SC6.4.6 Construction standards

SC6.4.6.1 Water sensitive urban design construction and establishment requirements

SC6.4.6.1.1 Introduction

This sub-section is a supporting document to the Water by Design, 2010, *Construction and Establishment Requirements: Swales, Bioretention Systems and Wetlands* (Construction and Establishment Guidelines), South East Queensland Healthy Waterways Partnership, Brisbane. The Construction and Establishment Guidelines are adopted in whole, with the exceptions and additions as noted in this planning scheme policy.

Editor's note—the most up to date version of the Construction and Establishment Guidelines can be purchased from Water by Design.

SC6.4.6.1.2 Irrigation

Supplementary irrigation may be required to maintain system functionality during prolonged periods of dry. Water supply to bioretention and wetland systems is greatly influenced by localised residential runoff; hence council imposed water restrictions or prolonged periods of dry should be met with supplementary irrigation. Irrigation (temporary or permanent) may be requested by council during landscape installation. All irrigation plans are to be approved for use by council.

Editor's note—use Form D: Swales; Form G: Bioretention systems; Form H: Constructed Wetlands from the Construction and Establishment Guidelines.

SC6.4.6.1.3 Vegetation establishment

Throughout the sub-section, reference is made to building phase protection by temporary measures. Where 80-90% of the building phase is referred to in the text the developer should ensure upwards of 90% build out before removal of temporary measures and establishment of the approved vegetation.

SC6.4.6.1.4 Weed management

Typha spp have shown an ability to dominate systems in Townsville and disable their functionality and maintainability. Although some Typha species are native they are considered an environmental weed whose control is recommended (Queensland Government Department of Primary Industries and Fisheries, October 2010). As such Typha spp should be removed from systems early to prevent spread and actively managed to ensure that the system is free of the weed at the point of handover. This will ensure that hydrological functioning is maintained, reduce snake habitat (both real and/or perceived), increase vector control, protect desirable, approved species; and reduce fuel loads when systems dry out.

The Developer is to ensure that all waterways are free of Typha spp at the end of the defects liability period.

SC6.4.6.1.5 Dredge spoil dewatering areas

As council refuse facilities do not accept "wet waste", the developer will need to incorporate dredge spoil dewatering areas for sediment and aquatic weeds removal into their design. Any dewatering area proposed should be suitable for maintenance vehicle access. The area should be positioned as close as practical to the constructed wetland/drainage channel, be an adequate size and designed to contain the excavated material and associated runoff. The dredge spoil area will not only meet the needs of the developer during the construction and operational phases. Dredge spoil areas must be identified and approved by council prior to any excavation.

Dredge spoil areas are to be retained for the duration of the construction and operational phases of the wetland/drainage canal that is being maintained.
The developer must determine dredge spoil area locations based on the following criteria;

(1) Estimated amount and frequency of dredge material to be dewatered;

(2) Proximity to existing residential and commercial properties;

(3) Proximity to proposed wetland/drainage channel; and

(4) Potential for dredge spoil to emit offensive odours. (ie high clay/weed content).

Editor's note—use Form A: Swales; Form A: Bioretention Systems; Form C: Constructed Wetlands from the Construction and Establishment Guidelines.

SC6.4.6.1.6 Salwater intrusion

Section 4.9 of the Construction and Establishment Guidelines lists potential failures. Saltwater intrusion should be considered as an additional defect or failure.

Table SC6.4.6.1.1 Potential failure scenarios for swales and rectification actions

Defect or Failure	Causes	Rectification
Saltwater Intrusion	Physical disturbance/excavation of clay liner during routine maintenance works. Drying/cracking of clay liner during routine maintenance and system resetting works. System overtopping during Highest Astronomical Tide (HAT): • system should be designed for highest expected tide over lifespan of asset; and • overtopping in tidal areas during storm surge and heavy rainfall typically appears manageable due to stratification of fresh on salt during high tides. This should be taken into account. Poor design/construction. No liner present. Low lying wetland encroaching water table.	Provide supplementary water to lower salinity of intruded water and/or leach accumulated salts from underlying soils. Review construction designs such as spill weir heights and clay liners for deficiencies/inefficiencies. Engage soil scientist and water sensitive urban design specialist to review soils/clay lining and species compositions if system fails.

SC6.4.6.2 Water supply

SC6.4.6.2.1 Introduction

(1) Scope

This policy sub-section provides standards, advice and guidelines for the construction of water supply infrastructure including:

(a) mains up to DN600 nominal size; and

(b) small pump stations.

This sub-section excludes the construction of:

(c) reservoirs, including repainting of reservoirs;

(d) treatment plants;

(e) dams;

(f) headworks, including bores and weirs;

(g) dosing plant; and

(h) larger pump stations.

The Contractor shall carry out the work, and supply materials meeting the requirements of the reference documents, and, in particular, in accordance with the requirements of the *Water Supply Code of Australia* except as otherwise specified herein.

(2) Reference and source documents

Documents referenced in this sub-section are listed below whilst being cited in the text in the abbreviated form or code indicated. The Contractor shall possess, or have access to, the documents required to comply with this sub-section.

References to the *Water Supply Code of Australia* are made where there are parallel sections or equivalent clauses to those in this sub-section. Where not called up as part of this sub section, these references are identified by part and section numbers and enclosed in brackets thus (WSA Part, Section).

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this policy sub-section are as follows:

SC6.4.3.21 Townsville Water and Waste planning and design guidelines
SC6.4.4.8 Standard drawings
SC6.4.6.28 Minor concrete works

Note—SC6.4.4.8 Standard drawings shall take precedence over the WSAA standard drawings. Where any standard drawing used in conjunction with this sub-section includes technical requirements that conflict with this sub-section, the requirements of this sub-section shall take precedence.

(b) Australian Standards

Note—references in this sub-section or on the drawings to Australian Standards are noted by their prefix AS or AS/NZS. Where not otherwise specified in this sub-section or the drawings, the Contractor shall use the latest Australian Standard, including amendments and supplements, available within two weeks of close of tenders.

AS/NZS 1111	*ISO metric hexagon commercial bolts and screws*
AS/NZS 1112	*ISO metric hexagon nuts*
AS 1152	*Specification for test sieves*
AS/NZS 1260	*PVC-U pipes and fittings for drain, waste and vent applications*
AS 1272	*Unsintered PTFE tape for thread sealing applications*
AS 1289.5.4.1	*Methods of testing soils for engineering purposes – Soil compaction and density tests- Compaction control test – Dry density ratio, moisture variation and moisture ratio*

AS 1289.5.6.1	*Methods of testing soils for engineering purposes – Soil compaction and density tests- Compaction control test – Density index method for a cohesionless material*
AS 1289.5.7.1	*Methods of testing soils for engineering purposes – Soil compaction and density tests- Compaction control test – Hilf density ratio and Hilf moisture variation (Rapid method)*
AS 1349	*Bourdon tube pressure and vacuum gauges*
AS 1432	*Copper tubes for plumbing, gasfitting and drainage applications*
AS 1444	*Wrought alloy steels – Standard, hardenability (H) series and hardened and tempered to designated mechanical properties*
AS 1449	*Wrought alloy steels – Stainless and heat-resisting steel plate, sheet and strip*
AS/NZS 1477	*PVC pipes and fittings for pressure applications*
AS 1565	*Copper and copper alloys – Ingots and castings*
AS 1579	*Arc welded steel pipes and fittings for water and waste water*
AS/NZS 1594	*Hot-rolled steel flat products*
AS 1627.4	*Metal finishing – Preparation and pre-treatment of surfaces - Abrasive blast cleaning of steel*
AS 1646	*Elastomeric seals for waterworks purposes*
AS 1657	*Fixed Platforms, walkways, stairways and ladders – Design, construction and installation*
AS 1830	*Grey cast iron*
AS 60529	*Degrees of protection provided by enclosures (IP Code)*
AS/NZS 2032	*Installation of PVC pipe systems*
AS 2033	*Installation of polyethylene pipe systems*
AS 2129	*Flanges for pipes, valves and fittings*
AS/NZS 2280	*Ductile iron pipes and fittings*
AS 2419.2	*Fire hydrant installations – fire hydrant valves*
AS 2528	*Bolts, studbolts and nuts for flanges and other high and low temperature applications*
AS/NZS 2566.1	*Buried flexible pipelines – Structural design*
AS/NZS 2566.2	*Buried flexible pipelines – Installation*
AS 2638	*Gate valves for waterworks purposes – Metal and resilient seated*
AS 2837	*Wrought alloy steels – Stainless steel bars and semi- finished products*
AS/NZS 3000	*Electrical installations (Wiring rules)*
AS/NZS 3008	*Electrical installations – selection of cable*
AS 3439	*Low voltage switchgear and control gear assemblies*
AS/NZS 3518	*Acrylonitrile butadine styrene (ABS) compounds, pipes and fittings for pressure applications*
AS 3571	*Glass-reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin – Pressure and non-pressure drainage and sewerage*
AS 3681	*Application of polyethylene sleeving for ductile iron piping*
AS 3690	*Installation of ABS pipe systems*
AS 3879	*Solvent cement and priming fluids for PVC (PVC-U and PVC-M) and ABS pipes and fittings*
AS 3862	*External fusion-bonded epoxy coating for steel pipes*
AS 3952	*Water supply –Spring hydrant valve for waterworks purposes*
AS 3996	*Access covers and grates*
AS/NZS 4087	*Metallic flanges for waterworks purposes*
AS/NZS 4129	*Fittings for polyethylene (PE) pipes for pressure applications*
AS/NZS 4130	*Polyethylene (PE) pipes for pressure applications*
AS/NZS 4158	*Thermal-bonded polymeric coatings on valves and fittings for water industry purposes*
AS/NZS 4321	*Fusion bonded medium density polyethylene coating and lining for pipes and fittings*
AS/NZS 4680	*Hot-dip galvanised (zinc) coatings on fabricated ferrous articles*
AS/NZS 4765	*Modified PVC (PVC-M) pipes for pressure applications*
AS 4794	*Non-return valves – Swing check and tilting disc*

(c) Other

Department of Energy and Water Supply, *Planning Guidelines for Water Supply and Sewerage*, April 2010

Water Services Association of Australia (WSAA) - *WSA 03 – 2011 - Water Supply Code of Australia*

International Erosion Control Association (IECA), *Best Practice Erosion and Sediment Control, 2008*

British Standard - *BS 410 - Specification for test sieves*

SC6.4.6.2.2 Materials

(1) General

The Contractor shall comply with the requirements of the manufacturer's recommendations regarding the handling, transport and storage of materials and as further specified in this sub-section.

Prior to the delivery of products and materials, the contractor is expected to obtain relevant product or material certification from the manufacturer which shall be presented to the Superintendent if requested.

The Contractor shall not use damaged or defective materials, including coatings and linings, outside the manufacturer's recommended limits.

If the Contractor proposes to use alternative products and materials other than the products and materials authorised by Townsville Water and Waste, the design drawings and this sub-section, an approval from Townsville Water and Waste is required prior to delivery and use of alternative products or materials.

(2) Unplasticised and modified PVC (uPVC and PVC-M)

Unplasticised PVC (uPVC) and modified PVC (PVC-M) pipes and fittings for mains and suction pipes shall comply with AS/NZS 1477 and AS/NZS 4765, shall be suitable for use with rubber ring (elastomeric) seals complying with AS 1646 joints and shall be of the class and size as shown on the Design drawings. (WSA 03 – 2011, Part 1, Section 4.)

PVC pipes and fittings for mains and suction pipes shall be installed in accordance with AS/NZS 2032 and AS/NZS 2566.1.

Pipes and fittings are to be handled and stored protected from sunlight. The Contractor shall provide protection for the pipes and fittings from ultra violet light and damage. The Contractor shall take account of the time for storage and type of shelter.

(3) Acrylonitrile butadine styrene (ABS)

ABS pipes and fittings shall comply with AS/NZS 3518 to the class, size, use, shape and colour as shown on the Design drawings and installed in accordance with AS/NZS2566.2 and AS 3690.

ABS pipes and fittings shall be joined in accordance with the manufacturer's instructions using solvent cement to AS 3691.

(4) Glass reinforced plastic (GRP)

The use of this material is not permitted by council.

(5) Ductile iron (di) pipe and fittings

Ductile iron (DI) pipes and fittings shall comply with AS/NZS 2280 and shall be of the class, size and lining, as shown on the Design drawings, and installed in accordance with AS/NZS 2566.2. Jointing shall be with rubber rings (elastomeric), complying with AS 1646, to the class and type as shown on the design drawings.

Flanges shall be to the table shown on the design drawings. Bolts and nuts for flanged joints shall be galvanised, or stainless steel as for the pumps specified herein, unless shown otherwise on the design drawings.

All pipework shall be sleeved externally with polyethylene sleeving in accordance with the requirements of AS 3681 unless specified otherwise to be coated and lined. All fittings shall be fusion-bonded coated, in accordance with AS/NZS 4321, or wrapped. The Contractor shall wrap all unprotected joints in the trench with a petrolatum tape system approved by the Superintendent.

(6) Steel pipeline and fittings

Steel pipelines and fittings shall comply with AS 1579 and AS/NZS 1594 and shall be of the class, size, lining and coating as shown on the design drawings. (WSA 03 – 2011, Part 1, Section 4).

The Contractor shall wrap all unprotected joints in the trench with a petrolatum tape system approved by the Superintendent.

The jointing system shall be rubber ring (elastomeric), complying with AS 1646, unless shown otherwise on the design drawings.

The Contractor shall not lay continuously welded steel pipelines parallel to, when in close proximity, high voltage power lines.

(7) Copper pipe and fittings

Copper tube and fittings shall comply with AS 1432 and shall be of the size and type as shown on the design drawings.

The Contractor shall install copper tube, capillary and compression fittings, insulated from ferrous mains, as shown on the design drawings (WSA 03).

(8) Polyethylene (PE)

Polyethylene pipe shall comply with AS/NZS 4129 and AS/NZS 4130 and shall be of the class and size as shown on the design drawings and installed in accordance with AS 2033 (WSA 03 – 2011, Part 1, Section 4).

Jointing shall be by butt thermal fusion or by electrofusion couplings, or with compression fittings.

Fittings up to 110mm shall comply with AS/NZS 4129. Fittings from 110 mm to 600 mm shall be ductile iron in accordance with AS/NZS 2280 and coated internally and externally in polyethylene in accordance with AS/NZS 4129.

The Contractor shall provide pipe of the appropriate external diameter consistent with the required internal diameter shown on the design drawings.

(9) Steelwork

Structural steelwork, including ladders, brackets, and covers, complying with AS 1657, shall be abrasive blast cleaned to AS 1627.4 Class 2.5 and hot dip galvanised to AS/NZS 4680. (WSA 03 – 2011, Part 1, Section 4.)

SC6.4.6.2.3 Valves and hydrants

(1) General

The Contractor shall ensure that the valves and hydrants supplied are compatible with the pipework such that proper sealing is provided between the pipe flanges and the valve. The concrete lining in pipework shall not be chipped away or reduced to provide clearance from the working parts of valves.

The Contractor shall ensure that the valves and hydrants are installed so as to facilitate maintenance. The Contractor shall take into account the manufacturer’s recommendations, the requirements shown on the design drawings, the type of connection, lubrication of connecting bolts, and the location of valves within valve chambers or type of backfill material. (WSA 03 – 2011, Part 2, Section 15.13.)

The type of external corrosion protection of buried valves and hydrants shall be fusion-bonded medium density polyethylene coating to AS 3862 and AS/NZS 4321 or thermal-bonded polymeric coating to AS/NZS 4158.

Flanges shall comply with AS 2129 and AS 4087 and shall be of the class and size shown on the design drawings.

(2) Stop valves

Sluice valves shall be resilient seated valves manufactured in accordance with AS 2638. The valves shall be flanged where permitted by Townsville Water and Waste unless shown otherwise on the Drawings (WSA 03 - 2011 Part 1, Section 8.2).

Ball valves shall be flanged where permitted by Townsville Water and Waste unless shown otherwise on the Design drawings (WSA 03 - 2011 Part 1, Section 8.2).

Butterfly valves shall be flanged where permitted by Townsville Water and Waste unless shown otherwise on the Design drawings (WSA 03 - 2011 Part 1, Section 8.2).

Knife Gate valves shall be flanged where permitted by Townsville Water and Waste unless shown otherwise on the Design drawings (WSA 03 - 2011 Part 1, Section 8.2).

Scour valve assemblies shall be as shown on the Design drawings.

Valves shall be operated by a removable key. The Contractor shall size “Tee Key” valve operators and hand wheels to operate the valves under all operating conditions throughout their full range with no greater than 180 Newtons applied to the ends of the key bar or the rim of the wheel.

Hand wheels, where specified, shall display an embossed or engraved arrow, together with “open” and/or “close” corresponding to the valve operation.

(3) Air valves

Air valves shall be of the double air valve type with integral isolating valve of minimum size DN80, and shall be installed as shown in the Design drawings (WSA 03 – 2011 Part 1, Section 8.4).

Air valves shall be installed such that they can be maintained without affecting supply.

The Contractor shall obtain the consent of Water Authority for the use of other types of air valves.

(4) Non-return valves

Non-return valves shall be of the swing check type to AS 3578 or AS 4794 of cast iron or steel body, cover and disc with bronze body and disc seat rings. The leaf shall swing clear and provide an unobstructed waterway (WSA 03 – 2011 Part 1, Section 8.5). Wafer style non-return valves shall not be used.

The body cover shall be located and sized to allow the valve flap to be removed and the seat to be inspected without removing the valve body.

Where shown on the design drawings, non-return valves shall have an extended spindle, minimum grade 316 stainless steel complying with AS 1449, fitted with an adjustable counterweight, together with a proximity switch to indicate a no-flow condition.

No flow switches shall have the following features:

(a) be of the eccentric cam operated limit switch type.

(b) have a minimum rating of 10 amps, 240 V AC, 50- Hz.

(c) be oil tight and dust proof to IP 65.

(d) be suitable for 25 mm conduit entry.

(e) be mounted on rigid stainless steel complying with AS 1449 adjustable brackets. The brackets shall be free of sharp edges and exposed corners.

(5) Spring hydrants

Spring hydrant bodies shall be manufactured in accordance with AS 3952 and installed in accordance with AS 2419.2 except as varied below (WSA 03 - 2011 Part 1, Section 8.8).

The top of spring hydrants shall be between 100 mm and 300 mm below finished surface level as detailed in SC6.4.4.8 Standard drawings SD-350. If necessary, this shall be achieved by the use of hydrant risers of various heights.

