SECTION 32

CIVIL

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Version	Date	Authors	Summary of Changes
	30/11/15	FortisEM & Manager, Infrastructure Services	First Edition
V1	02/07/18	Manager, Infrastructure Services	2018 general review update

32.0 CIVIL

This document is a sub-section of the James Cook University (JCU) Design Guidelines and is not to be read in isolation. Consultants and Contractors are required to comply with all sections of the JCU Design Guidelines.

32.1 Design Process Requirements

The consultant shall be held responsible / liable for ensuring that all works necessary for the complete installation and successful operation are included in the design and specifications. Specific deliverables are required at the end of each project stage, namely:

32.1.1 Approvals Required during Design

Approval shall be obtained from the JCU Estate Directorate, Deputy Director, Planning and Development in SD for the:

- Plain concrete or alternative aggregate size or colour mixes when required to match existing exposed aggregate footpaths,
- Use of pavers or feature pavers in lieu of reinforced concrete pathways,
- Use of rendered block or inter locking link block walls as retaining walls,
- Concrete driveways not designed in accordance with the Cement Concrete & Aggregates Australia T48-2009 guide,
- Traffic growth rate for road design basis is not determined from a traffic study,
- Selected design vehicles for the project,
- Use of a sprayed bituminous seal for road or carpark surfaces,
- Earthworks not carried out in accordance with “AS3798 Guidelines on Earthworks for Commercial and Residential Developments”,
- Design IFD rainfalls
- Contour maps produced from local council’s GIS used to determine the hydrological catchments and to measure areas,
- Reduced levels for open channel cross sections if not to Australian Height Datum (AHD),
- Use of trenching through existing roads to install services, and the
- Non-realignment of existing services within the development envelop.

Approval shall be obtained from the JCU Estate Directorate, Manager, Infrastructure Services in SD for the:

- Engineering designs not completed by RPEQ Engineers,

- All considerations, assumptions, subgrade test results, the need or otherwise for subsurface drainage, all calculations and other documentation required under this design specification for pavement designs including design CBR of untreated road subgrade less than 3 percent, and the

- Minimum construction and permanent clearances for HV and LV conductors.

Approval shall be obtained from the JCU ICT Programme Manager, Infrastructure Services in SD for the:

- Minimum construction and permanent clearances for Communications conduits.

32.1.2 Site Infrastructure Connection Approvals

The Manager, Infrastructure Services approves all connections to JCU infrastructure, including any driveways or road intersections.

32.1.3 Schematic Design (SD) Report / Design Review

Report Content in addition to requirements of Section 30:

- Design Basis, included Design Loads, Traffic Data, Hydrology Data, Estimated stormwater flow calculations, special load considerations, geotechnical values (specifically advise on any assumptions made)

- Concept alignments, routes, and long section with chainage schedules

- Proposed road and carpark signage and lines

- Estimated stormwater flow calculations

- Layout drawings showing any interfaces with existing services and structures, including proposed services corridor/trenches (integrated services drawing).

32.1.4 Developed Design (DD) Report / Design Review

Report Content in addition to requirements of Section 30:

- Detailed design, included Design Loads, Traffic Data, Hydrology Data, stormwater flow calculations, special load considerations, final geotechnical values

- Final alignments, routes, and long section with chainage schedules

- Final road or carpark signage and lines

- Provide detailed information of all existing and new site services. This information may be shown on the other engineering drawings, but the civil discipline is responsible to develop and check an integrated services drawing to ensure minimum clearances are achieved in all 3 dimensions and that trenching costs are minimised.

The Developed Design JCU RPEQ Certification Schedule below shall be completed by the DD Design Engineer and submitted for confirmation.

Project Name		
Project Number		
Date		
Company		
RPEQ Design Engineer Name		
RPEQ Licence Number		
Road Area	sqm	
Carpark Area	sqm	
Calculated Building Peak Stormwater Flow (Q100)	l/s	
Civil Estimated Capital Investment (ex GST)	$(ex GST)	
	Manager Infrastructure Services	
All specific design elements are included in the design	YES / NO	
Does the SD Report include Life Cycle Costing	YES / NO	

32.1.5 Construction Contract Document Requirements

In addition to requirements of Section 30, include an updated Certification Schedule as per 32.1.4 completed by the CD RPEQ Design Engineer.

32.1.6 Handover Requirements

Undertake a witness inspection of the operation. Ensure that the Consulting Engineer and JCU Manager, Asset Strategy and Maintenance and/or JCU Manager, Infrastructure Services (or representatives) are present.

32.1.7 Design Approvals and Workmanship Guarantee

Irrespective of directions received from JCU, the Consultant remains fully responsible for the design solution developed.

All designs done for and on behalf of JCU require RPEQ certification, unless approved by the Manager, Infrastructure Services.

A Form 15 Design Certification is to be provided for approval prior to construction commencing and all works are required to be certified by a RPEQ Engineer prior to practical completion being awarded.

For civil infrastructure, the RPEQ's certification letter shall provide the following minimum information:

- Location of works, including lot and plan number
- Reference documentation
- Reference to contractor quality documents and workmanship guarantee
- Description of works certified
- Basis of certification

- Certifying RPEQ's registration number

JCU requires a certificate from the Contractor guaranteeing that the works have been constructed in accordance with the Drawing, Specifications and Contract approved for construction by JCU.
This Workmanship Guarantee shall be included in the project specification by the consultant – and be completed by an appropriately qualified Engineer, commissioned and paid for by the Contractor, and shall be as follows:

WORKMANSHIP GUARANTEE

Contractor:

Project:

Contract Number:

I/We being a Civil Engineering Construction Firm (Contractor) and having been commissioned by way of contract, or otherwise, to carry out the construction of the works comprising of ALL CIVIL CONSTRUCTION do hereby certify that:

The works have been constructed in accordance with the drawings and documents approved by James Cook University for the construction of the project and relevant Australian Standard Codes of Practice, and further, during the course of construction, I/we have called for the inspections and testing required in the documentation and confirm that the inspections and tests have met the Specifications in all respects. We further guarantee that the standard of workmanship between inspections has been maintained at all times and that the materials used in the construction have been approved, are in compliance with the specification and, where required, stamped by the manufacturer to guarantee their authenticity.

