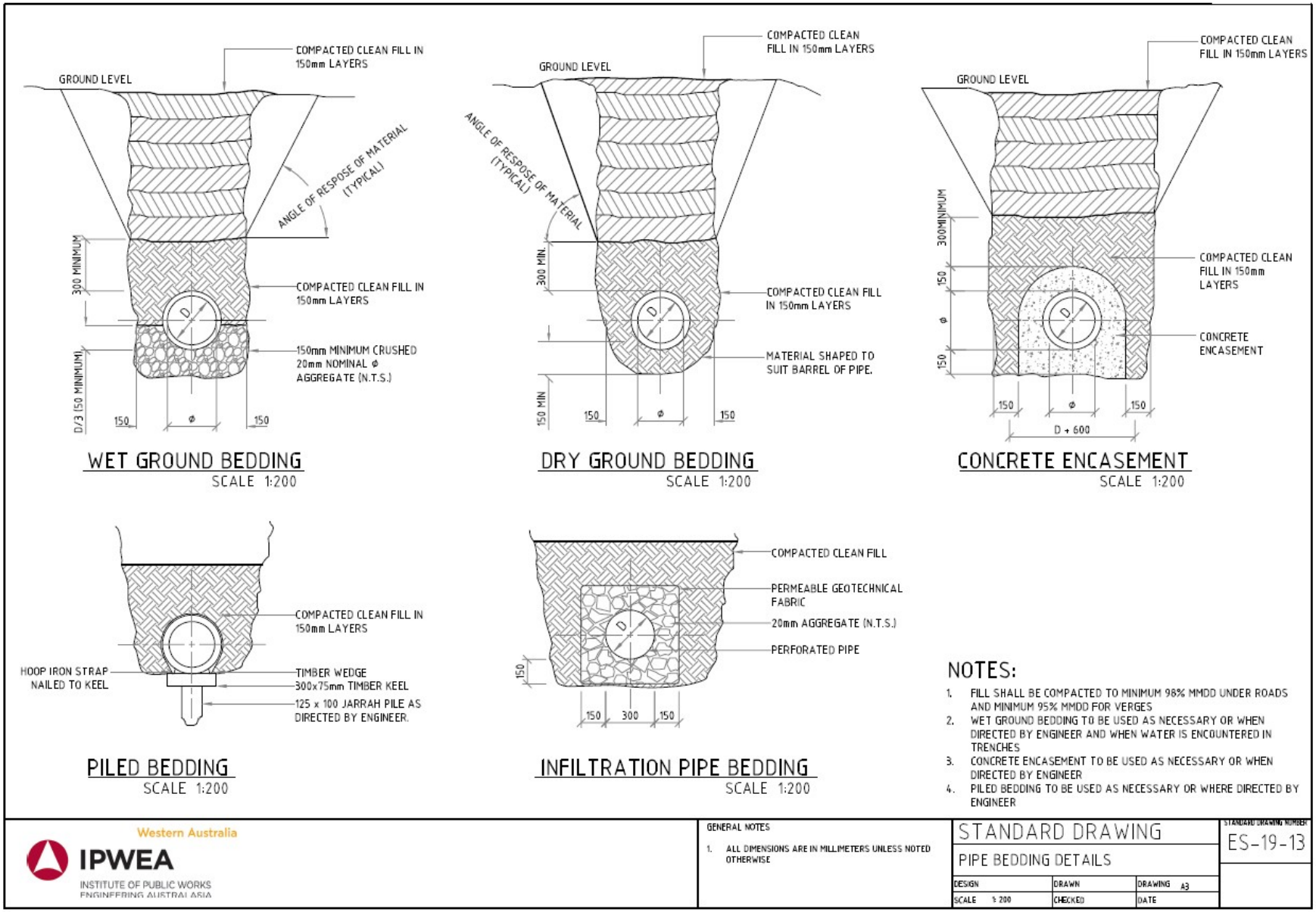
10.7 Step Irons



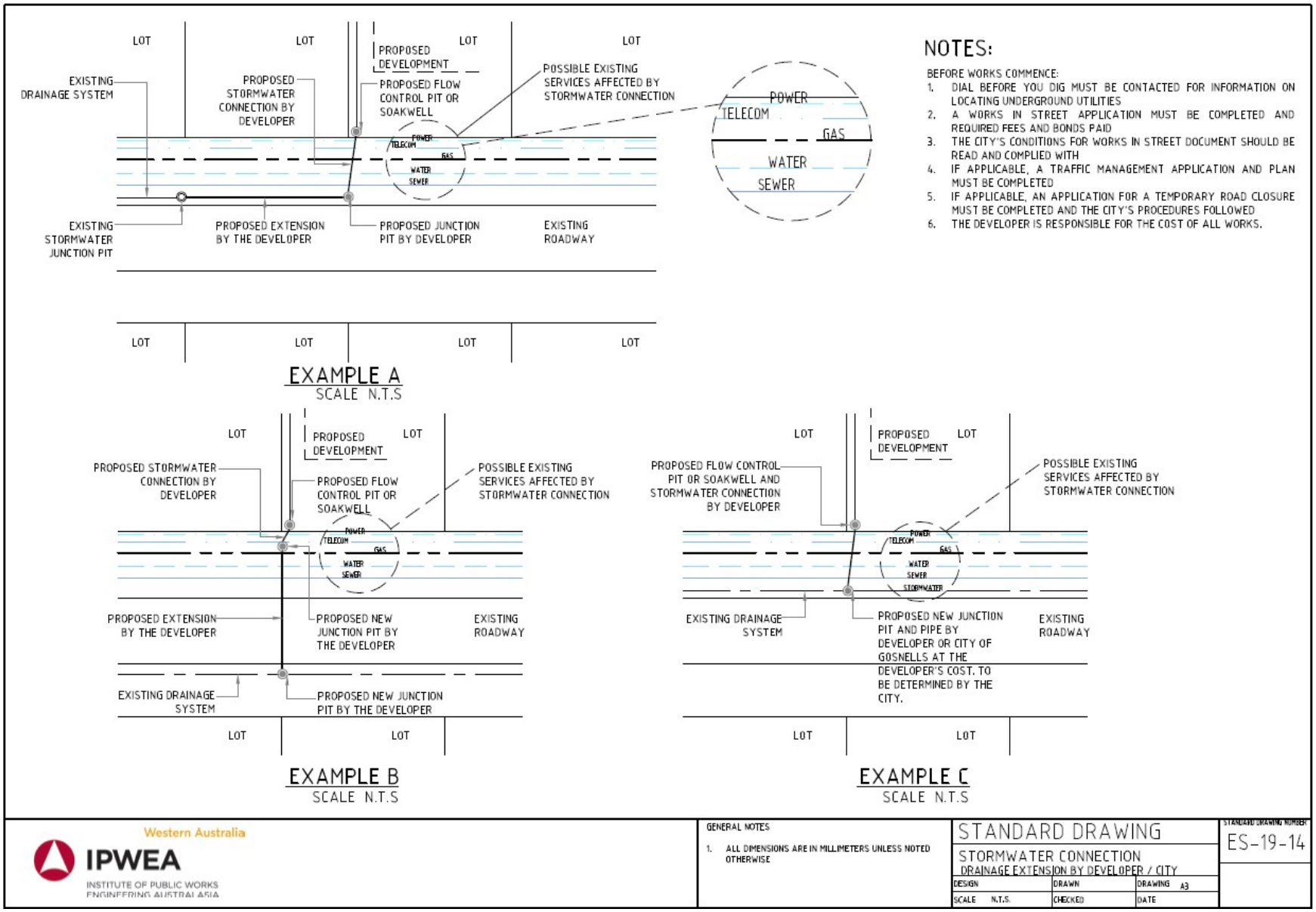
10.8 Pit Bases



10.9 Pipe Bedding Details



10.10 Stormwater Connection



10.11 Subsoil Drainage Detail