Spring hydrants shall be protected internally and externally with fusion-bonded coating in accordance with AS4158, or equivalent protection approved by the Superintendent.

(6) Pressure reducing valves

Pressure reducing valves shall be of the type as shown on the design drawings.

Pressure reducing valves shall be installed with isolating valves to facilitate maintenance.

SC6.4.6.2.4 Pipeline construction

(1) General

The Contractor, employees, or subcontractors, engaged in excavations, including tunnelling, are to be accredited for the work. Proof of accreditation must be provided to the Superintendent for approval prior to the release of the hold point.

The Contractor shall not change the pipeline alignment without prior concurrence of Townsville Water and Waste. The Contractor shall provide full details, of any proposed changes to the pipeline alignment, to the Superintendent for submission to Townsville Water and Waste. The Superintendent shall obtain the decision of Townsville Water and Waste prior to the release of the hold point.

(2) Location

The location of the mains and pump stations, sizes of mains, types of chambers and covers and the classes of pipes shall be as shown on the design drawings. The pipelines shall be laid to grades and locations shown on the design drawings and to tolerances in the Water Supply Code unless directed otherwise by the Superintendent (WSA 03 – 2011, Part 2, Section 21). The Contractor shall confirm the locations immediately prior to construction (WSA 03 – 2011, Part 2, Section 11).

(3) Cover over pipelines

The minimum depth of cover to be provided for mains, measured vertically from the finished ground level to the top of any socket, shall be as follows (refer to SC6.4.4.8 Standard drawings SD-325):

(a) 750 mm in embankments;

(b) 600 mm in roadways and commercial areas; and

(c) 450 mm elsewhere.

Lesser cover may be provided where special protection of the pipelines has been shown on the design drawings or directed by the Superintendent.

The maximum cover shall be 1200 mm, however, greater cover may be provided where special situations occur, where there is conflict with other services or to meet grading requirements.

(4) Crossings

Where a pipeline crosses a road, creek or involves features shown on the design drawings, under the control of any Authority, the Contractor shall carry out the work in accordance with the requirements of that Authority. The Contractor shall provide written notification to the Authority of the intention to carry out the work, and pay the appropriate fees. (WSA 03 - 2011 Part 2, Section 15.16.) The Contractor shall obtain the written approval from the Authority prior to commencement of work. Such written approval shall be supplied to the Superintendent if requested. The Superintendent shall advise at the time of notification by the Contractor whether the option to request the written approval is to be exercised.

Where shown on the design drawings, the Contractor shall use trenchless methods for the installation of the mains. The installation of the main by open trenching shall not be permitted over the lengths designated for trenchless installation (WSA 03 – 2011 - Part 2, section 15.15).

The Contractor shall address, in its method statement for trenchless conduit installation, the following:

(a) general description of method and sequence of operation;

(b) size, depth and position of temporary pits required;

(c) use of specialist subcontractors;

(d) specialist equipment to be used; and

(e) grout type and method of injection.

The encasement pipe shall be as detailed on the design drawings. The encasement pipe shall extend 1m behind the back of kerb on either side of the carriageway.

The carrier pipe shall be positioned on support cradles and the carrier pipe shall be centrally located within the encasement pipe.

After installation and pressure testing of the carrier pipe, the Contractor shall fill the annular space between the carrier pipe and the encasement pipe with suitable grout or cementitious grout filler.

Where the carrier pipe is ductile iron cement lined (DICL), any length of pipe which is enclosed within the encasement pipe need not be wrapped in polyethylene tubing.

(5) Earthworks

The Contractor shall carry out all excavations for structures and pipelines to the lines, grades and forms shown on the design drawings or as directed by the Superintendent within the specified tolerances.

With excavation near existing underground services and structures, the Contractor shall be responsible in obtaining approval of the appropriate Authority and comply with all the requirements of the approval including having regard for drainage, dewatering, silt control, noise abatement, proximity to existing buildings and generally for the amenity of adjacent owners (WSA 03- 2011, Part 2, Section 13). The Contractor shall locate, protect and repair, as necessary, all services affected by the Works at the Contractor's expense.

The Contractor shall leave a clear space of 600 mm minimum between the edge of any excavation and the inner toe of stockpiles. No excavated materials shall be stockpiled against the walls of any building or fence without the written permission of the owner of such building or fence. Topsoil from excavations shall be stockpiled separately and utilised to restore the surface after backfilling.

At the completion of work each day, the Contractor shall install safety fencing to statutory requirements along the edges of open excavations to isolate them from the public. The Contractor shall provide fenced walkways and vehicular crossings across trenches to maintain access at all times from carriageway to individual properties or within individual properties and advise all affected residents beforehand. All installations shall be of adequate size and strength and shall be illuminated to prevent accidents.

The Contractor shall carry out erosion and sedimentation control at all construction sites in accordance with *Best Practice Erosion and Sediment Control.*

The Contractor shall take account of safety issues and possible wet weather effects to limit the extent of excavation left open. (WSA 03 - 2011 Part 2, Sections 13.1 and 13.2.)

(6) Minimum trench width for pipelines

The minimum clear width of trench (inside internal faces of timbering or sheet piling, if used) to a height of 150 mm above the top of the pipe shall be as shown in Table SC6.4.6.2.1.

Table SC6.4.6.2.1 Minimum trench widths

NOMINAL SIZE OF PIPE (DN)	Minimum clear width of trench(mm) (inside timbering or sheet piling, if any)	
	Pipe other than PVC/PE	PVC/PE Pipe
100	450	450
150	450	450
200	500	450
225	550	500
250	550	500
300	600	550
375	700	650
400	700	650
450	750	700
500	850	800
525	850	800
600	950	900

Where the design drawings provide for a trench to be excavated across a paved or improved surface, the width of the trench shall be kept to a minimum. Bitumen and concrete surfaces shall be carefully cut, by sawcutting or other means approved by the Superintendent, so as to provide a neat straight line free from broken ragged edges. The Contractor is responsible in obtaining approval from the relevant Authority and/or owner before starting any excavation across paved or improved surface.

The Contractor shall widen the trench where necessary for the installation of valves and fittings and protective coating systems.

(7) Excavation depth

The Contractor shall excavate trenches to 75 mm below the underside of the pipe barrel and socket or coupling except for mains to be laid on other than rock foundations or as otherwise shown on the design drawings.

The excavation shall be carried out such as to ensure solid and uniform support for each pipe over the whole length of barrel with chases provided for joints and wrapping.

(8) Support of excavation

The Contractor shall adequately support all excavations to statutory requirements as the Works proceed. When withdrawing supports, the Contractor shall exercise every precaution against slips or falls (WSA 03 – 2011 Part 2, Section 13.5).

The Contractor shall ensure that timber is left in place where its removal may endanger structures in the vicinity of the excavation.

(9) Pipe bedding

When excavation of the trench has been completed the Contractor shall obtain the Superintendent's approval prior to commencing pipe laying, jointing and bedding. The Superintendent’s approval of the excavated trench is required prior to the release of the hold point.

Crusher screenings shall only be used for pipe bedding where sand or other non-cohesive material is not readily available locally or where the Contractor can demonstrate that its use will not impede repair operations. (WSA 03 – 2011 Part 2, Section 14.)

Pipes (excluding PVC/PE pipes) may be laid directly on other than rock foundation. The Contractor shall provide non-cohesive granular bedding, having a minimum thickness of 100 mm below the barrel and socket of the pipe, where rock or other hard material occurs in the bottom of the trench. The bedding material shall conform to the sands classification described in SC6.4.4.8 Standard drawings SD-370, either loose clean sand and /or medium dense clean sand.

For PVC/PE pipes, irrespective of foundation, the material to be used for pipe bedding (underlay a minimum of 75 mm below the underside of the pipe barrel and socket, side support and overlay to a depth of 150 mm above the top of the pipe) as shown in Figure 5.1 in AS 2032 shall be in sand or other non-cohesive granular material, either crushed, natural or blended, and its grading shall fall within the limits in Table SC6.4.6.2.2, except that where the materials cannot be reasonably sourced from within the vicinity, the Contractor may use materials satisfying the classification in the second paragraph above provided also that the material meets the requirements for passing sieve sizes 9.5mm and 6.7mm shown in Table SC6.4.6.2.2:

Table SC6.4.6.2.2 Grading of bedding material for PVC and PE pipes

Sieve size aperture width (AS1152)	Equivalent BS sieve size (BS410)	Percentage passing
9.5 mm	3/8 inch	100
6.7 mm	1/4 inch	90 - 100
425 µm	No. 36	40 - 90
150 µm	No. 100	0 - 10

All mains laid on grades steeper than 50 per cent shall be encased in concrete as detailed on the design drawings.

(10) Laying and jointing of pipes

Unless detailed otherwise in this sub-section, the Contractor shall install pipes in accordance with AS/NZS 2032, AS 2033, AS/NZS 2566.1 or AS 3690 as appropriate (WSA 03 - 2011 Part 2, Sections 15, SC6.4.4.8 Standard drawings SD- 315 and SD-320).

Before being laid, all pipes, fittings, valves, and materials to be used shall be cleaned and examined by the Contractor and, if required by the Superintendent, the Contractor shall suspend each one in a sling to enable the Superintendent to inspect it. If directed by the Superintendent, the Contractor shall oil valves and repack valve glands.

The Contractor shall ensure that the interior of the pipeline is clean and free from obstructions. Plugs shall be used to prevent foreign matter entering sections of pipeline which are left uncompleted overnight.

The Contractor shall take all necessary precautions to prevent flotation of pipes during laying, backfilling and initial testing. Any temporary supports shall be removed prior to completion of backfilling.

Except where solvent cement joints are needed to make up or install fittings, joints in pipelines shall be flexible, rubber ring (elastomeric) joints, either roll-on or skid type or, where shown on the Design drawings, mechanical joints, either fixed flange or bolted gland type.

For pipes with rubber ring (elastomeric) joints, only the lubricant specified in writing by the manufacturer shall be applied in making the joint. The Contractor shall make the joint such that the witness mark shall, at no point, be more than 1 mm from the end of the socket.

Pipes may be cut as needed or directed by the Superintendent to suit closing lengths, to remove damaged pipe or fittings or to remove sockets if necessary when jointing a socketed fitting.

For field cuts, a mechanical pipe cutter shall be used, except that PVC/PE pipes may be cut using a power saw or a fine toothed hand saw and mitre box. For field cuts of ductile iron or steel, the Contractor shall ensure that fire fighting equipment, in working order, is on the site prior to the field cuts being made. If the Contractor proposes to use a petrol engined pipe cutter in an excavation, the Contractor shall ensure that a safe atmosphere is maintained in the excavation at all times.

The Contractor shall prepare the ends of any pipes cut in the field to the manufacturer’s written instructions, or as directed by the Superintendent.

Where pipes are cut in the field, the Contractor shall make a witness mark on the pipe using a felt-tip marking pen at the length specified by the manufacturer from the end of the pipe. The Contractor shall not use PVC/PE

pipes with scored witness marks. Where the same manufacturer does not make spigots and sockets, the Contractor shall refer to the socket manufacturer for the correct marking depth.

Where PVC/PE pipes are to be joined to ductile iron pipes, the joints shall be made by inserting a PVC/PE spigot into a ductile iron socket. Ductile iron spigots shall not be joined to PVC/PE sockets. Alternatively, multi-fit mechanical couplings or flanged adaptor couplings may be used to join pipes of different materials.

The Contractor shall conform to the relevant statutory and work, health and safety requirements when cutting and disposing of asbestos cement pipes and submit a method statement for approval of the Superintendent.

Flexibly jointed pipelines with gradual changes in alignment or grade shall be laid with the joint being deflected after it has been made. The Contractor shall comply with the manufacturer's written recommendations in respect of maximum deflection for each joint provided that no joint shall be deflected to such an extent as to impair its effectiveness.

The maximum angle of deflection between adjacent pipes shall be limited to 2o or 0.035 radian in areas subject to mine subsidence or slippage.

Unless otherwise directed by the Superintendent, the Contractor shall lay pipes on continuously rising grades from scour valve to air release valve, notwithstanding any minor irregularities in the ground surface. Detectable identification tape shall be laid along the line of non-metallic mains within 150mm of the finished surface (SC6.4.4.8 Standard drawings SD-325).

(11) Trench stops

Where a pipe is laid on bedding at a grade of 5 per cent to 14 per cent, the Contractor shall construct, as below, trench stops consisting of bags filled with clay, or sand or cement stabilised sand and sealed: (SC6.4.4.8 Standard drawings SD-374)

(a) at the socket side of the joint nearest to the position of a stop required in accordance with the formula hereinafter, a recess 100 mm deep to suit the width of bag shall be excavated into the bottom of the trench across its full width and into both sidewalls and extend to within 300 mm below finished surface level; and

(b) the bags shall be placed around and above the pipe, as in (a) above, so as to give close contact with the pipe and to fill the entire space between the excavated recess and the pipe. Bags shall not be placed onto sand bedding.

The distance between trench stops shall be determined by the following formula:

$$D = \frac{100}{G}$$, whereby

D = Distance between stops in m

G = Grade of pipe expressed in per cent.

(12) Concrete bulkheads

Where a pipe is installed at a grade of 15 per cent to 29 per cent, the Contractor shall construct concrete bulkheads. Where a pipe is installed at a grade 30 per cent to 50 per cent, the Contractor shall construct concrete bulkheads integral with concrete encasement. Where a pipe is to be installed at a grade of 50 per cent or more the Contractor shall provide a site specific design. Bulkheads shall be of 25 MPa concrete complying with SC6.4.6.28 Minor concrete works, 150 mm minimum thickness as follows: (SC6.4.4.8 Standard drawings SD-374 and WSA 03 – Part 2, Section 15.10)

(a) Where concrete bedding or encasement to pipe is required, the 150 mm thick bulkhead shall be cast integral with the concrete bedding or encasement across the width of trench and shall be keyed into both sidewalls a minimum of 150 mm. The bulkhead shall extend to 300 mm below finished surface level or such other level as directed by the Superintendent.

(b) Where other bedding, or no bedding, is applicable, the bulkhead shall also be keyed into the bottom of the trench 150 mm for the full width of trench.

(c) A 75 mm nominal diameter drain hole shall be provided in the concrete bulkhead immediately above the top of the encasement bedding or foundation and crushed rock or gravel shall be placed in and at the

upstream end of the drain hole to act as a filter. The gravel shall be 10 to 20 mm in size within 150 mm in all directions upstream and above the invert of the drain hole beyond which another 150 mm thick surround of gravel 2 to 10 mm in size shall be placed.

The distance between concrete bulkheads shall be determined by the following formula:

Concrete bulkhead (grade of 15 per cent to 29 per cent)

$$D = \frac{L}{G}$$

Concrete encasement (continuous) and concrete bulkhead (grade of 30 per cent to 50 per cent)

$$D = \frac{100}{G}$$, whereby

L = 80 X Pipe length, m

= 450 m max

if L> 100 m use intermediate trench stops at spacing < 100/G

D = Distance between bulkheads in m

G = Grade of pipe expressed in per centum

(13) Valve and hydrant chambers

The Contractor shall construct around each valve and hydrant a chamber of the type and to the details shown on the Design drawings (WSA 03 – 2011, Part 2, Section 15.13).

The concrete shall comply with SC6.4.6.28 Minor concrete works.

Valve chamber covers shall be painted with white pavement marking paint while hydrant chamber covers shall be painted with yellow pavement marking paint.

Where the type of valve chamber is such that the body, or part of the body, of the valve is to be backfilled before the valve chamber is constructed, the Contractor shall either wrap the valve using a tape consisting of synthetic fibre open weave cloth impregnated with saturated hydro-carbons, applied in accordance with the valve manufacturer's written instructions, or apply at least one coat of corrosion preventing material to the valve body after the valve has been installed but before backfilling. The coating material shall be compatible with the coating material which has been applied to the valve prior to delivery.

(14) Chamber covers and frames

Covers and frames shall not be warped or twisted. Surfaces shall be finished such that there are no abrupt irregularities and gradual irregularities shall not exceed 3 mm. Unformed surfaces shall be finished to produce a surface that is dense, uniform and free from blemishes. Exposed edges shall have a minimum 4 mm radius.

Tolerances for the dimensions on the COVER shall be - 3mm + NIL.

Tolerances for the dimensions on the FRAME shall be - 3mm + 3mm.

Covers shall be seated as shown on the design drawings or as directed by the Superintendent.

Covers shall be finished flush with the surface in road pavements, footpaths and other paved surfaces. Elsewhere, covers shall be finished 25 mm above the surface of the ground, or such other level as directed by the Superintendent, in a manner designed to avoid as far as possible, the entry of surface water.

Cast iron covers and frames shall be manufactured in accordance with AS 3996 and shall be installed and filled with concrete, as necessary, in accordance with the manufacturer's written requirements.

The Contractor shall take care to avoid lateral movement, cracking and subsidence when installing plastic covers and frames.

(15) Service connections

Not applicable.

(16) Thrust and anchor blocks

Thrust and anchor blocks shall be constructed where shown on the design drawings to the dimensions depicted therein or as otherwise directed by the Superintendent. The blocks shall be provided at valves, flexibly jointed bends, tees, enlargers and reducers or any other point where unbalanced forces resulting from internal pressures will occur (SC6.4.4.8 Standard drawings SD-371 and WSA 03 – 2011, Part 2, Section 15.7).

The Contractor shall provide permanent thrust blocks of 20 MPa concrete, complying with sub-section SC6.4.6.28 Minor concrete works, such that the thrust blocks bear against undisturbed material normal to the direction of thrust resulting from internal pressures over the bearing area not less than that directed by the Superintendent.

The Contractor shall provide permanent anchor blocks of 20 MPa concrete, complying with sub-section SC6.4.6.28 Minor concrete works, of a volume not less than that directed by the Superintendent.

The Contractor shall provide temporary anchorages adequate to restrain the pipe when under test.

The Contractor shall obtain the consent of Townsville Water and Waste for the type and use of restrained joints, as an alternative to thrust blocks, in the case of congested service corridors and urgent commissioning.

(17) Concrete encasement

The use of Concrete encasement shall not be permitted unless otherwise approved by Townsville Water and Waste.

(18) Wrapping of pipelines

Where shown on the design drawings, the Contractor shall enclose a pipeline or a section thereof, in lay-flat polyethylene sleeving (WSA 03 – 2011, Part 2, Section 15.11).

The materials to be used shall be high impact resistance polyethylene sleeving, of minimum thickness 0.2 mm polyethylene film approved by the Superintendent and 50 mm wide plastic adhesive tape.