Name: *Signature:*

Position: *Date:*

32.2 Pathway and Cycleway Design Requirements

Despite JCU campuses having a mix of path types, the requirement is now to install exposed aggregate footpaths. When required to match existing footpaths, plain concrete or alternative aggregate mixes maybe adopted with approval by JCU Estate Directorate, Deputy Director, Planning and Development. This section does not include requirements for dedicated vehicle paths or hardstands.

32.2.1 General

The design of cycleways and pathways should generally be undertaken in accordance with the minimum requirements of the AUSTROADS Guides. All design shall incorporate all the requirements for disabled access as appropriate in accordance with AS1428 and the Disabled Discrimination Act.

Designers should be familiar with geometric design requirements in terms of width, grade, stoping sight distances, change in grade, horizontal curvature, crossfall, drainage, super elevation and sight distances on horizontal curves.

A number of cycle way types may be utilised, to determine the acceptable solution, the designers shall undertake consultant with the JCU Project Manager and stakeholder groups. Cycle ways can be provided on road and off road and may consist of the following solutions:

- Sharked Parking/Bicycle Lanes
- Wide Kerbside Lanes
- Shared Traffic Lanes
- Exclusive Bicycle Lanes
- Sealed Shoulder
- Shared use Bicycle/Pedestrian Pathways
- Separated Pathways; and
- Exclusive Cycle ways

The most commonly used pathways on JCU sites include Sealed Shoulders and shared pathways.

The design of any cycle/path way is required to conform to acceptable widths, gradients and cross-falls and the appropriate slip resistance codes for pedestrian use. Consideration of aggregate type for skid and slip resistance (avoid glassy and smooth aggregates) is important to ensure the foot paths are safe when wet. All footpaths should be ambulant compliant to AS1428 and other Disabled Access Codes as required.

32.2.2 Minimum Design Standards

Notwithstanding the minimum design requirements of Austroads, the following minimum design standards have been set by JCU:

All foot paths shall be constructed with polymeric film underlay installed over the prepared foundation. Lap joints at least 200 mm and seal the laps and penetrations with waterproof adhesive tape. Face the laps away from the direction of concrete pour. Take the underlay up vertical faces past the damp proof course where applicable, and tape fix at the top. Patch or seal punctures or tears before pouring and cut back after concrete has gained strength and forms have been removed as required. Painting – as per section 32.6.11.

Aluminium tactile indicators tiles to be installed according to 1428.1-2009 and in addition, to ensure longevity shall be chemical set, all holes shall be cleaned out before anchoring and shall be a minimum 2 mm bigger than the stem of the tactile.

50 mm PVC conduits are to be provided under paving in agreed locations (approx. 20m intervals) for future services with locations marked on kerbs/pavements with a plate as detailed in Section 25 of these design guidelines.

	Minor Pedestrian Pathway (Infrequent Use)	Medium Pedestrian Only	Cycleway only	Shared Use Pathway with minor vehicle loading
Path Width	1.2m	1.8m	2.0m	2.5m
Concrete Thickness	100mm	100mm	100mm	150mm
Concrete Grade	N25	N25	N25	N32
Reinforcement	SL72	SL72	SL72	SL82
Cross Fall: Min: Max:	 1:100 1:40	 1:100 1:40	 1:50 1:20	 1:50 1:20
Max Grade:	3% for 25m* 4% for 20m* 5% for 15m*	3% for 25m* 4% for 20m* 5% for 15m*	3% for 200m 5% for 100m 10% for 20m	30% for 25m* 4% for 20m* 5% for 15m*
*A level rest area of 1.2m long is to be provided where this length is exceeded				

It is a requirement for the design of all paths that the following investigations are undertaken prior to commencement of design:

- Pot holing of existing services to be undertaken to confirm location & depth of existing services identified by the JCU Manager, Infrastructure Service during Schematic Design Stage.

32.2.3 Fill Material

All concrete to be reinforced, laid on compacted CBR 15 fill (100 mm thick pedestrian use, 150 mm thick for incidental vehicle use), and be complete with expansion, construction and dowel joints. Existing top soil and organic matter should be stripped from under the proposed location prior to commencement of construction.

32.2.4 Aggregate

Aggregate must be part of concrete mix (avoid seeded aggregate finish). Aggregate to be carefully washed out to ensure stones do not project more than 2mm. Any other colour to be integral and aggregate type and finish to be approved by the JCU Estate Directorate, Deputy Director, Planning and Development if not in accordance with the table below.

The following table outlines aggregate mix designs:

Area	Aggregate	Cement	Pigment
Townsville	20% Honey 70% Burdekin Rock. 7-10mm agg.	25MPa	N/A
Cairns	Tinaroo Gold and Barron	Equivalent to mix supplied by Hanson	

32.2.5 Steps, Ramps and Walkways

All Steps, Ramps and Walkways shall be compliant to the National Construction Code and AS1428.1-2009. It is a requirement that all Ramps and Walkways are ambulant compliant. Steps should generally be avoided.

Handrails are to be provided for steps and ramps and generally match adjacent existing handrail design elsewhere on campus to 1428.1-2009. Polished stainless steel handrails are preferred though hot dip galvanised rails may be used upon approval. No Painting.

32.2.6 Pavers

All new works are to be of reinforced concrete construction. In existing areas, pavers should be removed and replaced with reinforced concrete where possible.

Where approval is granted by the JCU Estate Directorate, Deputy Director, Planning and Development for the use of approved feature pavers they are to be fixed on a concrete base slab 100mm thick and laid, cleaned, sealed, to manufacturer's specification.

32.2.7 Retaining Walls

Avoid retaining walls where possible and use battered banks.

Walls adjacent to ramps and buildings are to be in situ concrete (colour to be integral) masonry/stone as appropriate to the situation. They must be constructed to engineering specification and coated with an approved vandal resistant sealant. No timber walls. Approval from the JCU Estate Directorate, Deputy Director, Planning and Development is to be sought for the use of rendered block or inter locking link block walls.

Back of retaining walls to be waterproofed and protected by an appropriate drainage system

Design consideration is to be given to capping, falls on capping, possible future staining of walls and use for casual seating.

Install sub surface drainage adjacent to paths and buildings in all turfed areas as well as at the edge of all roads, at the lowest point of the subgrade of the road pavement.

32.2.8 Kerbs

Kerbs shall comply with the relevant local government authority standard designs and drawings

32.2.9 Garden Edges

Where mown grass areas abut gardens, kerbs and walls, edges are to be concrete, min. 100 mm wide and 125 mm deep, finished with a steel float and construction joints at 1500 mm maximum centres. Any colour additives to be integral. Any elevated edges to be fitted with pipes/slots at ground level to expedite drainage from planted areas.