The width of the sleeving when flat shall be in accordance with the manufacturer's written recommendations for the size and type of the pipeline which is to be encased. Precautions shall be taken so that exposure to direct sunlight does not exceed 48 hours.

For dual trenching, pipelines shall be identified by colour sleeving, blue stripe for potable water and lilac for recycled water, or an appropriate identification tape.

Application of the polyethylene sleeving and plastic adhesive tape shall be in accordance with the pipe manufacturer's written instructions or as directed by the Superintendent. The Contractor shall take due care not to damage the sleeving during its application or during the backfilling of the trench. Each pipe shall be encased in a length of sleeving overlapped for a minimum of 250 mm at each field joint, and the ends of each length of sleeving shall be held in position with at least three circumferential turns of adhesive tape. As the polyethylene sleeving material covering the pipe will be loose, excess material shall be neatly drawn up around the pipe barrel, folded into an overlap on top of the pipe and held in place by means of strips of plastic tape at approximately 1 metre intervals. Bends, tapers and similar fittings shall be covered by polyethylene sleeving as specified for the pipes. The Contractor shall hand wrap valves, hydrants and irregular shaped fittings and joints using flat polyethylene sheets secured with plastic adhesive tape, or other suitable material, to provide an adequate seal. The flat polyethylene sheets may be obtained by splitting suitable lengths of sleeving.

The Contractor shall rectify any damage done to the polyethylene sleeving before, during or after backfilling of the trench.

(19) Corrosion protection of steel bolts and nuts

The Contractor shall wrap all galvanised steel bolts and nuts, used for installation below ground, of flanges, bolted gland joints, mechanical joints, tapping bands using a tape, approved by the Superintendent, consisting of synthetic fibre open weave cloth impregnated with saturated hydrocarbons applied in accordance with the

manufacturer's recommendations or as directed by the Superintendent. Bolts and nuts shall be dry, clean and free from rust immediately before wrapping.

SC6.4.6.2.5 Pipeline testing and restoration

(1) Testing of pipelines

The Contractor shall pressure test mains to detect leakage and defects in the pipeline including joints, thrust and anchor blocks. Pipelines shall be tested in sections approved by the Superintendent as soon as practicable after each section has been laid, jointed and backfilled provided that:

(a) if so specified, or if the Contractor so desires, some or all of the pipe joints shall be left uncovered until the whole of the section has been successfully pressure tested to the satisfaction of the Superintendent; and

(b) the pressure testing shall not be commenced earlier than seven days after the last concrete thrust or anchor block in the section has been cast.

For the purpose of this clause, a section shall be defined as a length of pipeline which can be effectively isolated for testing, e.g. by means of main stop valves.

Pressure testing shall not be carried out during wet weather unless otherwise approved by the Superintendent.

During pressure testing, all field joints, which have not been backfilled, shall be clean, dry and accessible for inspection.

During the pressure testing of a pipeline, each stop valve shall sustain at least once, the full test pressure on one side of the valve in closed position with no pressure on the other side for at least 15 minutes.

Before testing a pipeline section, the Contractor shall flush and clean it to the satisfaction of the Superintendent and fill it slowly with water, taking care that all air is expelled. Purging of air from rising mains shall be promoted by opening air valves. In order to achieve conditions as stable as possible for testing by allowing for absorption, movement of the pipeline and escape of entrapped air, the section shall be kept full of water for a period of not less than 24 hours prior to the commencement of the pressure testing.

The hydrostatic test pressure, which shall be applied to each section of the pipeline, shall be 1200 kPa.

The Contractor shall maintain the specified test pressure as long as required by the Superintendent while the Contractor examines the whole section. In any case, the specified test pressure shall be maintained for not less than 4 hours. For the purpose of determining the actual leakage losses, the Contractor shall carefully measure and record the quantity of water added in order to maintain the pressure during the period of testing.

The pressure testing of a section shall be considered to be satisfactory if:

(a) there is no failure of any thrust block, anchor block, pipe, fitting, valve, joint or any other pipeline component;

(b) there is no visible leakage; and

(c) the measured leakage rate does not exceed the permissible leakage rate as determined by the following formula:

$Q_1 = 0.14DLH$

where:

Q_1 = permissible leakage rate (litres per hour)

D = nominal diameter of pipe (m)

L = length of section tested (km)

H = average test head (m)

Any failure, defect, or visible leakage which is detected during the pressure testing of the pipeline or during the defects liability period shall be made good by the Contractor at the Contractor's expense. This constitutes a hold point.

Unless directed by the Superintendent, the maximum test length shall be 1000 m. The hydrostatic pressure testing shall be conducted in accordance with Section 6 and Appendix M of AS/NZS 2566.2.

(2) Connection to existing pipes

Connections to existing pipes carrying water shall be made at such times as will cause the least interference with the supply. The Contractor shall make arrangements with Townsville Water and Waste or other Authority concerned for the timing of the work including the need to isolate the existing mains and notification of affected dwelling occupants. The Superintendent shall be given 5 working days notice of such arrangements. (WSA 03 – 2011 Part 2, Section 22.)

(3) Disinfection and flushing of pipelines

The Contractor shall disinfect all water mains after satisfactory testing in accordance with this sub-section (WSA 03 – 2011 Part 2, Section 20). The Contractor shall adopt procedures for the disinfection of the mains with the concurrence of Townsville Water and Waste. All test results submitted are required to be NATA certified.

After disinfection and testing is completed, the Contractor shall flush all water mains to ensure that the disinfected water used in the process do not enter sections of the system already in service. Flushing and disposal of disinfected water shall be in accordance with WSA 03 – 2011 Part 2, Section 20.2.

(4) Bacteriological testing

(a) General

Disinfection of a water main may be required to ensure suitable water quality parameters are maintained. When disinfection of a main is required, bacteriological testing of the disinfected water must be undertaken.

Disinfection may also be required where there is a likelihood of contamination. A bacteriological test must also be undertaken on all new disinfected mains following satisfactory completion of swabbing/flushing and pressure testing of the water main.

(b) Test procedure

Water mains shall be tested as follows:

(i) scour past the sampling point;

(ii) engage a NATA registered laboratory to collect representative water samples from the test section of the water main; and

(iii) dispose of testing water in accordance with the relevant environmental Regulator and/or Water Agency requirements.

(c) Satisfactory bacteriological test

The water main will be deemed compliant if:

(i) the test results fall within the water quality parameter limits specified in the Table SC6.4.6.2.3; or

(ii) the water quality parameter test results in the test section of water main are no worse than the water quality parameter test results measured by testing an influent sample of existing mains water, provided that the influent sample was collected by the NATA registered laboratory at the same time as water sample from the test section of water main was collected.

Table SC6.4.6.2.3 Water quality parameter limits

Water quality parameter	Unit	Acceptable range
pH	-	6.8–8.5*
Chlorine (free)	mg/L	0.5–2.0
Total Coliform count	cfu/100mL	0
Faecal Coliform count or E.Coli count	cfu/100mL	0
Heterotrophic Plate count	cfu/mL	0–10

* for cement mortar lined mains an upper level pH of 9.2 is acceptable

For failed tests, the water main shall be swabbed, flushed and/or disinfected and then re-tested. This shall be undertaken until all test results are satisfactory.

(5) Backfill and compaction

After laying and jointing of a pipeline has been completed the Contractor shall present the laid and jointed pipes for inspection by the Superintendent prior to the commencement of trench backfilling. The Superintendent's approval to the laid and jointed pipes is required prior to the release of the hold point. Backfill shall not be placed until the Superintendent has given approval.

Material for the side support and overlay of the pipe shall comply with the requirements for pipe bedding specified SC6.4.6.2.4(9) Pipe bedding. The material shall be compacted in layers of not more than 150 mm to a Density Index of 70 as determined in accordance with AS1289.5.6.1 and with reference to WSA 03 – 2011, Part 2, Section 16.3.

The Contractor shall backfill the remainder of the excavation and compact the backfill in layers of not more than 150 mm thick as follows: (WSA 03 – 2011, Part 2, Section 17).

(a) Where the trench is within a roadway, proposed roadway, or footpath area, the remainder of the trench shall be (WSA 03 – 2011, Part 2, Section 17):

(i) backfilled with a non-cohesive granular material, with a grading falling generally within the limits detailed herein for pipe bedding, and compacted to Density Index of 70 when determined in accordance with AS1289.5.6.1 for cohesionless materials:

(A) below 0.3 m of the subgrade road surface; and

(B) in the road reserve, up to top of overlay zone;

(ii) backfilled with selected material, and compacted to 100 per cent of the standard maximum dry density of the material when determined in accordance with AS 1289.5.4.1, to top of subgrade level of the road surface, but excluding the pavement layers;

(iii) backfilled with selected material, and compacted to 95 per cent of the standard maximum dry density of the material when determined in accordance with AS 1289.5.4.1, to finish surface level of the areas of trench outside of roadways;

(iv) backfilled with road base and sub-base material as per existing or proposed pavement layers and compacted to 100 per cent of the standard maximum dry density of the material when determined in accordance with AS 1289.5.4.1.

(b) Elsewhere, unless stated otherwise, the remainder of the trench shall be backfilled with ordinary excavated backfill material. Where suitable material is not available, granular material may be used for the full depth of backfilling. The material shall be compacted to a density Index of 70 when determined in accordance with AS1289.5.6.1 for cohesionless materials or 98 per cent of the standard maximum dry density of the material when determined in accordance with AS1289.5.7.1 for cohesive materials.

The Contractor shall carry out backfilling and compaction without damaging the pipe or its external coating or wrapping or producing any movement of the pipe.

The Contractor shall carry out compaction tests 75 mm to 100 mm below the level being tested.

Where a roadway is to be sited over existing infrastructure, excavation of trench material down to overlay zone and subsequent backfilling with appropriate select material to the underside of sub-base to the compaction requirements stated above.

The Contractor may compact backfill by trench flooding only where:

(i) the ground and backfill material is cohesionless sand;

(ii) water for flooding has been sourced at the site;

(iii) the process will not create mud which would be moved off site by vehicles or construction plant. The process is closely monitored to ensure adequate volumes are added to sufficiently compact the materials to achieve the compaction requirements as specified in WSA 03 – 2011, Part 2 –

Table 19.1; and

(iv) additives are not used.

(6) Valve and hydrant marking

The Contractor shall clearly mark the position of each stop valve, scour valve, air valve and hydrant on completion of backfilling in a manner and position in accordance with SC6.4.4.8 Standard drawings SD-345 and/or shall be consistent with the method(s) in use by Townsville Water and Waste.

Where, in the opinion of the Superintendent, a valve or hydrant is at too great a distance from any existing wall, fence, kerb face, or post, the Contractor shall provide and set in the ground a post with the relevant marking plate fixed at the top of the post, facing the fitting. The distance to the valve or hydrant in metres, to an accuracy of 0.1 m, shall be permanently marked on the plate with legible numbers a minimum 80 mm high. Wooden posts are not to be used where there is evidence, by rotting or termite activity, that the integrity of the posts will be affected.

The post shall conform to the following requirements:

(a) the post shall be of sufficient length to be set firmly in place under saturated ground conditions;

(b) when installed, the post shall project 1000 mm above the ground, provided that where tall grass or crops are likely to obscure the post, its height above the ground shall be increased to 1500 mm; and

(c) the post shall be painted with 2 coats of white enamel for exterior use.

The Contractor shall fix marking plates as soon as practicable after each valve or hydrant is installed. However, the Contractor shall temporarily cover marking plates for hydrants using masking tape or other approved cover which the Contractor shall remove on satisfactory completion of the pressure testing of the pipeline.

For hydrants, the Contractor shall affix blue two-way reflective raised pavement markers to the road pavement in accordance withSC6.4.4.8 Standard drawings SD-345.

(7) Restoration of surfaces

The Contractor shall clean pavements, lawns and other improved areas and leave them in the same order as they were at the commencement of the Works. The Contractor shall restore any fencing removed during construction and shall restore lawns with turf cut and set aside from the original surface and with turf imported from a source approved by the Superintendent (WSA 03 – 2011, Part 2, Section 23). The restoration works shall be done progressively and as soon as possible after the section of works is completed.

The Contractor shall maintain all restored surfaces in the condition to which they are restored until the expiry of the defects liability period applicable to those surfaces, notwithstanding that any deterioration of the restored surfaces, and the need for their maintenance may or may not be due to defects which become apparent or arise from events which occur during the defects liability period. The Contractor shall maintain pavements with crushed igneous rock, gravel or other suitable material allowing for consolidation and shall then restore them to a condition equivalent to that of the original pavement.

The Contractor shall maintain all restored surfaces in the condition to which they are restored until the expiry of the defects liability period applicable to those surfaces, notwithstanding that any deterioration of the restored surfaces, and the need for their maintenance may or may not be due to defects which become apparent or arise from events which occur during the defects liability period. The Contractor shall maintain pavements with crushed igneous rock, gravel, asphaltic concrete or other suitable material allowing for consolidation and shall then restore them to a condition equivalent to that of the original pavement. Final restoration may include, if required by the Superintendent, the removal of temporary restoration.

In other than roadways, the Contractor shall place the backfill sufficiently high to compensate for expected settlement and further backfilling shall be carried out or the original backfill trimmed at the end of the defects liability period in order that the surface of the completed trench may then conform to the adjacent surface. Surplus material shall be removed and disposed of to areas arranged by the Contractor. Where dry weather conditions have persisted after the original backfilling, including during the defects liability period, the Contractor

shall take all necessary steps to consolidate the trench before removing surplus materials from the site.

In locations where, in the opinion of the Superintendent, surplus material left in the vicinity of the trench would not be objectionable, the surplus material may be disposed by spreading neatly in the vicinity of the trench to the satisfaction of the Superintendent in such a way as to avoid future erosion of the backfill and adjacent ground surfaces. The Contractor shall maintain the backfill and adjacent ground until the expiry of the defects liability period.

Where, within public or private property, the reasonable convenience of persons will require such, the Contractor shall level trenches at the time of backfilling or otherwise as directed by the Superintendent. The Contractor shall make good any subsequent settlement, as required by placing additional fill.

The Contractor shall immediately restore any damaged or disturbed private property and services.

Should the Contractor elect to tunnel under paving, kerb and channel or other improved surfaces in lieu of trenching, backfilling shall be so carried out as to restore full support to those surfaces, and payment shall be made for the restoration of the surfaces as though they had been removed and replaced. The Contractor shall remain responsible for the repair of the improved surfaces, if subsequently damaged due to subsidence of the backfill, until the end of the defects liability period.

The Contractor shall provide notice to affected property owners of any pending works.

SC6.4.6.2.6 Pump stations

(1) Pumps

Pump construction materials for centrifugal end suction pumps shall comply with the following:

DESCRIPTION	MATERIAL
PUMP	
Casing and suction bend	Cast iron AS 1830 Gr T200
Wear rings	Cast iron AS 1830 Gr T200
Impeller	316 Stainless steel AS 1449
Impeller nut	Gunmetal AS 1565-905C
Shaft	316 Stainless steel AS 2837
Shaft sleeve	Phosphor bronze AS 1565-9060/316
Neck bush, lantern ring	Phosphor bronze AS1565-9060
Gland	Cast Iron AS1830 Gr T200
Gland studs	316 Stainless steel AS 2837
Gland nuts	316 Stainless steel AS 2837
Fixing nuts and bolts handhold	316 Stainless steel AS 2837
Covers	316 Stainless steel AS 1449
Fitted bolts and nuts, casing and dowels	316 Stainless steel AS 2837
Forcing screws	316 Stainless steel AS 2837
Water thrower and drip tray	316 Stainless steel AS 1449
Pump set base plate	Cast iron AS 1830 Gr T200/Fabricated steel
MOTOR	
Motor frame and end shield	Cast iron/Mild steel
Motor terminal box	Cast iron/Mild steel
Motor fan cover	Mild steel
Motor fan	Metal
HOLDING DOWN BOLTS	316 Stainless steel AS 2837
MECHANICAL SEALS	
Seal faces	Tungsten carbide or equal
Springs	Nickel chrome steel
Secondary seal	Fluoro carbon or nitrile rubber

The Contractor shall provide a written warranty from the Manufacturer of the equipment. This action constitutes

a hold point. The Superintendent's approval of the warranty is required prior to the release of the hold point.

The Manufacturer's warranty shall require the Manufacturer to accept liability for any defect in materials or workmanship which becomes apparent at any time within two years after the date of delivery of any piece of equipment used in Work under the Contract.

All nuts and bolts shall be manufactured in accordance with AS/NZS 1111 and AS/NZS 1112 150 metric series and fitted with washers beneath bolts heads and nuts. Requirements are:

(a) all bolts, nuts and washers shall be stainless steel to AS 1449 and AS 2837, minimum grade 316. All bolts, nuts and washers are to be of the same grade and supplied passivated;

(b) all threads are to be rolled;

(c) all bolt heads and nuts shall be hexagonal;

(d) all bolts, studs, set screws and nuts for bolting flanges and other pressure containing purposes shall conform to AS 2528;

(e) all nuts and bolts subjected to vibration shall be fitted with lock washers or lock nuts;

(f) all concrete anchor bolts, nuts, locking nuts and large series washers required for the bolting down of pump set discharge bends shall be provided. These anchor bolts shall be as recommended by the equipment designer with a minimum diameter of 16 mm; and

(g) concrete anchor bolts shall be chemical masonry anchor type, set to their full depth, suitable for the required duty.

Bolts on all flanges will protrude no more than 10mm past the nut when tightened.

The Contractor shall apply sufficient anti-seize/anti-galling material to the threads of all stainless steel fasteners. The material shall be Polytetrafluoroethylene (PTFE), either tape to AS 1272, dipped or sprayed, or molybdenum disulphide.

(2) Pressure gauges

The Contractor shall install one diaphragm protected, glycerine oil filled, direct mounting, bottom connection pressure gauge complying with AS 1349 per centrifugal pump installation. Cases shall be fabricated from stainless steel complying with AS 1449 or bronze. The protective diaphragm shall be suitable for dismantling for cleaning without affecting the accuracy of the gauge.

The gauge face shall be 100 mm in diameter and calibrated in metres head of water. The gauge shall accurately indicate the pump operating head and the pump no-flow head.

Each gauge shall be supplied with the nominally sized metric equivalent of three of the following bronze fittings: gate valve, union, nipple and reducing nipple.

Gauges and fittings shall be screwed into the pipe wall of ductile iron pipes, or pipe fittings, 150 mm and larger. In pipework less than 150 mm, gauges and fittings shall be screwed into a tapping band. Where shown on the design drawings, the Contractor shall install a ball valve to allow removal of the gauge.

The pressure gauge range for single or parallel pumps duty shall be 0 to 1.7 times the closed valve head of the pumps.

(3) Electrical compliance

The Works shall be in accordance with the requirements specified in SC6.4.3.21.4 Electrical and mechanical except where this sub-section or the Design drawings indicate otherwise. The technical requirements detailed on the Design drawings shall take precedence over the requirements of this sub-section should clauses be in disagreement.

Except where SC6.4.3.21.4 Electrical and mechanical requires a higher standard, works shall be carried out in accordance with AS/NZS 3000, the service rules of the supply authority and all relevant statutory authorities.

The Contractor shall supply the Superintendent a proof of compliance with a standard or specified test. Such proof shall comprise a test certificate from an approved independent testing authority.

The Contractor shall submit all designs and material to each Authority having jurisdiction for approval. The Contractor shall arrange for each Authority having jurisdiction to inspect the works. The Superintendent shall be advised a minimum of 7 working days in advance of the date of any inspection by an Authority. The Superintendent shall advise at the time of notification by the Contractor whether the option to attend the inspections is to be exercised.

(4) Switchgear and control gear assembly (SCA)

The Contractor shall supply and install the SCA designed and assembled by a manufacturer approved by the Superintendent.

The SCA shall be of outdoor, stationary, free standing, metal-enclosed, cubicle type series with a minimum degree of protection of IP56D as specified in AS 60529.

All equipment shall be securely mounted on suitable mounting panels and comprise individual compartments. A hot dipped galvanised steel channel base shall be provided.

Starter contactors shall have the appropriate rating for the proposed pumps to AC3.

All necessary terminals with terminal and cable numbers shall be supplied and installed in accordance with the Design drawings.

The Contractor shall liaise with the electricity supply authority to supply pad locks for the metering equipment, at the Contractor’s expense. The Superintendent shall supply pad locks for use on the SCA at no cost to the Contractor.

The electrical characteristics of the SCA shall be:

Main Circuit: 415/240 V, 50 Hz, 3-phase, 4-wire.
Motor Control Circuit: 240 V, 50 Hz.
Common Control Circuit: 240 & 24 V, A.C.
Prospective short-circuit current: 14kA for 1 second.
Peak Factor: 2.2
Power Factor Correction (Determined in consultation with Townsville Water and Waste)
Earthing (M.E.N. system)

All cables shall enter the SCA from below.

The Contractor shall supply data from the switchgear supplier confirming Type “2” co ordination between contactors, motor protection relays and corresponding circuit breakers, to the Superintendent.

Refer to standard specification TCC24 clause 18 for starter selection requirements and functional specification for the project.

The Contractor shall carry out factory tests in the presence of the Superintendent's Representative and in accordance with the requirements stipulated in SC6.4.3.21.4 Electrical and mechanical and the results shall comprise all routine Tests specified in AS 3439.

Inspections and functional tests shall be in accordance with TCC24 clause 21.

The Contractor shall ensure, after approval has been given by the Superintendent, that any relays, programmable logic controllers, and fittings likely to be adversely affected during delivery shall be adequately protected or shall be removed and packed separately in protected containers. Where equipment has been removed, cover plates shall be provided.

The Contractor shall be responsible for any damage that may occur during transit and unloading at site.

The Contractor shall ensure that spare parts, tools etc., are packed separately from the main plant and shall be marked “Spare Parts”, “Tools” etc., as applicable.

The Contractor shall supply spare parts in accordance with the schedule supplied by the Superintendent.

The Contractor shall supply and install control equipment that is compatible with the existing equipment.

(5) Electrical installation

The Contractor shall liaise with the Supply Authority for the electricity supply to the pump station site.

The Contractor shall be responsible for all facilities required by the Supply Authority for revenue metering equipment and the payment of all associated connection, inspection fees and capacity charges.

The Contractor shall supply and install all cabling including consumer mains, motor, control and instrumentation cables, conduits and electrical pits.

The Contractor shall install all wiring in HD-PVC underground conduits laid in accordance with the Supply Authority’s requirements, with a minimum 500 mm below the finished ground level in non-trafficable areas and 600 mm below the finished ground level in trafficable areas. The trench and backfill material shall be free of rocks and other foreign matter likely to damage the conduits.

The Contractor shall run electrical marker tape 150 mm below the finished ground level directly above the conduits for the entire length of the conduits. Marker tape shall be orange in colour, 150 mm wide and stamped with the words “DANGER – ELECTRIC CABLES BELOW” or similar.

The Contractor shall route all underground cabling with the approval of the Superintendent. Brass marking plates shall be positioned on a concrete surround clearly showing the direction of the incoming consumer mains. Wording and markings shall read “DANGER – ELECTRICAL CABLES BELOW”. The Superintendent’s approval of the route of all underground cabling is required prior to the release of the hold point.

The Contractor shall determine the points of attachment on site and the Contractor shall supply and install any consumer’s connection poles for the consumer mains required by the Supply Authority.

The consumer mains shall be generally run underground and commence at the point of attachment on a steel consumers pole (if applicable), installed near the property boundary and run in conduit to the switchboard.

No aerial conductors are to be installed over structures, access road or vehicle manoeuvring areas.

The minimum size of the consumers’ mains shall be sized to satisfy the following requirements:

(a) current carrying capacity to suit the maximum demand with an excess current carrying capacity of 30 per cent minimum;

(b) be sized for a voltage drop less than 1.5 per cent to the maximum demand as calculated;

(c) be single core PVC/PVC cables. XLPE insulated cable may also be used;

(d) comply with the requirements of the Supply Authority; and

(e) AS/NZS 3000 and AS/NZS 3008.

In addition to the requirements of the Supply Authority and as specified in SC6.4.3.21.4 Electrical and mechanical (Townsville Water planning and design guidelines) the main earthing conductor shall be run in conduit to the main earthing electrode. The main earthing connection shall be contained in an earthing electrode connection box similar to ALM type ERB-1 up to 50 mm2 cable and a Type 4 pit for larger cable.

Earth electrode shall be bonded and suitably labelled with an engraved brass label.

Surge diverters shall be earthed in accordance with manufacturer's instructions.

The Contractor shall bond the pump station metallic pipework to the main earth.

Refer also to TCC24 clause 28.1 for installation instruction requirements.

Metering equipment and installation shall comply with the Queensland Electricity Connections and Metering Manual.

The Contractor shall gland cables entering the outdoor SCA compartment using non-ferrous metallic or plastic glands with neoprene compression seals and connect the on-flow switch and pump motor cables to the appropriate terminals. Cables shall not be jointed.

The Contractor shall seal, at the completion of commissioning tests, all conduits into the outdoor SCA with a non-setting sealing compound to prevent the ingress of vermin.

(6) Testing and commissioning of pump station

The Contractor shall test and/or inspect all materials, equipment, installation and workmanship to prove compliance with the sub-section requirements. The submission to the Superintendent of satisfactory test results constitutes a hold point. The approval of the Superintendent is required prior to the release of the hold point.

Tests and inspections shall comply with relevant Australian Standards.

Testing shall include pre-commissioning, field testing and performance testing of each part of the whole installation.

Pre-commissioning is the preparation of plant or equipment so that it is in a safe and proper condition and ready for commissioning and operation. It includes all aspects of plant operation such as safety, electrical, mechanical and instrumentation.

The Contractor shall conduct pre-commissioning in a logical sequence in accordance with the programme prepared by the Contractor and approved by the Superintendent.

The Contractor shall prepare pre-commissioning record sheets for each item of equipment to ensure results of tests are satisfactorily recorded and that all necessary checks or tests have been performed.

Specific requirements for pre-commissioning shall include, but are not limited to:

(a) initial charges of lubricant in addition to any special lubricant requirements for initial flushing or treatment of the system or for "running in";

(b) physical checks and tests such as completeness of assembly, rotational tests (including checking that the rotation of electrical motors is in the correct direction), alignment checks, balancing and vibration checks, temperature, pressure and flow measurements, clearances, belt alignment and tension, etc., depending on the type of equipment;

(c) electrical and instrument installation tests, including motor insulation tests and checking instruments against certified instruments and correcting as necessary;

(d) tests of the correct functioning of automatic and manual control and protection equipment, including simulating danger conditions, mal-operations or failures, to check that all instruments and controls function correctly. These tests shall also include adjusting instrument set points and alarm settings and proving correct operation of alarms; and

(e) equipment and system operating tests. The Contractor shall certify compliance of each item and submit a signed copy to the Superintendent prior to commissioning.

The Contractor shall carry out pre-commissioning tests to the satisfaction of the Superintendent and shall record the results of the tests on the appropriate Pre-commissioning Record Sheet.

Refer to TCC24 clause 28.1.11 for electrical test documentation requirements.

The Contractor shall furnish the Superintendent with one signed copy of each completed Pre-commissioning Record Sheet countersigned by the Superintendent's Representative who witnessed the test.

Commissioning is the running of the plant and equipment to ensure flow through the pumping system, carrying out any necessary testing and adjustments until it is ready and suitable for normal starting and running under service conditions.

The Contractor shall give the Superintendent 5 working days notice of the Contractor’s intention to undertake commissioning and supply to the Superintendent the copies of each of the pre-commissioning record sheets and three copies of the operational and maintenance manuals at the time that notice of commissioning is given.

The Contractor shall conduct commissioning in a logical sequence in accordance with a programme prepared by the Contractor and approved by the Superintendent.

Throughout commissioning the Contractor shall be responsible for the test programme.

The Contractor shall provide continuous supervision by personnel experienced in the operation of the equipment and shall have qualified personnel in attendance to carry out all necessary adjustments and/or remedial work during the commissioning tests.

The Contractor shall prepare schedules, test record sheets and programmes for approval by the Superintendent prior to each stage of the overall commissioning.

The Contractor shall carry out final testing and commissioning (min 1 day duration) of the electrical services in conjunction with the mechanical equipment (e.g. pump, etc.) including setting and adjustment of equipment in accordance with the requirements in SC6.4.3.21.4 Electrical and mechanical (Townsville Water planning and design guidelines).

The Contractor shall arrange for all testing, commissioning and any adjustments to be carried out by qualified personnel.

(7) Practical completion of pump station

The Contractor shall fulfil the following requirements before the Certificate of Practical Completion is issued:

(a) receipt by the Superintendent of a certificate of approval from the relevant statutory authorities;

(b) pump station is in working order as demonstrated by the testing and commissioning;

(c) approval by the Superintendent of Operating and maintenance manuals; and

(d) receipt by the Superintendent of as-built drawings of the pump station.

(8) Telemetry

The Contractor shall make provision for equipment to link the pump station to the existing telemetry network to be provided by Townsville Water and Waste at the Contractor's expense. Refer to TCC24 clause 17.1, 28.2, Appendix B2 and Appendix C.

The pump station shall operate automatically by control signals from the telemetry system. In addition, either one or any combination of pumps may operate at any one time by control signals from the telemetry system.

(9) Operation and maintenance manuals

(a) Manuals shall contain the following information:

(i) contractor's name, address and telephone number;

(ii) client's contract number, job name; and

(iii) pump station general arrangement drawing showing pumps, motors, valves, pipework, switchboard and electrical installation.

(b) Manuals for pumps shall contain the following information:

(i) manufacturer;

(ii) type and model number;

(iii) serial number;

(iv) dimensioned general arrangement drawing of pump and motor;

(v) sectional arrangement drawing with parts and list;

(vi) dimensioned sectional arrangements detailing:

(A) maximum and minimum shaft/bearing clearance (radial);

(B) maximum and minimum impeller/bowl clearance (radial);

(C) maximum and minimum impeller/bowl clearance (axial);

(D) impeller/bowl wear rings;

(E) motor/pump coupling - type, make and model number; and

(F) mechanical seals where applicable.

(c) Manual for motors shall contain the following information:

(i) manufacturer;

(ii) type and model number;

(iii) serial number;

(iv) dimensioned general arrangement drawing;

(v) sectional arrangement drawing for submersible motor power cabling where applicable;

(vi) gland sealing arrangement drawing for submersible motor power cabling where applicable;

(vii) cables where applicable; and

(viii) terminal block arrangement drawing where applicable.

(d) Manuals for electrical equipment shall comply with TCC24 clause 23 and requirements for electrical drawings are described in TCC24 clause 22.

(e) Manuals for valves shall contain a dimensioned sectional arrangement drawing with parts and material list for all valves.

(f) Manuals shall contain the following test curves:

(i) pump witnessed test curves;

(ii) motor test curves; and

(iii) motor torque/speed/efficiency characteristic curves.

(g) The operating and maintenance manual shall include:

(i) safe working procedures: for switching and isolating the supply and distribution system;

(ii) description of operation;

(iii) maintenance procedures: recommended maintenance periods and procedures;

(iv) tools: particulars of maintenance equipment and tools provided, with instructions for their use.

(v) equipment: a technical description of the equipment supplied, with diagrams and illustrations where appropriate;

(vi) dismantling: where necessary, procedures for dismantling and reassembling equipment; and

(vii) spare parts: a list of the spare parts provided.

(10) Trouble shooting instructions shall be included for pumps, motors, valves and SCA.

(11) Step by step procedures for dismantling and reassembly of pumps, motors and valves using any special tools shall be detailed together with step by step procedures for replacement of wearing parts such as bearing,

seals, wear rings, etc.

SC6.4.6.2.7 Construction compliance

(1) Work-as-executed details and operation and maintenance manual

The Contractor shall submit to the Superintendent work-as-executed drawings showing the actual location and alignment of pipelines, and all pump station details together with operating and maintenance manuals.

Details shall include the size, type, levels of pipelines, valve and hydrant chamber types and cover details, easement requirements for maintenance, pump details, switchboard equipment details and station structural details.

The Contractor shall ensure that a Registered Surveyor certifies the plans showing location and alignment.

The Contractor shall provide records, for Townsville Water and Waste's Asset Register, to the Superintendent at the time of practical completion of the Contract. The records are to be in a form consistent for inputting into the Asset Register as directed by the Superintendent.

SC6.4.6.3 Sewerage system

SC6.4.6.3.1 Introduction

(1) Scope

This sub-section is for the construction of the following:

(a) gravitation sewers up to DN600 nominal size;

(b) common effluent sewers, both gravity and pressurised;

(c) vacuum sewerage systems;

(d) rising mains up to DN600 nominal size;

(e) standard appurtenances such as maintenance holes, maintenance shafts and property connection sewers; and

(f) small pump stations, usually limited to single wells with submersible pumps.

This sub-section excludes the construction activities for:

(g) treatment plants;

(h) headworks;

(i) dosing plant;

(j) larger pump stations; and

(k) works controlled by others, including overflow management

The Contractor shall carry out the work, and supply materials meeting the requirements of the reference documents and, in particular, in accordance with the requirements of the Water Services Association of Australia publications WSA 02-2002 – *Sewerage Code of Australia*, WSA 07 – 2005 - *Sewerage Pumping Station Code of Australia*, and WSA 07-2011 *Pressure Sewerage Code of Australia*, except as otherwise specified herein. Sewerage works should be designed in accordance with SC6.4.3.21 Townsville Water planning and design guidelines in conjunction with Department of Energy and Water Supply's *Planning Guidelines for Water Supply and Sewerage.*

For the purposes of this sub-section, "access chambers" are referred to as "maintenance holes".

(2) Reference and source documents to be read and applied in conjunction with this policy sub-section are as follows:

Documents referenced in this sub-section are listed below whilst being cited in the text in the abbreviated form or code indicated. The Contractor shall possess, or have access to, the documents required to comply with this sub-section.

References to the *Sewerage Code of Australia* are made where there are parallel sections or equivalent clauses to those in this sub-section. Where not called up as part of this sub-section, these references are identified by edition, part and section numbers and enclosed in brackets thus (WSA Edition, Part, Section).

(a) Development manual planning scheme policy sub-sections

SC6.4.3.21 Townsville Water and Waste planning and design guidelines
SC6.4.4.8 Standard drawings
SC6.4.6.28 Minor concrete works
SC6.4.6.30 Control of traffic

Note—where any standard drawing used in conjunction with this sub-section includes technical requirements that conflict with this sub-section, the requirements of this sub-section shall take precedence.

(b) Australian Standards

Note—references in this sub-section or on the design drawings to Australian Standards are noted by their prefix AS or

AS/NZS. Where not otherwise specified in this sub-section or the design drawings, the Contractor shall use the latest Australian Standard, including amendments and supplements, available within two weeks of close of tenders.