32.3 Driveway Design Requirements

32.3.1 Design Method

Concrete driveways are to be designed in accordance with the Cement Concrete & Aggregates Australia T48-2009 guide to industrial floors and pavement design guide.

Other design methods may be accepted subject to approval from the JCU Estate Directorate, Deputy Director, Planning and Development. All pavements shall be designed for unlimited number of vehicle movements and have an appropriate allowance for commercial vehicles (including garbage trucks, delivery trucks, fire trucks etc.).

32.3.2 Geotechnical Design Parameters

A minimum CBR 3 shall be used for the design of all concrete driveways unless sufficient CBR testing has been undertaken by a Geotechnical Engineer to establish a design CBR. CBR testing should be undertaken by a 4 day soaked CBR test. The use of DCP's to establish the design CBR is not permissible.

It is a requirement for the design of all driveways that the following investigations are undertaken prior to commencement of design:

- Detail Level Survey (undertaken by a registered surveyor) coordinated with all known services as per JCU's GIS Systems shown clearly on the drawings. Refer also to Section 34;
- Where no existing traffic data is available a traffic count/study must be undertaken.
- Pot holing of existing services to be undertaken to confirm location & depth of existing services identified by the JCU Manager, Infrastructure Service during Schematic Design Stage.

32.3.3 Design Vehicles & Turning Circles

All driveway designs shall be accompanied by turning circles demonstrating that the driveway is suitable for used by the design vehicles for the project. The design vehicles should include, but not be limited to the following:

- B99 car
- Garbage trucks
- Fire trucks, ambulance etc.
- Delivery trucks
- EWP'S and small cranes

The selected design vehicles for the project must be submitted to the JCU Estate Directorate, Deputy Director, Planning and Development for approval during SD.

32.4 Pit Design Requirements

32.4.1 Stormwater Pits

Stormwater drainage pits shall meet the following minimum specification:

- 32MPa Concrete (Slump tests shall be carried out and results confirmed by JCU Representative)
- 150mm thick walls and base
- Hot dipped galvanised reinforcement shall be used at all construction joint locations
- Class C lid in accordance with AS3996-2006

Stormwater pits shall be designed and constructed in accordance with Townsville City Council (TCC) minimum requirements for the Townsville campus and FNQROC minimum requirements for the Cairns campus.

All other sites shall be designed and constructed in accordance with the Local Governments standards or Townsville City Council minimum requirements. The designer shall adopt the standard which is more onerous. It is a requirement that the designer provide all details for the pits on the project documentation and not reference the local government authority standards on their document.

Fill shall be provided around the top of all pits to provide a level surface. Fill shall extend a minimum of 600mm from the perimeter of the pit and any other measures required to prevent erosion shall be taken if required by specific site conditions.

Designer to consider design loads for each pit – minimum requirement provided for information only.

Inlet pits along roads shall be spaced so that the gutter flow width is limited in accordance with this sub-section and so that the inlet efficiency is not affected by adjacent inlet openings. Preference shall be given to the location of drainage pits at the upstream side of existing driveways, allotments and intersections.

Inlet pits are to be checked against Appendix 3 of QUDM (3rd Edition 2013 – provisional, or as amended). In the minor storm event, all stormwater pits are to be spaced such that there will be at least a single traffic lane (i.e. 3.0 m wide) that can pass along the road without the width of flow encroaching into that 3 m corridor. Absolute maximum width of flow is to be:

Absolute maximum widths of flow on roads

Location of flow	Max. width of flow (m)
Outside lane against kerb and channel (fall to kerb)	2.5
Inside lane against central median (fall to median)	0.5

32.4.2 Electrical and Communication Pits

Refer to Section 25 & 26 of the design guidelines for electrical and communication pit requirements respectively.

Where reinforced concrete pits are required, the minimum design standard to adopted is as follows:

- 32MPa concrete (Slump tests shall be carried out and results confirmed by JCU Representative)
- SL82 mesh
- Hot dipped galvanised reinforcement shall be used at all construction joint locations
- 150mm thick walls and base
- Class C lid in accordance with AS3996-2006
- 6mm thick steel lids for all inspection openings.

Cable marker direction arrows shall be provided for all pits. They shall be fully recessed with no sharp edges.

32.4.3 Chilled Water Pits

Refer to Section 20 of the design guidelines for Chilled Water Pit requirements

Cable marker direction arrows shall be provided for all pits. They shall be fully recessed with no sharp edges.

32.5 Carpark Design Requirements

32.5.1 Australian Standards

AS/NZS 2890 Set Parking Facilities
AS1428 Set Design for Access and Mobility

32.5.2 Austroads guides

Austroads Design Vehicles and Turning Path Templates Guide
Guide to Road Design set
Guide to Traffic Management set
Cycling Aspects of Austroads Guides(AS-G88-11)

32.5.3 Other Design Standards

Australian Government, Disability Standards for Accessible Public Transport 2002 (DSAPT)
Australian Government, Disability Standards for Accessible Public Transport Guidelines
Australian Government, Disability standards for premises
Australian Building Codes Board, Building Code of Australia
Institute of Public Works Engineering Australia, Qld Division, Complete Streets – Guidelines for Urban Street Design,2010
Queensland Government, Queensland Development Code (QDC)

32.5.4 Minimum Design Criteria

All JCU car parks shall be of asphalt construction and comply with following minimum design standards:

- 30mm DG10 Asphalt
- Minimum pavement on low traffic areas at JCU should be no less than 250mm
- Base Course: 125mm Type 2.1 DTMR Compliant Road Base Gravel compacted to 98% SDD, 3% CBR
- Sub-Base Course: 125mm Type 2.4 DTMR Compliant Road Base Gravel compacted to 98% SDD, 3% CBR
- Painting – as per section 32.6.11

All carparks shall be designed for a maximum speed limit of 20km/h and a minimum bay width of 2500mm.

A lesser design standard (including hardstand areas) may only be adopted with the approval of the JCU Estate Directorate, Deputy Director, Planning and Development, however generally the use of spray seals and gravel surfaces are not acceptable.

It is a requirement for the design of all carparks that the following investigations are undertaken prior to commencement of design:

- Detail Level Survey (undertaken by a registered surveyor) coordinated with all known services as per JCU's GIS Systems shown clearly on the drawings. Refer also to Section 34;

- Where no existing traffic data is available a traffic count/study must be undertaken.
- Pot holing of existing services to be undertaken to confirm location & depth of existing services identified by the JCU Manager, Infrastructure Service during Schematic Design Stage.