AS/NZS 1111	*ISO metric hexagon commercial bolts and screws*
AS/NZS 1112	*ISO metric hexagon nuts,*
AS 1152	*Specification for test sieves*
AS/NZS 1260	*PVC-U pipes and fittings for drain, waste and vent applications*
AS 1272	*Unsintered PTFE tape for thread sealing applications*
AS 1289.5.4.1	*Methods of testing soils for engineering purposes – Soil compaction and density tests- Compaction control test – Dry density ratio, moisture variation and moisture ratio*
AS 1289.5.7.1	Methods of testing soils for engineering purposes – Soil compaction and density tests- *Compaction control test – Hilf density ratio and Hilf moisture variation (Rapid Method)*
AS 1349	*Bourdon tube pressure and vacuum gauges*
AS 1444	*Wrought alloy steels – Standard, hardenability (H) series and hardened and tempered to designated mechanical properties*
AS 1449	*Wrought alloy steels – Stainless and heat-resisting steel plate, sheet and strip*
AS/NZS 1477	*PVC pipes and fittings for pressure applications*
AS 1565	*Copper and copper alloys – Ingots and castings*
AS 1579	*Arc welded steel pipes and fittings for water and wastewater*
AS/NZS 1594	*Hot-rolled steel flat products*
AS 1627.4	*Metal finishing – Preparation and pre-treatment of surfaces- Abrasive blast cleaning of steel*
AS 1646	*Elastomeric seals for waterworks purposes*
AS 1657	*Fixed Platforms, walkways, stairways and ladders – Design, construction and installation*
AS 1741	*Vitrified clay pipes and fittings with flexible joints – sewer quality*
AS 1830	*Grey cast iron*
AS 60529	*Degrees of protection provided by enclosures (IP Code)*
AS/NZS 2032	*Installation of PVC pipe systems.*
AS 2033	*Installation of polyethylene pipe systems*
AS 2129	*Flanges for pipes, valves and fittings*
AS/NZS 2280	*Ductile iron pipes and fittings*
AS 2528	*Bolts, studbolts and nuts for flanges and other high and low temperature applications*
AS/NZS 2566.1	*Buried flexible pipelines – Structural design*
AS/NZS 2566.2	*Buried flexible pipelines – Installation*
AS 2837	*Wrought alloy steels – Stainless steel bars and semi-finished products*
AS/NZS 3000	*Electrical installations (Wiring Rules)*
AS/NZS 3008	*Electrical installations –Selection of cables*
AS 3439	*Low voltage switchgear and controlgear assemblies*
AS 3518	*Acrylonitrile butadine styrene (ABS) compounds pipes and fittings for pressure applications*
AS 3571	*Glass filament reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin – Pressure and non-pressure drainage and sewerage*
AS 3578	*Cast iron non-return valves for general purposes*
AS 3681	*Application of polyethylene sleeving for ductile iron pipelines and fittings*
AS 3690	*Installation of ABS pipe systems*
AS 3972	*General purpose and blended cements*
AS 3996	*Access covers and grates*
AS/NZS 4058	*Precast concrete pipes (pressure and non-pressure)*
AS 4060	*Loads on buried vitrified clay pipes*
AS/NZS 4087	*Metallic Flanges for waterworks purposes*
AS/NZS 4129	*Fittings for polyethylene (PE) pipes for pressure applications*
AS/NZS 4130	*Polyethylene (PE) pipes for pressure applications*
AS 4198	*Precast concrete access chambers for sewerage applications*

Note—read “maintenance hole” for “access chamber”

AS 4321	*Fusion-bonded medium-density polyethylene coating and lining for pipes and fittings*
AS/NZS 4680	*Hot-dip galvanised (zinc) coatings on fabricated ferrous articles*
AS/NZS 4765	*Modified PVC (PVC-M) pipes for pressure applications*
AS 4794	*Non return valves – Swing check and tilting disc*

(c) Other

Department of Energy and Water Supply, *Planning Guidelines for Water Supply and Sewerage*, April 2010

Water Services Association of Australia (WSAA)

WSA 02-2002 - *Sewerage Code of Australia*
WSA 04-2005 - *Sewerage Pumping Station Code of Australia*
WSA 05-2013 - *Conduit Inspection Reporting Code*
WSA 07-2007 - *Pressure Sewerage Code of Australia*

British Standard - BS 410 - *Specification for test sieves*

International Erosion Control Association (IECA) - *Best Practice Erosion and Sediment Control*.

SC6.4.6.3.2 Materials

(1) General

The Contractor shall comply with the requirements of the manufacturer's recommendations regarding the handling, transport and storage of materials and as further specified in this sub section.

Prior to the delivery of products and materials, the contractor is expected to obtain relevant product or material certification from the manufacturer which shall be presented to the Superintendent if requested.

The Contractor shall not use damaged or defective materials, including coatings and linings, outside the manufacturer's recommended limits.

All gravity reticulation pipes shall be rubber ring (elastomeric), complying with AS 1646, jointed to the type, size and class as shown on the design drawings.

If the Contractor proposes to use alternative products and materials other than the products and materials authorised by Townsville Water and Waste, the design drawings and this sub-section, an approval from Townsville Water and Waste is required prior to delivery and use of alternative products or materials.

(2) Unplasticised and modified PVC (uPVC and PVC-M) pipe and fittings

Unplasticised PVC (uPVC) pipes and fittings for gravity systems shall comply with AS/NZS 1260, shall be suitable for rubber rings (elastomeric) joints and shall be of the class and size as shown on the design drawings. (WSA 02- 2002, Part 4, Section 10.)

Unplasticised PVC (uPVC) pipes and fittings for rising mains and suction pipes shall comply with AS/NZS 1477 and AS/NZS 4765, shall be suitable for rubber ring (elastomeric) joints and shall be of the class and size as shown on the design drawings. Modified PVC (PVC-M) pipes and fittings shall comply with AS/NZS 4765, shall be suitable for rubber ring (elastomeric) joints and shall be of the class and size as shown on the design drawings.

PVC pipes and fittings for mains and suction pipes shall be installed in accordance with AS/NZS 2032 and AS/NZS 2566.1.

Pipes and fittings are to be handled and stored protected from sunlight. The Contractor shall provide protection for the pipes and fittings from ultra violet light and damage. The Contractor shall take account of the time for storage and type of shelter.

(3) Polyethylene (PE) pipe and fittings

Polyethylene pipe shall comply with AS/NZS 4129 and AS/NZS 4130 and shall be of the class and size shown on the design drawings and installed in accordance with AS 2033. (WSA 02-2002, Part 2,Section 10.)

Jointing shall be by butt thermal fusion or by electrofusion couplings, or with compression fittings.

The Contractor shall provide pipe of the appropriate external diameter consistent with the required internal diameter shown on the design drawings.

(4) Glass reinforced plastic (GRP) pipe and fittings

Glass filament reinforced thermosetting plastics (GRP) pipes shall comply with AS 3571 and shall be of the class and size as shown on the design drawings and installed in accordance with AS/NZS 2566.1. (WSA 02-2002, Part 2, Section 10.)

Pipes and fittings are to be handled and stored protected from sunlight. The Contractor shall provide protection for the pipes and fittings from ultra violet light and damage. The Contractor shall take account of the time for storage and type of cover.

(5) Ductile iron (DI) pipe and fittings

Ductile iron (DI) pipes and fittings shall comply with AS/NZS 2280 and shall be of the class, size and lining, as shown on the design drawings, and installed in accordance with AS/NZS 2566.1. Jointing shall be with rubber rings (elastomeric) to the class and type as shown on the design drawings and in accordance with (WSA 02-2002, Part 2, Section10).

Flanges shall be to the table shown on the design drawings. Bolts and nuts for flanged joints shall be galvanised, or stainless steel as for the pumps specified herein, unless shown otherwise on the design drawings.

All pipework shall be sleeved externally with polyethylene sleeving in accordance with the requirements of AS 3681 unless specified otherwise to be coated and lined. All fittings shall be thermal bonded polymeric coated, in accordance with AS/NZS 4158, or wrapped. The Contractor shall wrap all unprotected joints in the trench with a petrolatum tape system approved by the Superintendent.

(6) Steel pipeline

Steel pipelines and fittings shall comply with AS 1579 and AS/NZS 1594 and shall be of the class, size, lining and coating as shown on the design drawings or as specified in (WSA 02- 2002, Part 2, Section 10).

The Contractor shall wrap all unprotected joints in the trench with a petrolatum tape system approved by the Superintendent.

The jointing system shall be rubber ring (elastomeric) unless shown otherwise on the design drawings.

(7) Vitrified clay

Vitrified clay (VC) pipes and fittings shall comply with AS 1741 and shall be of the class of pipe, complying with the loading requirements of AS 4060, and size as shown on the design drawings and suitable for rubber ring (elastomeric) joints (WSA 02-2002, Part 2, Section10).

(8) Precast maintenance holes (MH)

Precast maintenance hole components shall comply with AS/NZS 1477 for PVC, AS 2033 for PE, AS 3518 for ABS, AS 3571 for GRP and AS 4198 for concrete (WSA 02-2002, Part 1, Section 6 and Part 3, Section 18).

If approved by the Superintendent, precast systems, complying with the drawings, may be used in lieu of cast in-situ systems (WSA 02-2002, Part 3, Section18.4). Precast system components shall not be delivered to the site before satisfactory documentary evidence has been submitted to the Superintendent that quality tests have been carried out.

(9) Preformed maintenance shafts (MS) and terminal maintenance shafts (TMS) including cover

Preformed maintenance shaft and terminal maintenance shaft components shall comply with AS/NZS 1477 for PVC, AS 2033 for PE, AS 3518 for ABS, AS 3571 for GRP and AS 4198 for concrete (WSA 02-2002, Part 1, Section 6 and Part 3, Section 19, SEW 1314 and SEW1316).

(10) Maintenance hole covers and frames

Cast iron maintenance hole covers and frames shall comply with AS 3996 and shall be of a type that is flush top cast cover, identifiable as SEWER, size, opening and class as shown on the design drawings. Covers and frames shall not be delivered to the site before satisfactory documentary evidence has been submitted to the Superintendent that quality tests have been carried out.

(11) Steelwork

Structural steelwork, including ladders, brackets and covers, complying with AS 1657, shall be abrasive blast cleaned to AS 1627.4, Class 2.5 and hot dip galvanised to AS/NZS 4680.

SC6.4.6.3.3 Pipeline construction

(1) General

The Contractor, employees, or subcontractors, engaged in excavations, including tunnelling, are to be accredited for the work. Proof of accreditation must be provided to the Superintendent prior to the release of the hold point (WSA 02-2002, Part 3, Section12.2.)

The Contractor shall not change the pipeline alignment without the prior concurrence of Townsville Water and Waste. The Contractor shall provide full details, of any proposed changes to the pipeline alignment, to the Superintendent for submission to Townsville Water and Waste. The Superintendent shall obtain the decision of Townsville Water and Waste prior to the release of the hold point.

(2) Location

The location of the sewers, maintenance holes, rising mains and pump stations, sizes and grades of sewers and rising mains, the types of maintenance holes and maintenance hole covers and the classes of pipes shall be as shown on the design drawings. The Contractor shall commence laying of pipelines at the lower end of the line unless directed otherwise by the Superintendent. The Contractor shall lay pipelines to grades and locations shown on the design drawings unless directed otherwise by the Superintendent. (WSA 02-2002, Part 3, Sections 13.1 and 13.2.)

(3) Cover over pipelines

The minimum depth of cover to be provided over pipelines shall be as follows: (WSA 02-2002, Part 1, Section 4.6.3 and WSA 02-2002, Part 3, Section 15.2).

LOCATION	MINIMUM COVER (mm)
Private property non vehicular new developments	600
Private property non vehicular existing developments	450
Private residential property subject to vehicular loading	750
Footpaths, sealed roads (non arterial)	900
Unsealed roads	1200
Arterial roads	1200

Lesser covers may be permitted where special protection of the pipelines has been shown on the design drawings or directed by the Superintendent (WSA 02-2002, Part 1, Section 4.6.3.)

(4) Crossings

Where a pipeline crosses a main or state road, creek or involves features shown on the design drawings, under the control of any Authority, the Contractor shall carry out the work in accordance with the requirements of that Authority. The Contractor shall provide written notification to the Authority of the intention to carry out the work,

and pay the appropriate fees (WSA 02-2002, 3, 17.13). The Contractor shall obtain the written approval from the Authority prior to commencement of work. Such written approval shall be supplied to the Superintendent if requested.

Where shown on the design drawings, the Contractor shall use trenchless methods for the installation of the sewer mains. The installation of the sewer main by open trenching shall not be permitted over the lengths designated for trenchless installation (WSA 02-2002, Part 3, Sections 13.5.4 and 17.12).

The Contractor shall address, in its method statement for trenchless conduit installation, the following:

(a) general description of method and sequence of operation;

(b) size, depth and position of temporary pits required;

(c) use of specialist subcontractors;

(d) specialist equipment to be used; and

(e) grout type and method of injection.

The encasement pipe shall be as detailed on the design drawings. The encasement pipe shall extend 1.0 m behind the back of the kerb on either side of the carriageway.

The carrier pipe shall be positioned on support cradles and the carrier pipe shall be centrally located within the encasement pipe.

After installation and pressure testing of the carrier pipe, the Contractor shall fill the annular space between the carrier pipe and the encasement pipe with suitable grout or cementitious grout filler (WSA 02-2002, Part 3, Section 17.12).

Where the carrier pipe is ductile iron cement lined (DICL), any length of pipe which is enclosed within the encasement pipe need not be wrapped in polyethylene tubing.

(5) Earthworks

The Contractor shall carry out all excavations for structures and pipelines to the lines, grades and forms shown on the design drawings, or as directed by the Superintendent, within the specified tolerances.

Prior commencement of excavation, the Contractor shall be responsible in obtaining approval from the appropriate Authorities and shall comply with all requirements of the approval including having regard for drainage, dewatering, silt control, noise abatement, proximity to existing buildings and generally for the amenity of adjacent owners (WSA 02-2002, Part 3, Section 15).

The Contractor shall leave a clear space of 600 mm minimum between the edge of any excavation and the inner toe of stockpiles. No excavated materials shall be stockpiled against the walls of any building or fence without the written permission of the owner of such building or fence. Topsoil from excavations shall be stockpiled separately and utilised to restore the surface after backfilling (WSA 02-2002, Part 3, Sections 14.7 and 15.9).

At the completion of work each day, the Contractor shall install safety fencing to statutory requirements along the edges of open excavations to isolate them from the public. The Contractor shall provide fenced walkways and vehicular crossways across trenches to maintain access at all times from carriageway to individual properties or within individual properties and advise beforehand all affected residents. All such installations shall be of adequate size and strength and shall be illuminated to prevent accidents (WSA 02-2002, Part 3, Section 15.1).

The Contractor shall locate, protect and repair, as necessary, all services affected by the Works at the Contractor's expense. The Contractor shall give notice of any interference to the works caused by an existing service and submit a proposed work method statement (WSA 02-2002, Part 3, Sections 13.5.2 and 13.7).

The Contractor shall carry out erosion and sedimentation control at all construction sites in accordance with *Best Practice Erosion and Sediment Control*.

The Contractor shall take account of safety issues and possible wet weather effects to limit the extent of excavation left open (WSA 02-2002, Part 3, Section 15.7).

(6) Minimum trench width for pipelines

The minimum clear width of trench (inside internal faces of timbering or sheet piling, if used) to a height of 150 mm above the top of the pipe shall be as shown in Table SC6.4.6.3.1 (WSA 02-2002, Part 3, Section 15.2 and SC6.4.4.8 Standard drawings SD-460).

Table SC6.4.6.3.1 Minimum trench widths

Nominal size of PIPE (DN)	Minimum clear width of trench(mm) (inside timbering or sheet piling, if any)	
	Pipe other than PVC/PE	PVC/PE Pipe
80	400	350
100	400	350
150	450	400
200	500	450
225	550	500
250	550	500
300	600	550
375	700	650
400	700	650
450	750	700
500	850	800
525	850	800
600	950	900

Where the design drawings provide for a trench to be excavated across a paved surface, the width of the trench shall be kept to a minimum. Bitumen and concrete surfaces shall be carefully cut, by sawcutting, or other means approved by the Superintendent, so as to provide a neat straight line free from broken ragged edges (WSA 02-2002, Part 3, Section15.3).

The Contractor shall widen the trench where necessary for the installation of valves and fittings and protective coating systems.

(7) Maximum trench width

For gravitation sewers or rising mains of pipe materials other than PVC or PE, no restriction shall be placed on the maximum width of trench due to the structural strength of the pipe provided the depth to invert of the pipe does not exceed the depths shown in column (ii) of Table SC6.4.6.3.2.

The Superintendent may, however, restrict the width of trench due to local conditions. The Superintendent shall not restrict the width of trench to less than as shown in column (iii) of Table SC6.4.6.3.2.

Where the depth to invert exceeds that shown in column (ii) of Table SC6.4.6.3.2 – Maximum trench widths, the maximum width of trench (outside timbering or sheet piling, if used) to a height of 150 mm above the top of the pipe shall be as shown in column (iii) of Table SC6.4.6.3.2.

Table SC6.4.6.3.2 Maximum trench widths

Nominal size of pipe (mm) (i)	Maximum depth to invert, unlimited width trench (m) (ii)	Maximum trench width, depths greater than in column (ii) (mm) (iii)
150	8.0	750
225	6.5	825
300	5.5	900
375	4.5	975
400	4.5	975
450	4.5	1050
525	4.0	1125
600	4.0	1200

For gravitation sewers or rising mains of PVC/PE pipe the maximum width of trench from the trench base to a height of 150 mm above the top of the pipe shall be the outside diameter of the pipe barrel plus 400 mm. However, in timbered or travelling box excavated trenches, the width of trench when measured to the outside of the support used may be increased to a maximum of 580 mm plus the outside diameter of the pipe barrel.

The Contractor shall supply a method statement of any special construction control, where shown on the design drawings, to the Superintendent's approval.

(8) Excavation depth

The Contractor shall excavate trenches to a minimum of 100 mm below the underside of the pipe barrel and socket or coupling except for rising mains to be laid on other than rock foundations or as otherwise shown on the design drawings (WSA 02-2002, Part 3, Section 15.8 and SC6.4.4.8 Standard drawings SD 461).

The excavation shall be carried out such as to ensure solid and uniform support for each pipe over the whole length of the barrel with chases provided for joints and wrapping.

(9) Support of excavation

The Contractor shall adequately support all excavations to Statutory requirements as the Works proceed. When withdrawing supports, the Contractor shall exercise every precaution against slips or falls. (WSA 02-2002, Part 3, Section 15.6).

The Contractor shall ensure that timber is left in place where its removal may endanger structures in the vicinity of the excavation.

(10) Pipe bedding

When excavation of the trench has been completed the Contractor shall obtain the Superintendent's approval prior to commencing pipe laying, jointing and bedding. The Superintendent's approval of the excavated trench is required prior to the release of the hold point (WSA 02-2002 -2002, Part 3, Section 15.8), or where sewers are to be located in water charged ground (present or predicted to occur) will require specialist geotechnical analysis and design. The contractor shall inform the Superintendent immediately upon encountering ground water and await further direction (WSA 02-2002, Part 1, Sections 8.5 and 8.6.7).

Crusher screenings may only be used for pipe bedding where sand or other non- cohesive material is not readily available locally or where the Contractor can demonstrate that its use will not impede repair operations (WSA 02-2002, Part 3, Section 16).

Pipes for gravitation sewers (excluding PVC/PE pipes), shall be bedded on sand or other non-cohesive material. Pipe bedding shall consist of a non-cohesive granular material, having a minimum thickness of 75 mm below the barrel and socket of the pipe, and its grading shall generally fall within the following limits shown in Table SC6.4.6.3.3.

Table SC6.4.6.3.3 Grading of bedding material for pipes other than PVC and PE

Sieve size aperture width (AS 1152)	Equivalent BS sieve size (BS410)	Percentage passing
22.4 mm	1 inch	100
6.7 mm	¼ inch	90 - 100
425 µm	No. 36	40 - 90
75 µm	No. 200	0 - 10

Pipes for rising mains (excluding PVC/PE pipes) may be laid directly on other than rock foundation. The Contractor shall provide non-cohesive granular bedding, having a minimum thickness of 100 mm below the barrel (SC6.4.4.8 Standard drawings SD-461) and socket of the pipe, where rock or other hard material occurs in the bottom of the trench or where specified or directed by the Superintendent. The bedding material shall be either loose clean sand and /or medium dense clean sand or as directed by the Superintendent.