32.5.5 Design Vehicles

James Cook University campus roads and carparking are subject to a wide range of vehicles and any design should take this into consideration. Potential design vehicles include, but are not limited to:

- Cars
- Buses
- Delivery Trucks
- Commercial Vehicles
- Construction Vehicles
- Buses
- EWP's and Small Cranes

It is also noted that parking on the Townsville Campus is also subject to occasional use from Military Vehicles such as Bushmasters and the Land 121 range of military vehicles.

32.6 Road Design Requirements

The objective in the design of the road pavement is to select appropriate pavement and surfacing materials, types, layer thicknesses and configurations to ensure that the pavement performs to its design functions and requires minimal maintenance under the anticipated traffic loading for the design life adopted, which is typically 20 years for James Cook University.

Safety is a key consideration on James Cook University campuses as most students are typically inexperienced drivers. All design should take this into consideration to further minimise the risk of incidents occurring.

32.6.1 Australian Standards

- AS 1289 – Methods of testing soils for engineering purposes
- AS 1289.4.2.1 - Methods of testing soils for engineering purposes - Soil chemical tests
- AS 2439.1 - Perforated drainage pipe and associated fittings.
- AS/NZS 1477 - PVC pipes and fittings for pressure applications.

32.6.2 Department of Transport and Main Roads

- Pavement Design Manual – Supplemental to 'Part 2: Pavement Structural Design' of the Austroads Guide to Pavement Technology.
- MRTS05 - Unbound Pavements
- MRTS11 - Sprayed Bituminous Surfacing (Excluding Emulsion)
- MRTS12 - Sprayed Bituminous Emulsion Surfacing
- MRTS31 - Heavy Duty Asphalt
- MRTS08 – Plant-Mixed Stabilised Pavements using Cement or Cementitious Blends

- MRTS13 – Bituminous Slurry Surfacing
- MRTS17 - Bitumen
- MRTS18 – Polymer Modified Binder
- MRTS20 – Cutback Bitumen
- MRTS21 – Bituminous Emulsion
- MRTS30 – Dense Graded and Open Graded Asphalt (10/10)
- MRTS35 – Recycled Materials for Pavements
- MRTS38 – Pavement Drains
- MRTS39 – Lean Mix Concrete sub-base for Pavements
- MRTS40 – Concrete Base in Pavements Jointed Unreinforced, Jointed Reinforced, Continuously Reinforced and Steel Fibre Reinforced Pavements

32.6.3 Other Design Standards

- Austroads, Guide to Pavement Technology (all parts).
- Austroads, Guide to Road Design – Geotechnical Investigation and Design.
- Concrete Masonry Association of Australia:
- Local Government Authority policies and guidelines

It is a requirement for the design of all roads that the following investigations are undertaken prior to commencement of design:

- Detail Level Survey (undertaken by a registered surveyor) coordinated with all known services as per JCU's GIS Systems shown clearly on the drawings. Refer also to Section 34;
- Where no existing traffic data is available a traffic count/study must be undertaken.
- Pot holing of existing services to be undertaken to confirm location & depth of existing services identified by the JCU Manager, Infrastructure Service during Schematic Design Stage.

32.6.4 Pavement Design Traffic

The design traffic loading of all roads shall be based on a minimum design life of 20 years. Where a rigid (concrete) pavement design is requested, the minimum design life shall be 40 years.

Design traffic loading for campus areas must be calculated in equivalent standard axles (ESAs) for the applicable design life of the pavement, taking into account present and predicted commercial traffic volumes, axle loadings and configurations, commercial traffic growth and street capacity.

The design traffic loading shall take account of both the construction traffic associated with the project and the in-service traffic any future developments. Consideration shall be given to the relevant campus master plan in determining both future traffic volumes and future construction traffic.

Further to 32.5.5, the pavement design shall include all traffic data and/or assumptions made in the calculation of the design traffic. The estimated design traffic must generally be made in accordance with Guide to Pavement Technology – in particular Part 2 Pavement Structural Design for the calculation of design traffic volumes up to and exceeding 106 ESAs. Appropriate information shall be provided in the Schematic Design Report and Detailed Design Report to ensure that all assumptions and design data are acceptable.

In the absence of other traffic data, the designer shall allow to undertake a traffic study or count to determine the design traffic volumes. The use of assumed values shall not be permitted without the approval of the JCU Estate Directorate, Deputy Director, Planning and Development. Where approval is provided the minimum design traffic to be assumed shall be 1 x 106 ESA.

JCU campuses are low speed areas, 50km/h in Townsville and 20km/h for carparks and the Cairns campus.

Traffic growth rate to be determined based of traffic study unless agreed with JCU Estate Directorate, Deputy Director, Planning and Development.

32.6.5 Geotechnical Evaluation

The designer must arrange a detailed geotechnical investigation of the naturally occurring material along the alignment of the proposed roads. The extent of any areas of filling and cutting must be determined and the strength of the underlying materials must be considered in the overall pavement design.

The geotechnical investigation, including both field and laboratory testing are to be undertaken in accordance with all relevant Australian Standards (e.g. AS 1289) and *Guide to Road Design* in particular *Part 7 Geotechnical Investigation and Design.*

The design CBR value (for empirical pavement design) or elastic parameters (for mechanical pavement design) shall be determined by a RPEQ Civil or Geotechnical engineer.

Where practicable, the Design CBR obtained from laboratory testing should be confirmed by testing performed on existing road pavements near to the job site under equivalent conditions and displaying similar subgrades.

32.6.6 Environmental Considerations

The pavement design shall include all considerations for environmental factors – as required here and in Section 21, and any assumptions made that would reduce or increase design subgrade strength, or affect the choice of pavement and surfacing materials.

These assumptions should be included in the Schematic Design and Detail Design reports.

32.6.7 Minimum Pavement Thickness

Notwithstanding subgrade testing and subsequent pavement thickness design, the minimum pavement thickness must not be less than 350 mm. This is necessary to ensure that there is sufficient thickness for future insitu stabilisation of pavements (without the risk of mixing the subgrade into the pavement during the process).

Additionally, individual compacted layer thickness shall be chosen to suit construction process and shall not be less than 125 mm nor greater than 250 mm for optimal compaction and to avoid lamination of layers.