For PVC/PE pipes, irrespective of foundation, the material to be used for pipe bedding (underlay a minimum of 100 mm below the underside of the pipe barrel (SC6.4.4.8 Standard drawings SD-461) and socket, side support and overlay to a depth of 150 mm above the top of the pipe) as shown in Figure 5.1 in AS 2032 shall be in sand or other non-cohesive granular material, either crushed, natural or blended, and its grading shall fall within limits shown in Table SC6.4.6.3.4 Grading of bedding material for PVC and PE Pipes, except that where the materials cannot be reasonably sourced from within the vicinity, the Contractor may use materials satisfying the classification in the second paragraph above, provided also that the material meets the requirements for passing sieve sizes 9.5 mm and 6.7 mm as shown in Table SC6.4.6.3.4.

Table SC6.4.6.3.4 Grading of bedding material for PVC and PE Pipes

Sieve size aperture width (AS1152)	Equivalent BS sieve size (BS410)	Percentage passing
9.5mm	3/8 inch	100
6.7mm	1/4 inch	90 - 100
425µm	No. 36	40 - 90
150µm	No. 100	0 - 10

The Contractor shall bed all gravitation sewers laid on grades of 15 per cent to 50 per cent on 20 MPa concrete complying with sub-section SC6.4.6.28 Minor concrete works. Such concrete bedding shall have a thickness of at least 75 mm below the underside of the barrel and socket of the pipe and shall extend to a level above the bottom of the pipe of one quarter of the external diameter of the pipe and a width across the trench not less than the minimum width shown in Table SC6.4.6.3.1 Minimum trench widths.

The Contractor shall encase all gravitation pipelines and rising mains, laid on grades steeper than 50 per cent, in concrete as detailed on the design drawings.

(11) Laying and jointing of pipes

Unless detailed otherwise in this Specification, the Contractor shall install pipes in accordance with AS 2032, AS 2033, AS/NZS 2566.1 or AS 3690 as appropriate (WSA 02-2002, Part 3, Section 17).

Before being laid, all pipes, fittings, valves, and materials to be used shall be cleaned and examined by the Contractor and, if required by the Superintendent, the Contractor shall suspend each one in a sling to enable the

Superintendent to inspect it. If directed by the Superintendent, the Contractor shall oil valves and repack valve glands.

The Contractor shall ensure that the interior of the pipeline is clean and free from obstructions. Plugs shall be used to prevent foreign matter entering sections of pipeline which are left uncompleted overnight.

The Contractor shall take all necessary precautions to prevent flotation of pipes during laying, backfilling and initial testing. The Contractor shall remove any temporary supports prior to completion of backfilling.

Except where solvent cement joints are needed to make up or install fittings, joints in pipelines shall be flexible, rubber ring (elastomeric) joints (either roll-on rubber ring (elastomeric) or skid type) or, where shown on the design drawings, mechanical joints (either fixed flange or bolted gland type). (WSA 02-2002, Part 3, Section 17.1.)

For pipes with roll-on rubber ring (elastomeric) joints, spigots and sockets shall be clean and dry. The Contractor, after making the joint, shall check that the rubber ring (elastomeric) has rolled in evenly, and, if not, the Contractor shall withdraw the pipe and remake the joint.

For pipes with skid type rubber ring (elastomeric) joints, only the lubricant specified in writing by the manufacturer shall be applied in making the joint. The Contractor shall make the joint such that the witness mark shall, at no point, be more than 1 mm from the end of the socket.

Pipes may be cut as needed, or directed by the Superintendent, to suit closing lengths, to remove damaged pipe or fittings or to remove sockets if necessary when jointing a socketed fitting.

For field cuts, a mechanical pipe cutter shall be used, except that PVC/PE pipes may be cut using a power saw or a fine toothed handsaw and mitre box. For field cuts of ductile iron or steel, the Contractor shall ensure that fire fighting equipment, in working order, is on the site prior to the field cuts being made. If the Contractor proposes to use a petrol-engine pipe cutter in an excavation, the Contractor shall ensure that a safe atmosphere is maintained in the excavation at all times.

The Contractor shall prepare the ends of any pipes cut in the field to the manufacturer's written instructions, or as directed by the Superintendent.

Where pipes are cut in the field, the Contractor shall make a witness mark on the pipe at the length specified by the manufacturer from the end of the pipe. The Contractor shall not use PVC/PE pipes with scored witness marks. Where the same manufacturer does not make spigots and sockets, the Contractor shall refer to the socket manufacturer for the correct marking depth.

Where PVC pipes are to be joined to pipes of another material, the joints shall be made as follows:

(a) for jointing PVC/PE spigot to VC socket or PVC/PE socket to VC spigot, the Contractor shall use a PVC/PE adaptor shall be used. The joints in both instances shall be made using a ring conforming to AS 1646.

(b) for jointing PVC/PE to ductile iron, the Contractor shall use a rubber ring (elastomeric) joint with an adaptor coupling.

The Contractor shall conform with the relevant Statutory and work, health and safety requirements when cutting and disposing of asbestos cement pipes.
Gravitation pipelines shall be constructed to the following tolerances:

(c) the maximum horizontal deviations to either side from the design axis of a pipeline shall be 20mm for all sizes of pipes (WSA 02-2002, Part 3, Section 23.1); and

(d) the invert level shall not deviate from the design grade line by more than 10 mm (WSA 02-2002, Part 3, Section 23.2).

Flexibly jointed pipelines with gradual changes in alignment or grade shall be laid with the joint being deflected after it has been made. The Contractor shall comply with the manufacturer's written recommendations in respect of maximum deflection for each joint provided that no joint shall be deflected to such an extent as to impair its effectiveness.

The maximum angle of deflection between adjacent pipes shall be limited to 2º or 0.035 radian in areas subject to mine subsidence or slippage.

Unless otherwise directed by the Superintendent, the Contractor shall lay pipes for rising mains on continuously rising grades from scour valve to air release valve, notwithstanding any minor irregularities in the ground surface.

Detectable identification tape to AS/NZS 2648.1 shall be laid along the line of the rising main within 150 mm of the finished surface or as otherwise directed by the Superintendent (WSA 02-2002, Part 3, Section 17.11.2 and SC6.4.4.8 Standard drawings SD-460).

(12) Connections to maintenance holes and structures

The Contractor shall connect pipelines to maintenance holes, structures or embedded concrete by means of 600 mm long pipes such that two flexible joints are provided, the first joint being at or within 150 mm of the face of the structure. The contractor shall not core any connections into wall sections of precast or cast insitu manholes <150 mm from any joint to the closest edge of core. Where flexible joints cannot be made with cut pipes, the Contractor shall select pipes from the various lengths provided in order to make the second joint within 300 mm of the position shown on the drawings (WSA 02-2002, Part 3, Section 18.10 and SC6.4.4.8 Standard drawings SD-470 and SD484).

The Contractor may vary slightly the positions of maintenance holes shown on the design drawings, subject to final approval by the Superintendent immediately prior to construction, to suit changes, such as erection of structures, growth of flora and installation of services. The positioning of a maintenance hole shall be such as to comply with occupational health and safety requirements for access by maintenance staff, providing a proper working area around the top and access into the hole. Once the final position of a maintenance hole has been established, construction shall be subject to the following requirements:

(a) for deviations from the design levels of maintenance holes as shown on the design drawings or as directed by the Superintendent during construction, the following tolerances shall apply (WSA 02-2002, Part 3, Section 23):

(i) where the difference in levels between the inlet pipe and the outlet pipe in a maintenance hole is 100mm or less:

Pipe Tolerance
Inlet - nil; + 10 mm
Outlet - 10 mm; + nil; and

(ii) where the difference in levels, as above, is greater than 100 mm:

Pipe Tolerance
Inlet - 10 mm; + 10 mm
Outlet - 10 mm; + 10 mm; and

(b) allowable lateral deviations from the final design position of maintenance holes shall be +/- 300 mm.

(13) Junctions and property connection sewers

The Contractor shall provide junctions for dead ends and property connection sewers or risers to properties to serve existing and future dwellings in accordance with this sub-section and the design drawings. Such junctions shall be inserted along pipelines in locations shown on the design drawings or directed by the Superintendent, with the service connection, where not shown on the design drawings, provided at a depth no deeper than 1.5 m provided the property still has service to the sewer, as follows (WSA 02-2002, Part 3, Sections 17.7 and 17.8):

(a) for existing dwellings, at the most practical point not outside the property boundary to facilitate the connection, considering existing sewage outlets. Separate connections shall be provided for dual occupancies; and

(b) for vacant blocks, at the most practical point not outside the property boundary to facilitate the connection, considering topography and likely positioning of sewage outlets.

Where the sewer is intended to serve a large block and/or where the sewer line is located more than 75 m from the premises, the Contractor shall extend the property connection sewer onto that block such that the maximum horizontal measurement in a straight line between the sewer connection point and the premises on the block is not more than 75 m.

Concrete support shall be provided for the full trench width in accordance with SC6.4.4.8 Standard drawings SD-455 complying with sub-section SC6.4.6.28 Minor concrete works.

Except where concrete encasement is ordered by the Superintendent, the Contractor shall sand compact

backfill around risers to the top of the socket or coupling on the highest branch off the riser, for the full width of trench and for a minimum distance of 500 mm upstream and downstream of the riser. Compaction density shall be as for the requirements for the trench pipeline.

All property connection sewers and junctions shall have a minimum diameter of 150 mm and have a screwed access cap. Property connection sewers shall have a maximum length of 10 m.

(14) Marking of junctions and property connection sewers

The Contractor shall clearly mark the position of each riser, junction or end of a property connection sewer on completion of backfilling. The marking shall be made by one of the following methods but the location of the mark or peg shall be consistent with the method(s) in use by Townsville Water and Waste and to the approval of the Superintendent (WSA 02-2002, Part 3, Section 17.9).

Where the position of a riser, junction or the end of a property connection sewer is at a substantial boundary fence or structure located on the boundary, a neatly stencilled letter "J" 50 mm high shall be painted thereon. An underground identification tape, as specified hereafter, shall finish flush with the existing ground surface as close to the boundary fence or structure as possible.

Elsewhere, the Contractor shall drive into the ground, a peg, 75 mm x 50 mm x 600 mm long at that position, and left flush with the surface of the surrounding ground. The Contractor shall connect the peg to an underground identification tape as specified hereafter.

The Contractor shall tie the identification tape to the junction or end of the property connection sewer, hold the tape in a vertical position during backfilling operations and finish tape flush with finished ground level.

The identification tape shall be 75 mm wide fawn coloured polyethylene tape with the inscription "Caution - buried sewer line", printed in heavy black letters every 200 mm.

(15) Trench stops

Where a sewer or rising main is laid on bedding at a grade of 5 per cent to 14 per cent, the Contractor shall construct, as below, trench stops consisting of bags filled with clay, or sand or cement stabilised sand and sealed. Reference shall be made to SC6.4.4.8 Standard drawings SD-482 and SD-483.

(a) At the socket side of the joint nearest to the position of a stop required in accordance with the formula hereinafter, a recess 100 mm deep to suit the width of bag shall be excavated into the bottom of the trench across its full width and into both sidewalls and extend to within 300 mm below finished surface level.

(b) The bags shall be placed around and above the pipe, as in (a) above, so as to give close contact with the pipe and to fill the entire space between the excavated recess and the pipe. Bags shall not be placed onto sand bedding.

The distance between trench stops shall be determined by the following formula:

$$D = \frac{100}{G}$$

D = Distance between stops in m

G = Grade of pipe expressed in per centum.

(16) Concrete bulkheads

Where a gravitation sewer or rising main is installed at a grade of 15 per cent to 29 per cent, the Contractor shall construct concrete bulkheads. Where a gravitation sewer or rising main is installed at a grade 30 per cent to 50 per cent, the Contractor shall construct concrete bulkheads integral with concrete encasement. Where any sewer line is to be installed with a grade exceeding 50 per cent, the contractor must provide a site specific design to incorporate all aspects of the site conditions including soil conditions. Bulkheads shall be of 20 MPa concrete complying with sub-section SC6.4.6.28 Minor concrete works, 150 mm minimum thickness as follows: (SC6.4.4.8 Standard drawing SD-482, WSA 02-2002, Part 1, Section 8.10 and WSA 02-2002, Part 3, Section 17.6)

(a) where concrete bedding or encasement to pipe is required, the 150 mm thick bulkhead shall be cast

integral with the concrete bedding or encasement across the width of trench and shall be keyed into both sidewalls a minimum of 150 mm. The bulkhead shall extend to 150 mm below finished surface level or such other level as directed by the Superintendent;

(b) where other bedding, or no bedding, is applicable, the bulkhead shall also be keyed into the bottom of the trench 150 mm for the full width of trench; and

(c) a 75 mm nominal diameter drain hole shall be provided in the concrete bulkhead immediately above the top of the encasement bedding or foundation and crushed rock or gravel shall be placed in and at the upstream end of the drain hole to act as a filter. The gravel shall be 10 to 20 mm in size within 150 mm in all directions upstream and above the invert of the drain hole beyond which another 150 mm thick surround of gravel 2 to 10 mm in size shall be placed.

The distance between concrete bulkheads shall be determined by the following formula: (WSA 02-2002, Part 1, Section 8.10.)

Concrete bulkhead

$$S = \frac{L_P}{G}$$

Concrete encasement (continuous) and concrete bulkhead S = 100/G, whereby

L_P = 80 X Pipe length, m

= 450 m max

if L_P > 100 m use intermediate trench stops at spacing < 100/G

S = Distance between bulkheads in m

G = Grade of pipe expressed in per centum

(17) Thrust and anchor blocks for rising mains

The Contractor shall construct thrust and anchor blocks where shown on the design drawings to the dimensions depicted therein or as otherwise directed by the Superintendent where it is deemed that the allowable bearing pressure of the ground and the design pressure on the pipeline are different to the actual pressures on site. The blocks shall be provided at valves, flexibly jointed bends, tees, enlargers and reducers or any other point where unbalanced forces resulting from internal pressures will occur.

The Contractor shall provide permanent thrust blocks of 20 MPa concrete, complying with sub-section SC6.4.6.28 Minor concrete works, such that the thrust blocks bear against undisturbed material normal to the direction of thrust resulting from internal pressures over the bearing area not less than that directed by the Superintendent.

The Contractor shall provide permanent anchor blocks of 20 MPa concrete, complying with sub-section SC6.4.6.28 Minor concrete works, of a volume and dimension not less than that directed by the Superintendent.

The Contractor shall provide temporary anchorages adequate to restrain the pipe when under test. The cost of providing such anchorages shall be deemed to be included in the rates tendered for laying and jointing rising mains.

The Contractor shall obtain the consent of Townsville Water and Waste for the type and use of restrained joints, as an alternative to thrust blocks, in the case of congested service corridors and urgent commissioning.

(18) Rising main fittings

The Contractor shall install rising mains, air release valves and inspection pipes where shown on the design drawings or directed by the Superintendent. All rising mains shall be topped with an appropriate identification tape.

The Contractor shall provide marking plates bearing the letters "DAV" for double air valves, "SCOUR" for scour pipes and "SRM" for sewage rising main at changes of direction and at such chainages that the location of the main is marked, at least once each 100 metres, as specified hereinafter. In urban areas, the kerb adjacent to each fitting is to be painted with 2 coats of non-slip paint coloured black.

Where, in the opinion of the Superintendent, a valve or fitting is at too great a distance from any existing wall,

fence or post to which the notice plate could be conveniently fixed, the Contractor shall provide and set in the ground a post with the relevant marking plate fixed at the top of the post, facing the fitting. The distance to the fitting in metres, to an accuracy of 0.1 m, shall be permanently marked on the plate with legible numbers a minimum 80 mm high. Wooden posts are not to be used where there is evidence, by rotting or termite activity, that the integrity of the posts will be affected.

The post shall conform to the following requirements:

(a) the post shall be of sufficient length to be set firmly in place under saturated ground conditions.

(b) when installed, the post shall project 1000 mm above the ground, provided that where tall grass or crops are likely to obscure the post, or where directed by the Superintendent, its height above the ground shall be increased to 1500 mm.

(c) the post shall be painted with 2 coats of white enamel for exterior use.

The Contractor shall encase in concrete pipes in gravity sewers or rising mains, as shown on the design drawings, with less than the specified cover above the top of the pipe barrel, or where directed by the Superintendent. Concrete shall be 20 MPa complying with sub-section SC6.4.6.28 Minor concrete works and have the following minimum dimensions (WSA 02-2002, Part 3, Section 20.6 and SC6.4.4.8 Standard drawing SD-463):

(a) for trenches in other than rock: 150 mm minimum under, on both sides and on top of the pipe barrel; and

(b) for trenches in rock: 100 mm minimum under the pipe barrel, 150 mm on top of the pipe barrel and for the full width of trench excavated.

In trenches of other than rock or fissured rock, a contraction joint consisting of a layer of bituminous felt 12 mm thick shall be formed in the concrete encasement at the face of each socket or at one face of each coupling.

Reinforcement in concrete encasement shall be as shown on the design drawings.

(19) Wrapping of pipelines

Where shown on the design drawings or directed by the Superintendent, the Contractor shall enclose a pipeline or a section thereof, in layflat polyethylene sleeving (WSA 02-2002, Part 3, Section 17.10).

The materials to be used shall be high impact resistance polyethylene sleeving of minimum thickness 0.2 mm polyethylene film, approved by the Superintendent, and 50 mm wide plastic adhesive tape.

The width of the sleeving when flat shall be in accordance with the pipe manufacturer's written recommendations for the size and type of the pipeline which is to be encased. Precautions shall be taken so that exposure to direct sunlight does not exceed 48 hours.

Where necessary to distinguish pipes within close proximity, pipelines shall be identified by colour sleeving or an appropriate identification tape.

Application of the polyethylene sleeving and plastic adhesive tape shall be in accordance with the pipe manufacturer's written instructions or as directed by the Superintendent. The Contractor shall take due care not to damage the sleeving during its application or during the backfilling of the trench. Each pipe shall be encased in a length of sleeving overlapped for a minimum of 250 mm at each field joint, and the ends of each length of sleeving shall be held in position with at least three circumferential turns of adhesive tape. As the polyethylene sleeve material covering the pipe will be loose, excess material shall be neatly drawn up around the pipe barrel, folded into an overlap on top of the pipe and held in place by means of strips of plastic tape at approximately 1 metre intervals. Bends, tapers and similar fittings shall be covered by polyethylene sleeving as specified for the pipes. The Contractor shall hand wrap valves, hydrants and irregular shaped fittings and joints using flat polyethylene sheets secured with plastic adhesive tape, or other suitable material, to provide an adequate seal. The flat polyethylene sheets may be obtained by splitting suitable lengths of sleeving.