32.6.8 Design CBR

The subgrade Design CBR adopted for the pavement design must consider the effect of moisture changes in the pavement and subgrade during the service life, and hence consideration must be given to the provision of subsurface drainage in the estimation of equilibrium in-situ CBRs, and hence in the design of the pavement structure.

Design CBR of untreated subgrade shall not be greater than 3% unless otherwise approved by JCU Manager, Infrastructure Services who reserves the right to carry out independent, 3rd party geotechnical investigations to confirm adopted design CBRs and respective pavement designs.

Subgrade treatment must be carried out on all subgrade CBR ≤ 3% (97% maximum dry density standard compaction at OMC). The equivalent CBR of the treated subgrade must be determined in

accordance with this document. Pavement design over treated subgrades may adopt the equivalent CBR determined in accordance with this document.

32.6.9 Pavement structure - general

Unbound granular materials used shall comply with the requirements of MRTS05. Bound layers shall comply with the requirements under MRTS08.

The subbase layer shall extend a minimum of 150 mm behind the rear face of any kerbing and/or guttering.

The base and surfacing shall extend to the face of any kerbing and/or guttering. Where the top surface of the subbase layer is below the level of the underside of the kerbing and/or guttering, the base layer shall also extend a minimum of 150 mm behind the rear face of the kerbing and/or guttering.

For un-kerbed roads, the subbase and base layers shall extend for the full width of the formation.

The pavement designer shall make specific allowance for traffic load concentrations within car park areas (e.g. entrances/exits).

The pavement designer shall make provision for pavement layer drainage on the assumption that during the service life of the pavement, ingress of water will occur. Compaction of the subbase, including 150 mm behind the rear face of the kerb and channel, must be carried out before trenching of the subsoil behind the kerb.

All pavements shall be designed in accordance with Guide to Pavement Technology Part 2: Pavement Structural Design.

32.6.10 Surfacing design

Generally all new roads shall be constructed of asphalt. The use of a sprayed bituminous seal shall not be permitted without the approval of the JCU Estate Directorate, Deputy Director, Planning and Development.

32.6.11 Painting and Linemarking

In accordance with AS4049 and DMRT Traffic and Road Use Management Manual Part 3, with particular note to type of paint and illuminance requirements.

32.6.12 Subsurface drainage design

Sub-surface drainage shall be provided where it is desirable to drain ground water or seepage from the subgrade and/or subbase. The drainage system shall generally take the form of Subsoil drain or Sub-pavement drain.

Subsoil or sub-pavement drains shall be provided on both sides of the formation in the following locations, unless the geotechnical report indicates the absence of subsurface moisture at the time of investigation and the likelihood that changes in the subsurface moisture environment will not occur within the design life of the pavement and/or the pavement has been specifically designed to allow for likely variations in subgrade and pavement moisture contents:

- cut formations where the depth to finished subgrade level is equal to or greater than 400 mm below the natural surface level;
- locations of known hillside seepage, high water table, isolated springs or salt affected areas;
- irrigated, flood-prone or other poorly drained areas;

- highly moisture susceptible subgrades, i.e. commonly displaying high plasticity or low soaked CBRs;
- use of moisture susceptible pavement materials;
- existing pavements with similar subgrade conditions displaying distress due to excess subsurface moisture; and
- and cut to fill transitions.

Where only one side of the formation is in cut, and the other side in fill, it may be sufficient to provide subsoil or sub-pavement drains only along the edge of the formation in cut.

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

The Design Drawings shall be suitably annotated to the potential need for subsoil or sub-pavement drains in addition to those shown on the Drawings.

32.6.13 Layout, alignment and grade

Typically the layout, alignment and grade of a road should be in accordance with the Local Government Authority requirements.

Where no local Government Authority requirements exist the minimum requirements of Queensland Smart Streets Design Guide.

32.6.14 Road Crossings & Trenches

The use of trenching through existing roads to install services shall not be permitted without the approval of the JCU Estate Directorate, Deputy Director, Planning and Development. Alternatives shall be considered and costed before trenching will be approved.

If approved, the minimum trench depth will be commensurate with the type of service and the minimum width will allow a roller or other approved compaction device to compact the fill sufficiently to prevent shrinkage and unevenness of the pavement on completion of the works and resurfacing.

32.6.15 Documentation of Pavement design criteria and calculations

All considerations, assumptions, subgrade test results, and calculations and other documentation required under this design specification shall be submitted with the pavement design for review/approval by the JCU Manager, Infrastructure Services with each peer review undertaken.

The Drawings shall clearly indicate the structure, material types and layer thicknesses of the proposed pavement and surfacing. The proposed location of all subsurface drains shall be clearly indicated on the Drawings, including the nominal depth and width of the trench, and the location with respect to the line of the kerb/gutter or edge of pavement. The location of outlets and cleanouts shall also be indicated on the Drawings.

Pavement design criteria shall be shown on the pavement drawings and include the ESA, CBR and expected design life. The pavement design shall include a summary of all laboratory and field test results and assumptions and/or calculations made in the assessment of Design CBR.

Assumptions and/or calculations made in the determination of the need or otherwise for subsurface drainage in special circumstances or as a variation to the requirements of this sub-section shall be submitted for approval by the JCU Manager, Infrastructure Services with the Drawings.

32.7 Building Pad & Site Earthwork Design Requirements

All earthworks are to be carried out in accordance with "AS3798 Guidelines on Earthworks for Commercial and Residential Developments", except where varied by this specification or the certifying engineer's design.

It is a requirement for the design that the following investigations are undertaken prior to commencement of design:

- Detail Level Survey (undertaken by a registered surveyor) coordinated with all known services as per JCU's GIS Systems shown clearly on the drawings. Refer also to Section 34;
- Pot holing of existing services to be undertaken to confirm location & depth of existing services identified by the JCU Manager, Infrastructure Service during Schematic Design Stage.

Any changes from the minimum specification below shall be approved by the JCU Estate Directorate, Deputy Director, Planning and Development prior to commencement of design.