The Contractor shall rectify any damage done to the polyethylene tubing before, during or after backfilling of the trench. The Contractor shall present the wrapped pipeline for inspection by the superintendent prior to commencing backfilling operations.

(20) Corrosion protection of steel bolts and nuts

The Contractor shall wrap all galvanised steel bolts and nuts, used for installation below ground, of flanges, bolted gland joints, mechanical joints, tapping bands using a tape, approved by the Superintendent consisting of synthetic fibre open weave cloth impregnated with saturated hydrocarbons applied in accordance with the manufacturer's recommendations. Bolts and nuts shall be dry, clean and free from rust immediately before wrapping.

(21) Cast-in-situ maintenance holes

For all maintenance holes concrete work, the Contractor shall comply with sub-section SC6.4.6.28 Minor concrete works in relation to the supply and placement of concrete and steel reinforcement, formwork, tolerances, construction joints, curing and protection except as specified below (WSA 02-2002, Part 3, Section 18.5 and SC6.4.4.8 Standard drawings SD-470 and SD-476).

Cement used in all concrete shall be Type SR to AS 3972. The Contractor may use fly ash additive to a maximum 20 per cent. Cement used shall be no older than 3 months since manufacture.

The minimum cement content shall be 360 kg/m³ of concrete and the water/cement ratio of the mix shall not be greater than 0.50 by mass.

(22) Covers and frames

Covers and frames shall not be warped or twisted. Surfaces shall be finished such that there are no abrupt irregularities and gradual irregularities shall not exceed 3 mm. Unformed surfaces shall be finished to produce a surface that is dense, uniform and free from blemishes. Exposed edges shall have a minimum 4 mm radius (WSA 02-2002, Part 3, Sections 18.1, 18.9 and 19.3).

Tolerances for the dimensions on the COVER shall be – 3 mm + NIL.

Tolerances for the dimensions on the FRAME shall be -3 mm +3mm.

Maintenance hole covers shall be seated on a layer of bitumen impregnated fibre board, having a cross-section of 25 x 25 mm. Alternatively another seating material of a cross-section and composition approved by the Superintendent may be used.

Maintenance hole covers shall be finished flush with the surface in roadways, footpaths and paved surfaces of any type. Elsewhere, covers shall be finished 25 mm above the surface of the ground where not shown otherwise on the design drawings, or such other level as directed by the Superintendent, in a manner designed to avoid as far as possible, the entry of surface water.

In locations where shown on the design drawings or directed by the Superintendent, the Contractor shall install a cast iron cover and frame. Where it is evident, or otherwise shown on the design drawings, the Contractor shall install bolt down frames and covers in areas subjected to 1 in 100 year flooding. Cast iron covers and frames shall be manufactured in accordance with AS 3996, and shall be installed and filled with concrete, as necessary, in accordance with the manufacturer's written requirements.

(23) Preformed maintenance hole and maintenance shaft systems

The Contractor shall supply components that make a watertight system and have a satisfactory surface finish.

Generally, preformed maintenance holes shall be made up in accordance with the design drawings, with components consisting of a base section, shaft sections, converter, cover and frame. Make-up Rings (1 only) of 100-150 mm may be used between converter section and cover to make up height differentials. The wall thickness of any reinforced component below the frame shall not be less than 84 mm.

Preformed maintenance shafts shall be made with section lengths that once constructed comprise the least amount of joints as required to satisfy height parameters and unit joint/wall penetration coring clearances.

The installation of all preformed components shall be in accordance with the manufacturers' recommended

procedures and requirements.

Backfill for all preformed maintenance holes and maintenance shafts shall be placed and compacted evenly around the maintenance hole to the required finished surface level according to location requirements. If necessary, the Contractor shall import and compact non-cohesive granular material.

(24) Bedding and backfill compaction requirements

After laying and jointing of a pipeline has been completed the Contractor shall present the laid and jointed pipes for inspection by the Superintendent prior to commencement of trench backfilling (WSA 02-2002, Part 3, Section 21). Backfill shall not be placed until the Superintendent has given approval.

Material for the bedding, side support and overlay of the pipe shall be as for pipe bedding specified in SC6.4.6.3.3(10) Pipe bedding. The material shall be compacted in layers of not more than 150 mm to a Density Index of 70 for the material used when determined in accordance with AS 1289.5.6.1.

The Contractor shall backfill the remainder of the excavation and compact the backfill in layers of not more than 150 mm thick as follows: (WSA 02-2002, Part 3, Section 21).

(a) Where the trench is within a roadway, proposed roadway, the remainder of the trench shall be:

(i) backfilled with a non-cohesive granular material, with a grading falling generally within the limits shown in Table SC6.4.6.3.3, and compacted to Density Index of 70 when determined in accordance with AS 1289.5.6.1:

(A) below 0.3 m of the subgrade road surface; and

(B) in the road reserve, up to top of overlay zone;

(ii) backfilled with selected material, and compacted to 100 per cent of the standard maximum dry density of the material when determined in accordance with AS 1289.5.4.1, to top of subgrade level of the road surface, but excluding the pavement layers;

(iii) backfilled with selected material, and compacted to 95 per cent of the standard maximum dry density of the material when determined in accordance with AS 1289.5.4.1, to finish surface level of the areas of trench outside of roadways; and

(iv) backfilled with road base and sub-base material as per existing or proposed pavement layers and compacted to 100 per cent of the standard maximum dry density of the material when determined in accordance with AS 1289.5.4.1

(b) Elsewhere, unless stated otherwise, the remainder of the trench shall be backfilled with ordinary excavated backfill material. Where suitable material is not available, granular material may be used for the full depth of backfilling. The material shall be compacted to a density Index of 70 when determined in accordance with AS 1289.5.6.1 for cohesionless materials or 98 per cent of the standard maximum dry density of the material when determined in accordance with AS 1289.5.4.1 for cohesive materials.

The Contractor shall carry out backfilling and compaction without damaging the pipe or its external coating or wrapping or producing any movement of the pipe.

The Contractor is to submit to the Superintendent for approval any proposal for construction of embankments in conformance with the drawings, including the method of placement and compaction and any limitations to the placement/ compaction over the top of any pipeline.

Where a roadway is to be sited over existing infrastructure, excavation of trench material down to overlay zone and subsequent backfilling with appropriate select material to the underside of sub-base to the compaction requirements stated above must be undertaken by the contractor.

The Contractor may compact backfill by trench flooding only where:

- the ground and backfill material is cohesionless sand;
- water for flooding has been sourced at the site;
- the process will not create mud which would be moved off site by vehicles or construction plant; and

- additives are not used.

The contractor shall carry out compaction tests to the full depth of zone being tested and present NATA certified test results to the Superintendent.

SC6.4.6.3.4 Pipeline testing and restoration

(1) General

The Contractor shall subject all sewers and maintenance holes to an initial test as soon as practicable after construction and backfilling is completed (WSA 02-2002, Part 3, Section 22).
All lines shall be clear and free from soil, slurry, liquids and other foreign substances at the time of initial and acceptance testing.

Where a vacuum system has been specified, the Contractor shall test the system in accordance with the testing schedule as shown on the design drawings.

(2) Initial test of gravitation sewers

The Contractor shall make the initial testing of gravitation sewers with compressed air. Before the initial test is performed, all pipe laying on the section shall be completed, and backfill shall be compacted to at least the level of the top of overlay section of trench filling. The Superintendent shall advise at the time of notification by the Contractor whether the option to inspect the initial testing is required (WSA 02-2002, Part 3, Section 22.4.2).

The initial test shall not be carried out before risers and/or property connection sewers are constructed.

Where the Superintendent approves the construction of pipelines in other than full lengths between maintenance holes, each length of pipeline shall be tested before backfilling together with the downstream portion of the maintenance hole length under construction.

The Contractor shall rectify any fault detected and obtain a satisfactory test before the remainder of backfill is placed.

(3) Initial test of maintenance holes

The Contractor shall test each maintenance hole for leakage, as soon as practicable after the maintenance hole is constructed and the maintenance hole cover surround fitted (WSA 02-2002, Part 3, Section 22.4.4).

Maintenance holes may be tested in conjunction with both upstream and downstream sections of mains using the low pressure vacuum method for the initial testing only in accordance with WSA 02-2002, Part 3, Section 22.4.4. It is advised that a pressure relief valve be installed inline with a maximum setting release of 50 kPa.

Alternatively, the Contractor may request to test manholes initially using hydrostatic means. The test shall be made by plugging all pipe openings in the walls and by filling the maintenance hole with water to the lowest point on the top of the maintenance hole cover surround. The plugs shall be positioned in the pipes as near as practicable to the internal face of the maintenance hole. The Contractor shall provide details of the alternative method proposed, for approval by the Superintendent, prior to its use.

(4) Ovality test and CCTV inspection

The Contractor shall carry out deflection testing in conformance with WSA 02-2002 Part 3, Section 22.6 upon completion of placement and compaction of trench and embankment fill. Submit proposal for deflection testing to the Superintendent for acceptance. Carry out a CCTV inspection of the sewer system and maintenance structures to WSA 05 Attachment E and WSA 02-2002 Part 3, Section 22.7 and SC6.4.2.2.6 Conduit assessment

The Contractor shall undertake ovality testing as follows:

(a) all sewers to DN 300 shall be tested to determine any excessive ovality using either a proving tool approved by the council or by CCTV light ring and approved measurement software. Ovality testing shall be undertaken after all earthworks on the subdivision are complete and no sooner than 14 days after

backfill of trenches has been completed. Sewer pipes having excessive ovality shall be replaced and the line retested (WSA 02-2002, Part 3, Section 22.6 & WSA 05-2013);

(b) the proving tool shall be rigid and non-adjustable having an effective length of not less than its nominal diameter. The minimum diameter at any point along the length shall be as specified in WSA 02-2002, Appendix G;

(c) the proving tool shall be fabricated from steel and have pulling rings at each end. The prover shall be marked to indicate the nominal pipe size and the prover outside diameter;

(d) Maximum Allowable Deflection = 3% of Mean Outside Diameter; and

(e) the testing shall require a “prover” to be pulled through each section of the pipeline by hand winching to demonstrate that the maximum allowable deflection is not exceeded.

(5) Acceptance test of gravitation sewers and maintenance holes

Acceptance testing shall be carried out before the issue of the Certificate of Practical Completion. Sewers or maintenance holes failing any test, shall be repaired and the test repeated. The process of testing, repair of defects and retesting shall continue until a satisfactory test is obtained. (WSA 02-2002, Part 3, Section 22.) The Contractor shall make the acceptance test on all components in the section of the sewer in the same manner and to the same methods as the initial test. The Contractor shall submit to the Superintendent satisfactory test results from the acceptance testing.

The Superintendent may permit hydrostatic testing as an alternative to air testing for acceptance of gravitation pipelines and maintenance holes after approval from council.

Where the project contains a combination of precast and cast insitu maintenance holes, then each group must be regarded as a separate population and testing frequencies shall be in accordance with WSA 02-2002, Part 3, Table 22.5.

The Superintendent may reject any pipeline or maintenance hole in which there is visible or detectable leakage.

(6) Testing with compressed air

The Contractor shall supply and keep all necessary equipment in a condition acceptable to the Superintendent.

All test gauges must have a current calibration certificate and have a range that is suitable to be able to read decimal increments. The minimum diameter of readable face shall be 100 mm.

Sewer lines may be tested by either vacuum (negative pressure) or by positive pressure. The use of inline manhole through connectors can be utilised for ease of testing multiple lines. Manholes and sewer lines shall be tested separately.

Compressed air shall be supplied by a compressor of the rotary vane type capable of supplying at least 1 m^3/minute at 35 kPa. The air shall be fed through a pressure-reducing valve capable of reducing pressure from that supplied to 28 kPa ± 4 kPa. The air shall then pass through an airtight line fitted with a pressure gauge reading from 0 to 50 kPa, a pressure relief valve that shall be set to blow off at 28 kPa ± 4 kPa and a gate valve to the pipeline to be tested.

The method of setting up and carrying out the test shall be as specified in WSA 02-2002, Part 3, Section 22.4.

(7) Allowable pressure drop times

The time taken for the pressure to drop from 25 kPa to 18 kPa shall be greater than that specified in WSA 02-2002, Part 3, Table 22.4.

Pressure drop times which are less than these may indicate leakage or excessive air permeability through unsaturated pipe walls with some materials. Vitrified clay pipes, in particular, suffer from excessive air permeability under dry summer conditions. When this occurs, pipes shall be thoroughly saturated with water before testing or a hydrostatic test applied.

In any case, where the allowable pressure drop time cannot be attained and there are no visible leaks, the Contractor shall apply a hydrostatic test.

(8) Hydrostatic testing

The Contractor shall not carry out hydrostatic testing unless prior approved by the superintendent.

The pipeline under test, and the pipe or hose with container, shall be filled with water until the free surface is level with the top of the container, when that container is suspended in accordance with the requirements set out below.

The test container shall be suspended at a level such that the test head applied to the pipeline is as follows:

(a) for initial test

  (i) when no property connection sewers or risers are constructed – a minimum head of 2 metres above the pipe invert at the upstream end of the line under test, or

  (ii) where property connection sewers and/or risers are constructed – a minimum head of 2 metres above the highest invert in the line under test, including its risers and property connection sewers;

(b) for acceptance test, a minimum head of 2 metres above the highest invert in the line under test, including its risers and property connection sewers, or above the free standing level of ground-water in the vicinity whichever is the higher; and

(c) such other lesser head as the Superintendent, at the Superintendent's discretion, may direct

The Contractor shall determine, at the Contractor's expense, the free standing level of groundwater, by a method acceptable to the Superintendent.

After allowing an interval for absorption, to be determined by the Superintendent, any fall of the free water surface shall be made good by adding extra water to the container. The Contractor shall measure the fall in water level during ten minutes thereafter.

The pipeline will be regarded as satisfactory if there are no visible leaks, and if the fall in water level is not more than 25 mm for each standard test length of the pipeline under test including property connection sewers and/or risers.

A standard test length in metres is defined as 1370 m divided by the effective diameter of the pipeline in millimetres. Where the pipeline under test is all of the same size, the effective diameter shall be the nominal size of that pipeline. Where the pipeline under test has property connection sewers and/or risers of smaller nominal size than the main sewer line, then the effective diameter shall be calculated as the product of the length and the nominal size of the larger pipe added to the product of the length and the nominal size of the smaller pipe; this sum shall be divided by the total length of pipeline under test; the result shall be the effective diameter.

(9) Visual inspection and measurement of infiltration

Whenever, in the case of acceptance testing, the pipeline is subjected to a significant head of groundwater (i.e. 1500 mm or more above the soffit of the sewer main provided that groundwater is at least 150 mm above any property connection sewer included in the test), the tests previously prescribed may be dispensed with in favour of visual inspection and measurement of infiltration upon request to the superintendent.

In such circumstances, the Contractor shall propose full details of the method by which the infiltration is to be measured (WSA 02-2002 Part 3, Section 22.5).

If the Superintendent, at the Superintendent's discretion, approves of an inspection and infiltration test being performed for the purposes of acceptance, the Superintendent shall determine the duration over which infiltration is to be measured. The rate of infiltration shall not exceed that determined by the following formula:

Rate of Infiltration

$$Q.I. = 0.65 (L_1 d_1 h_1 + L_2 d_2 h_2 + \ldots\ldots\ldots L_n d_n h_n) + H_a$$

Where:

Q.I. = rate of infiltration in litres/hour

L = length of pipe in metres
d = nominal size of pipe in metres
h = average head of groundwater over the invert level of the pipe in the section under test
H_a = head of groundwater above the invert level of the outlet pipe of the maintenance hole when the maintenance hole is included in the infiltration test.

The Contractor shall determine the head of groundwater, by a method approved by the Superintendent.

(10) Testing of rising mains

The Contractor shall pressure test rising mains to detect leakage and defects in the pipeline including joints, thrust and anchor blocks. Acceptance testing shall be carried out before the issue of the Certificate of Practical Completion. Rising mains failing any test, shall be repaired and the test repeated. The process of testing, repair of defects and retesting shall continue until a satisfactory test is obtained (WSA 07-2007, Part 3, Section 21). The Contractor shall submit to the Superintendent satisfactory test results from the acceptance testing.

Pipelines shall be tested in sections approved by the Superintendent as soon as practicable after each section has been laid, jointed and backfilled, provided that:

(a) if so specified or if the Contractor so desires, some or all of the pipe joints shall be left uncovered until the whole of the section has been successfully pressure tested to the satisfaction of the Superintendent; and

(b) the pressure testing shall not be commenced earlier than 7 days after the last concrete thrust or anchor block in the section has been cast.

For the purpose of this clause, a section shall be defined as a length of pipeline which can be effectively isolated for testing, e.g. by means of main stop valves. A maximum length of 1000 m can be tested in one continuous section unless otherwise approved by the superintendent.

Pressure testing shall not be carried out during wet weather unless otherwise approved by the Superintendent.

During pressure testing, all field joints which have not been backfilled shall be clean, dry and accessible.

During the pressure testing of a pipeline, each stop valve shall sustain at least once, the full test pressure on one side of the valve in closed position with no pressure on the other side for at least 15 minutes.

Before testing a pipeline section, the Contractor shall clean it to the satisfaction of the Superintendent and fill it slowly with water, taking care that all air is expelled. Purging of air from rising mains shall be promoted by opening air valves. In order to achieve conditions as stable as possible for testing by allowing for absorption, movement of the pipeline and escape of entrapped air, the section shall be kept full of water for a period of not less than 24 hours prior to the commencement of the pressure testing.

The hydrostatic test pressure which shall be applied to each section of the pipeline shall be equivalent to 1.25 times the maximum operating pressure of the pipeline but do not exceed 1.25 times the maximum operating pressure rating of the lowest rated pipe/fitting. The test procedure shall be in accordance with WSA 07-2007, Part 3, Section 21.4.

The Contractor shall maintain the specified test pressure for as long as required by the Superintendent, while the Contractor examines the whole section. In any case, the specified test pressure shall be maintained for not less than 4 hours. For the purpose of determining the actual leakage losses, the Contractor shall carefully measure and record the quantity of water added in order to maintain the pressure during the period of testing.