32.7.1 Geotechnical Testing

Prior to commencement of any new building works, a site specific geotechnical investigation shall be undertaken. Whilst the extent of investigation should be assessed on a project specific basis, the following minimum number of sampling points shall be as follows:

Site Size (hectare)	No. of Sampling Points	Site Size (hectare)	No. of Sampling Points
0.05	3	0.6	7
0.1	3	0.7	8
0.2	4	0.8	10
0.3	4	0.9	10
0.4	5	1.0	11
0.5	6	1.5	12
0.6	7	2.0	15

Any geotechnical investigation and report should as minimum:

- Establish existing ground conditions and subsoil properties
- Recommend foundations appropriate for the proposed development
- Assigned suitable design parameters
- Indicate site reactivity (shrink/swell) including classification in accordance with AS2870 where applicable
- Provide Ultimate and/or Allowable bearing capacity for the site (including values for bored piers). Different values may be provided for varying strata
- Provide Ultimate and/or Allowable tension and compression skin friction values for the site. Different values may be provided for varying strata
- Provide a Design CBR value if required for any driveways and/or access roads for a given development. Design CBR values should be based on a 4 day soaked CBR test
- Advice on potential settlements for the proposed loads
- Retaining wall design values, including soil friction angle, water level, global stability assessment, bulk density (dry and saturated) and other values as may be required to undertake the design.
- Material workability

The designer shall ensure sufficient investigation is completed prior to completing the design to minimise financial risks to JCU. It is not acceptable to specify that values are assumed and are to be confirmed by the contractor.

32.7.2 Compaction Inspection & Testing

Compaction testing and inspection shall be in accordance with AS3798 Table 8.1 and should be specified on the engineering drawings or specification. It is a mandatory requirement that proof rolling be conducted by an RPEQ Engineer and that all compaction tests are submitted to the RPEQ Engineer for approval. Testing is to be conducted by a NATA accredited laboratory. Copies of these tests to be included in the civil O&M manuals on project completion.

The exposed surface of each layer shall be proof rolled to ensure that no local soft spots exist. Any soft spots identified shall be excavated and replaced with compacted fill. Proof rolling should be conducted immediately after completion of compaction in accordance with Section 5.5 of AS3798.

All existing surface, including under buildings and car parking areas, are to be stripped of all vegetation, topsoil and uncontrolled fill. All tree stumps and roots are to be chased out and removed. Any excavations required to remove stumps and roots shall be backfilled with compacted fill. Disturbed bases of all excavations shall be compacted in accordance with AS3678 and these guidelines.

32.7.3 Fill Material

Fill shall be engineered fill unless otherwise approved. Fill shall be stable, free from organic matter and meet the following minimum specification:

Parameter	Value
Linear Shrinkage	<=12%
Plasticity Index	<= 20
Nominal Size	75mm Max
CBR	>= 15%
Moisture Content	±2% OMC

Fill material is to be placed in layers not exceeding 150mm loose thickness and shall be compacted to 98% of the standard compaction test. Compaction to 95% is not acceptable unless otherwise approved by a geotechnical engineer.

32.7.4 Landscape Architect Co-ordination

As required in Section 31 of these Design Guidelines.

32.8 Stormwater Drainage

Stormwater drainage design (additional information in Section 21 and Section 24) at JCU will meet the following criteria:

- Ensure local government authority requirements are met
- Undertake design in accordance with Local Government Authority requirements and Townsville City Council (TCC) requirements. Where there is a discrepancy between the two requirements the more onerous requirement shall be applied (irrespective of campus location).
- To ensure that inundation of private and public buildings located in flood-prone areas occurs only on rare occasions and that, in such events, surface flow routes convey floodwaters below the prescribed velocity/depth limits;
- To ensure no worsening of existing flood issues at each campus and where possible reduce/minimise existing
- To provide convenience and safety for pedestrians and traffic in frequent stormwater flows by controlling those flows within prescribed limits; and
- Retain within each catchment as much incident rainfall and runoff as is possible and appropriate for the planned use and the characteristics of the catchment.

In pursuit of these objectives, the following principles shall apply:

- New developments are to provide a stormwater drainage system in accordance with the "major/minor" system concept set out in QUDM (Third Edition 2013 – provisional or as amended); that is, the "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm runoff events while the "minor" system shall be capable of carrying and controlling flows from frequent runoff events; and
- Redevelopment - where the proposed development replaces an existing development, the on-site drainage system is to be designed in such a way that the estimated peak flow rate from the site for the design annual exceedance probability (AEP) of the receiving minor system is as required for a new development however the existing downstream system will be permitted to surcharge for the minor event provided that the system is not surcharging at the boundary of the development.

32.8.1 Hydrology

Design rainfall data is be obtained from one of the following methods:

- Design intensity-frequency-duration (IFD) rainfall - IFD relationships shall be derived in accordance with Volume 1, Book II, of AR&R, 1998 for the particular catchment under consideration
- The nine basic parameters read from Maps 1-9 in Volume 2 of AR&R shall be shown in the calculations submitted to JCU at each design phase, except where the Bureau of Meteorology provides a polynomial relationship for the catchment; or
- Design IFD rainfalls can be obtained from the Bureau of Meteorology website for specific locations and these are to be submitted to JCU Estate Directorate, Deputy Director, Planning and Development for approval prior to being used in design.

32.8.2 Catchment Area

Consideration must be given to likely changes to individual catchment areas caused by future development of each campus. Generally, each campus has available a master plan outlining future potential development, redevelopment and demolition works that may occur in the future. It is imperative that:

- Consideration must be given to proposed changes to individual catchment areas caused by the development being designed
- Consideration must be given to likely changes to catchment areas caused by the proposed master plan
- Catchment areas to be based on detail level survey data
- Where no detailed survey of the catchment is available, contour maps produced from local council's GIS may be used to determine the catchments and to measure areas - subject to JCU Estate Directorate, Deputy Director, Planning and Development approval. A suitable scale shall be chosen.

32.8.3 Rational method

- Rational method calculations to determine peak flows shall be carried out in accordance with QUDM (Third Edition 2013 – provisional)
- All calculations shall be carried out or supervised by a qualified engineer (RPEQ certified) who is experienced in hydrologic and hydraulic design
- Coefficients of discharge shall be calculated as per QUDM (Third Edition 2013 – provisional or as amended) and full details of coefficients utilised shall be provided
- The time of concentration of a catchment is defined as the time required for storm run off to flow from the most remote point on the catchment to the outlet of the catchment. Most

catchments will have multiple lengths of flow paths and gradients. The longest length flow path may not always govern the critical flow path. The hydrologic design should analyse several paths to assess any sensitivity to the catchment's time of concentration

- Where the flow path is through areas having different flow characteristics or includes property and roadway, then the flow time of each portion of the flow path shall be calculated separately
- The gradient of the flow path is to be calculated as a "weighted average mean" gradient as outlined in Technical Note 4.6.1 of QUDM (3rd Edition 2013 – provisional or as amended)
- The minimum time of concentration shall be taken as 5 minutes urban
- Flow paths to pits must be designed to accommodate the flows from the fully developed catchment and provide for anticipated obstructions such as fences, building pads, buildings and other likely obstructions. Flow paths should also take into consideration the Master Plan for the site. Any proposed changes to flow paths must be undertaken on a catchment wide basis to ensure flow paths are not diverted onto other land parcels which may result in damage or loss of enjoyment of the adjoining lands
- Surface retardance "n*" shall generally be derived from information in Volume 1, Book 8 Section 1.5.4 of AR&R 1998.

The design and analysis of stormwater drainage is to be based on the peak runoff flows from sub-catchments and from accumulated catchments. Designers are to show, by the assessment of partial catchment areas, that the peak flows have been identified.

32.8.4 Other hydrological models

JCU has carried out flood studies for both the Townsville and Cairns campus. Hydrological information from these models such as peak flows should be obtained to assist with the design of the stormwater system.

Other hydrological models may be used as long as the requirements of AR&R are met, summaries of calculations are provided and details are given of all program input and output.

Where computer analysis programs are used, copies of the final data files shall be provided on submission of the design to JCU and with the final drawings after approval JCU Estate Directorate, Deputy Director, Planning and Development.

32.8.5 Hydraulics

Hydraulic calculations shall generally be carried out in accordance with AR&R and shall be undertaken by a qualified person experienced in hydrologic and hydraulic design. The calculations shall substantiate the hydraulic grade line adopted for design of the system and shown on the drawings. Summaries of calculations are added to the plan and details of all calculations are given including listings of all programme input and output.

The "major" system shall provide a safe, well-defined overland flow path for larger storm events up to the maximum defined flood event. The "minor" system shall be capable of carrying and design flows from the lesser nominated flood events based on the land zoning of the area.

Downstream water surface level requirements are given below:

- Appropriate levels are to be obtained from the local government authorities current existing flood studies if available
- Known hydraulic grade line level from downstream calculations including pit losses at the starting pit in the design event

- Where the downstream starting point is a pit and the hydraulic grade line is unknown, details of the downstream system shall be obtained and further analysis performed to determine the hydraulic grade line
- Where the outlet is an open channel and the design storm is the minor event, details of the downstream system shall be obtained and further analysis performed to determine the hydraulic grade line. The top of the outlet pipe or the hydraulic grade line, or mean high water springs shall be the downstream control, whichever is higher;
- Where the outlet is an open channel, the design storm is the major event and downstream flood levels are not known, details of the downstream system shall be obtained and further analysis performed to determine the hydraulic grade line. The top of the outlet pipe or the hydraulic grade line shall be the downstream control whichever is the higher;
- Where the outlet is an open channel, the design storm is the major event and downstream flood levels are known, the downstream control shall be the highest of all duration events for the defined flood event
- The downstream water surface level used in the calculations should be provided to JCU Manager, Infrastructure Services; and
- The water surface in drainage pits shall be limited to 0.150 m, below the gutter invert for inlet pits and 0.150m below the underside of the lid for junction pits.

32.8.6 Major/minor system

Design of the drainage system should be in accordance with the major/minor flood management concept which recognises the dual requirements of the drainage system to provide for convenience and the protection of life and property for all storm events up to the defined flood event.

All design work undertaken should follow the guidelines set down in the *Queensland Urban Design Manual*, second edition 2007 unless otherwise instructed in this sub-section.

Minor system criteria as follows:

- Minimum pipes 375mm diameter; and
- Minimum box culverts 600mm wide x 300mm high.
- Maximum velocity of flow in stormwater pipelines shall be 4m/sec. Minimum velocity shall be determined by ensuring self-cleansing velocity is achieved; this requirement shall be deemed to be satisfied if the product of slope and diameter (S x D) is not less than 0.0008m where S = slope (m/m) and D is pipe diameter (m).

32.8.7 Stormwater detention

Installation of stormwater detention is required on all development sites where insufficient capacity in the downstream drainage systems exist and a minimum amount of detention will be that required to ensure no worsening of the flooding situation occurs during the defined flood event.

The requirements for stormwater detention design are outlined in *QUDM.*

The development shall limit any increase in discharge rate for all storm events up to and including the defined flood event unless the following is demonstrated:

- The downstream (“minor” or “major”) drainage systems have unutilised or uncommitted capacity greater than the increased peak stormwater discharge from the subject site; and
- The drainage capacity planned for or committed to other sites will not be consumed.

Where the downstream drainage capacity is unable to accept an increased stormwater discharge without the following resulting:

- Flooding; or
- Increased risk of danger, damage or nuisance to other persons or property; or
- Exceeding downstream roadway flow width and depth limits.

The developed site must not discharge more stormwater than the discharge calculated for pre-development flows.
Combined sedimentation and detention ponds must be designed in accordance with the local government authority Water Sensitive Urban Design guidelines so that remobilisation of sediment is minimised.

32.8.8 Specific Documentation to be provided

- Catchment area plans shall be drawn to scales of 1:500, 1:1000 or 1:5000, and shall show contours, direction of grading of kerb and channel, general layout of the drainage system with pit locations, catchment limits and any other information necessary for the design of the drainage system.
- The drainage system layout plan shall be drawn to a scale of 1:500 for urban areas and 1:1000 rural areas and shall show drainage pipeline location, drainage pit location and number and road centreline chainage, size of opening and any other information necessary for the design and construction of the drainage system.
- The plan shall also show all drainage easements, reserves and natural water courses. The plan may be combined with the road layout plan.
- The drainage system longitudinal section shall be drawn to a scale of 1:500 horizontally and 1:50 vertically and shall show pipe size, class and type, pipe support type in accordance with AS/NZS 3725 or AS/NZS 2032 as appropriate, pipeline and road chainages, pipeline grade, hydraulic grade line and any other information necessary for the design and construction of the drainage system.
- Open channel cross sections shall be drawn to a scale of 1:100 natural and shall show the direction in which the cross sections should be viewed. Reduced levels are to be to Australian Height Datum (AHD), unless otherwise approved by JCU Estate Directorate, Deputy Director, Planning and Development where AHD is not available.
- Details including standard and non-standard pits and structures, pit benching, open channel designs and transitions shall be provided on the drawings to scales appropriate to the type and complexity of the detail being shown.
- Work-as-executed drawings shall be submitted to JCU upon completion of the drainage construction. The detailed drawings may form the basis of this information; however, any changes must be noted on these drawings.
- A copy of a Hydrological Summary Sheet.
- Computer program output as long as summary sheets for hydrological and hydraulic calculations are provided with plans submitted for checking and with final drawings.
- Copies of final computer data files (electronic and hard copy), for both hydrological and hydraulic models shall be provided for JCU's database of flooding and drainage information in formats previously agreed with JCU Manager, Infrastructure Services.

32.9 Building Over or Near Services

This is supplemented by the Queensland Development Code *Mandatory Part 1.4 – "Building over or near relevant infrastructure"* and identifies and provides additional guidance for building of services on JCU grounds.

New developments shall be designed so that no new services are located under the building.

Where existing services fall within the development envelop, realignment of existing services will be required unless approved by JCU Estate Directorate, Deputy Director, Planning and Development on an exceptional basis.

A minimum exclusion zone between a structure and services should be maintained as follows (inter service clearance not shown here):

Service	Exclusion Zone
Chilled Water Main < 315mm	1m
Chilled Water Main >= 315mm	2m
High Voltage conductors	3m
High Voltage earth mats	1m
Low Voltage conductors	1m
Comms conduits	1m
Water Main	1m
Sewer Main	1m

The following minimum clearances will apply for structures permitted to be built over or adjacent to a service (Non electrical or Communication services):

- A minimum clearance of 250 mm must be maintained between the outside barrel of the service and the nearest projection of the foundation of the proposed structure, excluding swimming pools. Swimming pools shall be located to achieve a minimum clearance of 600 mm vertically and 1 m horizontally to the service;

- A minimum horizontal clearance of 1 m must be maintained between the outer face of the service and the nearest point of the foundation of the structure;

- The foundation of any structure, excluding a swimming pool, located within the zone of influence must extend a minimum of 150 mm below the projected zone or on solid rock. Pier and beam footings are generally acceptable;

- A minimum clear vertical space above a sewer manhole of 2.4 m must be maintained above the finished ground surface level for access purposes;

- A minimum horizontal clear space of 2.0 m must be maintained between structure and connection point on sewer, connection point on sewer refers to oblique branch (OB), vertical jump-up (VJU) and sewer manhole; and

- A minimum horizontal clear space of 2.0 m must be maintained between structure and outside face of gravity trunk sewer.

Additional detail shown in Figure 1.

Minimum construction and permanent clearances for HV and LV conductors to be determined on a case by case basis by the JCU Manager, Infrastructure Services.

Minimum construction and permanent clearances for Communications conduits to be determined on a case by case basis by the JCU ICT Manager, Network Services.

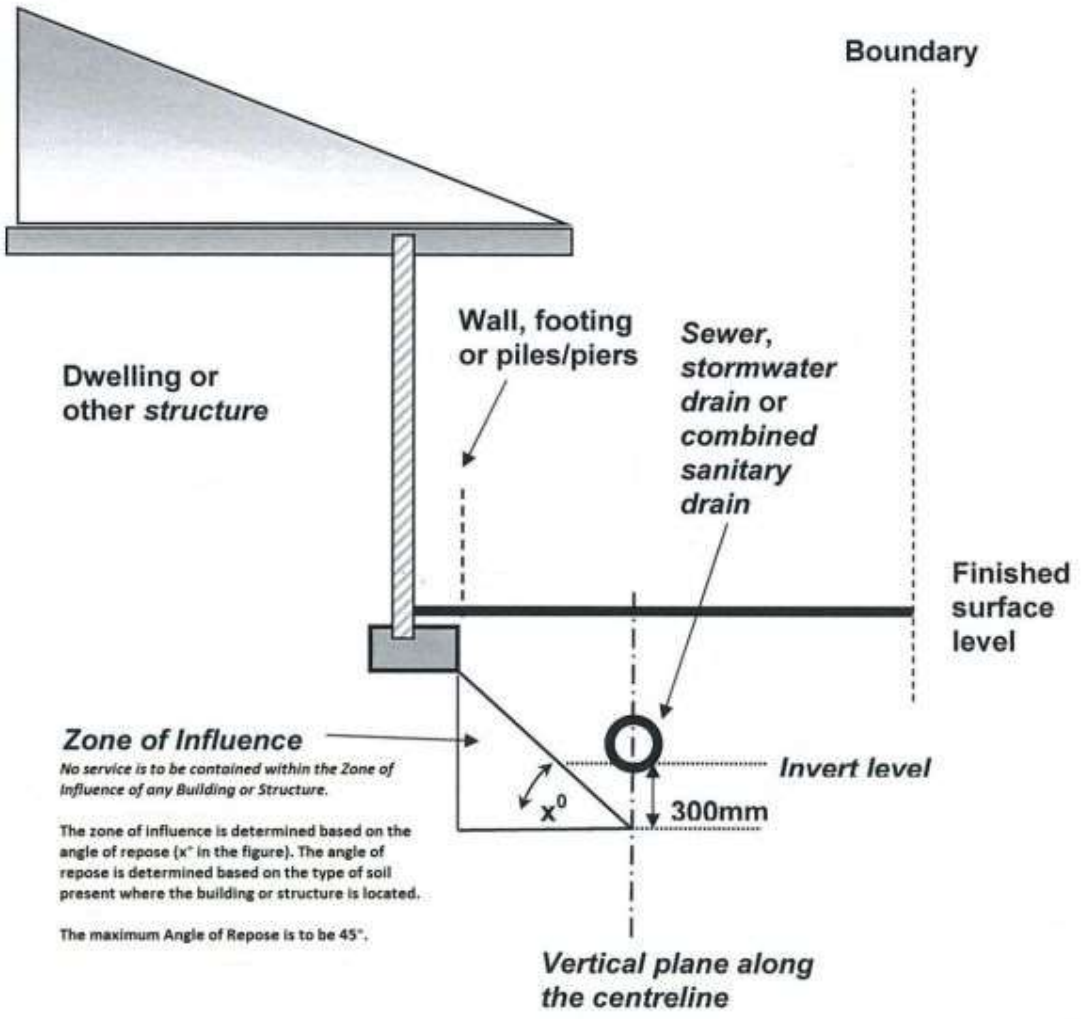

Figure 1

Install sub surface drainage adjacent to paths and buildings in all turfed areas.