The pressure testing of a section shall be considered to be satisfactory if:

- there is no failure of any thrust block, anchor block, pipe, fitting, valve, joint or any other pipeline component;
- there is no visible leakage; and
- the measured leakage rate does not exceed the permissible leakage rate as determined by the following formula:

$Q_1 = (0.14xDxLxH)$

where:

Q_1 = permissible leakage rate (litres per hour)

D = nominal internal diameter of pipe (m)

L = length of section tested (km)

H = average test head (m)

Any failure, defect, visible leakage and/or excessive leakage rate, which is detected during the pressure testing of the pipeline or during the defects liability period shall be rectified by the Contractor at the Contractor's expense. Where a thrust block or an anchor block fails, and such thrust block or anchor block has been constructed in accordance with the design drawings, and the failure is not, in the opinion of the Superintendent, the fault of the Contractor, the thrust or anchor block shall be strengthened or reconstructed as directed by the Superintendent. The cost of strengthening or reconstruction of such thrust or anchor block and the cost of retesting shall be paid as a Variation to the Contract, at such rates as are determined in accordance with the provisions of the General Conditions of the Contract.

For PE rising mains, testing shall be in accordance with WSA 07-2007, Part 3, Section 21.5.

Alternatively, the rising main may be tested by the use of compressed air. In this case, the Contractor shall provide details of the alternative method proposed, for approval by the Superintendent, prior to its use.

(11) Connection to existing sewers

The Contractor must request approval (request for private works quotation) for connection to existing sewers from Townsville Water and Waste. Works shall be either performed by the Sewer Agency or delegated to the contractor at the discretion of the Sewer Agency. Approval must only be requested upon satisfactory completion of all backfilling and testing. All necessary works required in completing connections to "live" maintenance holes (that is, accesses to sewer system that is currently in service), including all works undertaken by the Sewer Agency at "live" maintenance holes in delivering the works shall be the responsibility of the Contractor (WSA 02-2002, Part 3, Section 24).

(12) Restoration of surfaces

The Contractor shall clean pavements, lawns and other improved areas and leave them in the same order as they were at the commencement of the Works. The Contractor shall restore any fencing removed during construction and shall restore lawns with turf cut and set aside from the original surface and with imported turf from a source approved by the Superintendent. (WSA 02-2002, Part 3, Section 25.) The restoration works shall be done progressively and as soon as possible after the section of works is completed.

The Contractor shall maintain all restored surfaces in the condition to which they are restored until the expiry of the defects liability period applicable to those surfaces, notwithstanding that any deterioration of the restored surfaces, and the need for their maintenance may or may not be due to defects which become apparent or arise from events which occur during the defects liability period. The Contractor shall maintain pavements with crushed igneous rock, gravel or other suitable material allowing for consolidation and shall then restore them to a condition equivalent to that of the original pavement.

Immediately the backfilling of a trench excavated through a pavement has been completed, the Contractor shall temporarily restore the pavement. Where the trench crosses bitumen or concrete pavement, the surface is to be protected from deterioration. A pre-mixed asphaltic material may be used for such temporary restoration. The Contractor shall maintain the temporary restoration until final restoration is carried out. Final restoration of the pavement shall be carried out in accordance with SC6.4.4.8 Standard drawings SD-055 to restore the pavement and its sub-base to no less than the original condition. Final restoration may include, if required by the Superintendent, the removal of temporary restoration.

In other than roadways, the Contractor shall place the backfill sufficiently high to compensate for expected settlement and further backfilling shall be carried out or the original backfill trimmed at the end of the defects liability period in order that the surface of the completed trench may then conform with the adjacent surface. Surplus material shall be removed and disposed of to areas arranged by the Contractor. Where dry weather

conditions have persisted after the original backfilling, including during the defects liability period, the Contractor shall take all necessary steps to consolidate the trench before removing surplus materials from the site.

In locations where, in the opinion of the Superintendent, surplus material left in the vicinity of the trench would not be objectionable, the surplus material may be disposed by spreading neatly in the vicinity of the trench to the satisfaction of the Superintendent in such a way as to avoid future erosion of the backfill and adjacent ground surfaces. The Contractor shall maintain the backfill and adjacent ground until the expiry of the defects liability period.

Where, within public or private property, the reasonable convenience of persons will require such, the Superintendent may order the Contractor to level trenches at the time of backfilling. The Contractor shall make good any subsequent settlement, as required by placing additional fill.

The Contractor shall immediately restore any damaged or disturbed private property and services.

Should the Contractor elect to tunnel under paving, kerb and channel or other improved surfaces in lieu of trenching, backfilling shall be so carried out as to restore full support to those surfaces, and payment shall be made for the restoration of the surfaces as though they had been removed and replaced. The Contractor shall remain responsible for the repair of the improved surfaces, if subsequently damaged due to subsidence of the backfill, until the end of the defects liability period.

The Contractor shall provide notice to affected property owners of any pending works.

SC6.4.6.3.5 Pump stations

(1) General

Provide only products and materials authorised by Townsville Water and Waste, the drawings and this specification. The Contractor shall submit for approval any alternative or not authorised products and materials.

The Contractor must conform to manufacturer's recommendations for handling, transport and storage of materials and in a manner to prevent damage or deterioration or excessive distortion. Inspect all products and materials at the time of delivery and reject products and materials not in conformance with this specification and the manufacturers' recommendations. Maintain protective crating or packaging until immediately before use.

Damaged or defective materials are not to be installed or used, including coatings and linings, outside the manufacturer's recommended limits.

(2) Pumps

Pump construction materials for centrifugal end suction pumps shall comply with the following:

DESCRIPTION	MATERIAL
PUMP	Cast iron AS 1830 Gr T200
Casing and suction bend	Cast iron AS 1830 Gr T200
Wear rings	316 Stainless steel/AS 1449
Impeller	Gunmetal AS 1565-905C
Impeller nut	316 Stainless steel/AS 2837
Shaft sleeve	Phosphor bronze AS 1565-9060/316
Neck bush, lantern ring	Phosphor bronze AS 1565-9060
Gland studs	Cast Iron AS1830 Gr T200
Gland nuts	316 Stainless steel/AS 2837
Fixing nuts and bolts handhole	316 Stainless steel/AS 2837
Covers fitted bolts and nuts, casing and dowels	316 Stainless steel/AS 2837
Forcing screws	316 Stainless steel/AS 1449
Water thrower and drip tray	316 Stainless steel/AS 2837
Pump set base plate	316 Stainless steel/AS 2837
	316 Stainless steel/AS 1449
	Cast iron AS 1830 Gr T2000/Fabricated steel
MOTOR	Cast iron/Mild steel
Motor frame and end shield	Cast iron/Mild steel
Motor terminal box	Mild steel
Motor fan cover	Metal
Motor fan	
HOLDING DOWN BOLTS	316 Stainless steel/AS 2837
MECHANICAL SEALS	Tungsten carbide or equal
Seal faces	Nickel chrome steel
Springs	Fluoro carbon or nitrile rubber
Secondary seal	

The Contractor shall provide a written warranty from the manufacturer of the equipment. This action constitutes a hold point. The Superintendent's approval of the warranty is required prior to the release of the hold point.

The manufacturer's warranty shall require the manufacturer to accept liability for any defect in materials or workmanship which becomes apparent at any time within 2 years after the date of delivery of any piece of equipment used in work under the contract.

All nuts and bolts shall be manufactured in accordance with AS/NZS 1111 and AS/NZS 1112, 150 metric series and fitted with washers beneath bolts heads and nuts. Requirements are:

(a) all bolts, nuts and washers shall be stainless steel to AS 1449 and AS 2837, minimum grade 316. All bolts, nuts and washers are to be of the same grade and supplied passivated;

(b) all threads are to be rolled;

(c) all bolt heads and nuts shall be hexagonal;

(d) all bolts, studs, set screws and nuts for bolting flanges and other pressure containing purposes shall conform to AS 2528;

(e) all nuts and bolts subjected to vibration shall be fitted with lock washers or lock nuts;

(f) all concrete anchor bolts, nuts, locking nuts and large series washers required for the bolting down of pump set discharge bends shall be provided. These anchor bolts shall be as recommended by the equipment designer with a minimum diameter of 16 mm; and

(g) concrete anchor bolts shall be chemical masonry anchor type, set to their full depth, suitable for the required duty.

Bolts on all flanges will protrude no more than 10 mm past the nut when tightened.

The Contractor shall apply sufficient anti-seize/anti-galling material to the threads of all stainless steel fasteners. The material shall be Polytetrafluroethylene (PTFE), either tape to AS 1272, dipped or sprayed, or molybdenum disulphide.

(3) Preformed pump stations and package pump stations

Preformed components or systems, complying with the design drawings, if any, otherwise complying with AS 3518, AS 3571 or AS 4198 may be used in lieu of in-situ construction provided:

(a) preformed concrete wall units are to be manufactured to AS 4058 except as modified as for the requirements for precast maintenance hole units;

(b) joints shall be internal flush; and

(c) the Contractor shall supply components that make a watertight system and have a satisfactory surface finish.

Package pump stations may be supplied and installed provided:

(d) all components comply with the requirements of this sub-section; and

(e) the units are at least equivalent to the requirements of this sub-section and the design drawings.

(4) Electrical compliance

The Works shall be in accordance with the requirements contained in clause SC6.4.3.21.4 Electrical and mechanical except where this sub-section or the design drawings indicate otherwise. The technical requirements detailed on the design drawings shall take precedence over the requirements of this sub-section should clauses be in disagreement.

Except where clause SC6.4.3.21.4 Electrical and mechanical requires a higher standard, works shall be carried out in accordance with AS 3000, the Service Rules of the Supply Authority and all relevant statutory authorities.

The Contractor shall supply proof of compliance with a standard or specified test. Such proof shall comprise a test certificate from an approved independent testing authority.

The Contractor shall submit all designs and material, to each Authority having jurisdiction for approval. The Contractor shall arrange for each Authority having jurisdiction to inspect the Works. The Superintendent shall be advised a minimum of 7 working days in advance of the date of any inspection by an Authority. The Superintendent shall advise at the time of notification by the Contractor whether the option to attend the inspections is to be exercised.

(5) Switchgear and control gear assembly (SCA), controls

The Contractor shall supply and install the SCA designed and assembled by a manufacturer approved by the Superintendent.

The SCA shall be of outdoor, stationary, free standing, metal-enclosed, cubicle type series with a minimum degree of protection of IP56D as specified in AS 60529.

All equipment shall be securely mounted on suitable mounting panels and comprise individual compartments. A hot dipped galvanised steel channel base shall be provided.

The Contractor shall provide an effective barrier to prevent gases from the wet well entering the SCA.

Starter contactors shall have appropriate ratings for the proposed pumps to AC3.

All necessary terminals with terminal and cable numbers shall be supplied and installed in accordance with the design drawings.

The Contractor shall liaise with the electricity supply authority to supply padlocks for the metering equipment, at the Contractor's expense. The Superintendent shall supply padlocks for use on the SCA at no cost to the Contractor.

The electrical characteristics of the SCA shall be:

Main Circuit: 415/240 V, 50 Hz, 3-phase, 4-wire.
Motor Control Circuit: 240 V, 50 Hz.
Common Control Circuit: 240 & 24 V, A.C.
Prospective short-circuit current:
14kA for 1 second. Peak Factor: 2.2
Power Factor Correction (determined in consultation with the Superintendent)
Earthing (M.E.N. system)
Characteristics

All cables shall enter the SCA from below.

The Contractor shall supply data from the switchgear supplier confirming Type “2” co-ordination between contactors, motor protection relays and corresponding circuit breakers, to the Superintendent.

Refer to Standard Specification TCC24 clause 18 for starter selection requirements and functional specification for the project.

The Contractor shall carry out of factory tests in the presence of the Superintendent's Representative and in accordance with clause SC6.4.3.21.4 Electrical and mechanical and the results shall comprise all routine Tests specified in AS 3439. The Superintendent shall be given 7 days notice of the proposed date of such tests.

Inspections and functional tests shall be in accordance with TCC24 clause 21.

The Contractor shall pack the equipment for transport after satisfactory final factory inspection and tests, and after approval has been given by the Superintendent. The Contractor shall ensure that any relays, programmable logic controllers, and fittings likely to be adversely affected during delivery shall be adequately protected or shall be removed and packed separately in protected containers. Where equipment has been removed, cover plates shall be provided.

The Contractor shall be responsible for any damage that may occur during transit and unloading at site.

The Contractor shall ensure that spare parts, tools etc., are packed separately from the main plant and shall be marked “Spare Parts”, “Tools” etc., as applicable.

The Contractor shall supply spare parts in accordance with the schedule supplied by the Superintendent.

Automatic control of the pump station pumping equipment shall be by way of hydrostatic level sensor providing single pump duty operation unless shown otherwise on the drawings. The level sensor will be compatible with those in use in the system. A float switch shall be used to provide a HIGH HIGH(overflow) level alarm. Refer to TCC24 clauses18.2, 18.2, 19.1 and 19.2.

The following wet well levels shall be used in the automatic control of the pump operation system:

(a) STOP level;

(b) Duty Start level;

(c) Standby Start level; and

(d) High level.

Pump operation requirements are described in TCC24 clause 18.

The Contractor shall supply and install control equipment that is compatible with the existing equipment.

(6) Electrical installation

The Contractor shall liaise with the Supply Authority for the electricity supply to the pump station site.

The Contractor shall be responsible for all facilities required by the Supply Authority for revenue metering

equipment and the payment of all associated connection, inspection fees and capacity charges.

The Contractor shall supply and install all cabling including consumer mains, motor, control and instrumentation cables, conduits and electrical pits.

The Contractor shall install all wiring in HD-PVC underground conduits laid in accordance with the Supply Authority's requirements, with a minimum 500 mm below the finished ground level in non-trafficable areas and 600 mm below the finished ground level in trafficable areas. The trench and backfill material shall be free of rocks and other foreign matter likely to damage the conduits.

The Contractor shall run electrical marker tape 150 mm below the finished ground level directly above the conduits for the entire length of the conduits. Marker tape shall be orange in colour, 150 mm wide and stamped with the words "DANGER – ELECTRIC CABLES BELOW" or similar.

The Contractor shall route all underground cabling with the approval of the Superintendent. Brass marking plates shall be positioned on a concrete surround clearly showing the direction of the incoming consumer mains. Wording and markings shall read "DANGER – ELECTRICAL CABLES BELOW". The Superintendent's approval of the route of all underground cabling is required prior to the release of the hold point.

The Contractor shall determine the points of attachment on site and the Contractor shall supply and install any consumer's connection poles for the consumer mains required by the Supply Authority.

The consumer mains shall be generally run underground and commence at the point of attachment on a steel consumers pole (if applicable), installed near the property boundary and run in conduit to the switchboard.

No aerial conductors are to be installed over structures, access road or vehicle manoeuvring areas.

The minimum size of the consumers mains shall be sized to satisfy the following:

(a) current carrying capacity to suit the maximum demand with an excess current carrying capacity of 30 per cent minimum;

(b) be sized for a voltage drop less than 1.5 per cent to the maximum demand as calculated;

(c) be single core PVC/PVC cables. XLPE insulated cable may also be used;

(d) comply with the requirements of the Supply Authority; and

(e) AS 3000 and AS 3008.

In addition to the requirements of the Supply Authority and clause SC6.4.3.21.4 Electrical and mechanical, the Contractor shall run the main earthing conductor in conduit to the main earthing electrode. The main earthing connection shall be contained in an earthing electrode connection box similar to ALM type ERB-1 up to 50 mm2 cable and a Type 4 pit for larger cable.

Earth electrode shall be bonded and suitably labelled with an engraved brass label.

Surge diverters shall be earthed in accordance with manufacturer's instructions.

The Contractor shall bond the pump station metallic pipework to the main earth.

Refer also to TCC24 clause 28.1 for installation instruction requirements.

Metering equipment and installation shall comply with the *Queensland Electricity Connections and Metering Manual.*

The Contractor shall gland cables entering the outdoor SCA compartment using non-ferrous metallic or plastic glands with neoprene compression seals and connect the on-flow switch and pump motor cables to the appropriate terminals. Cables shall not be jointed.

The Contractor shall seal, at the completion of commissioning tests, all conduits into the outdoor SCA with a

non-setting sealing compound to prevent the ingress of vermin.

(7) Pressure gauges

The Contractor shall install one diaphragm protected, glycerine oil filled, direct mounting, bottom connection pressure gauge complying with AS 1349 per centrifugal pump installation. Cases shall be fabricated from stainless steel complying with AS 1449 or bronze. The protective diaphragm shall be suitable for dismantling for cleaning without affecting the accuracy of the gauge.

The gauge face shall be 100 mm in diameter and calibrated in metres head of water. The gauge shall accurately indicate the pump operating head and the pump no-flow head.

Each gauge shall be supplied with the nominally sized metric equivalent of three of the following bronze fittings: gate valve, union, nipple and reducing nipple.

Gauges and fittings shall be screwed into the pipe wall of ductile iron pipes, or pipe fittings, 150 mm and larger. In pipework less than 150 mm, gauges and fittings shall be screwed into a tapping band. On rising mains, where shown on the design drawings, the Contractor shall install a ball valve to allow removal of the gauge.

The pressure gauge range for single or parallel pumps duty shall be 0 to 1.7 times the closed valve head of the pumps.

(8) Valves

The Contractor shall ensure that the valves supplied are compatible with the pipework such that proper sealing is provided between the pipe flanges and the valve. The concrete lining in pipework shall not be chipped away or reduced to provide clearance from the working parts of valves.

The Contractor shall ensure that valves are installed so as to facilitate maintenance. The Contractor shall take into account the manufacturer's recommendations, the requirements shown on the design drawings, the type of connection, and lubrication of connecting bolts.

Flanges shall comply with AS 2129 to the class shown on the design drawings.

Unless shown otherwise on the design drawings, all valves shall be clockwise closing.

The Contractor shall size "Tee" Key valve operators and hand wheels to operate the valves under all operating conditions throughout their full range with no greater than 180 Newtons applied to the ends of the key bar or the rim of the wheel.

Hand wheels shall display an embossed or engraved arrow, together with "open" and/or "close" corresponding to the valve operation.

One "Tee" key operator per pump station, of suitable length for operating the respective valve from the surface level, shall be provided for each size of valve installed in each pump station.

Non-return valves shall be of the swing check type to AS 3578 of cast iron or steel body, cover and disc with bronze body and disc seat rings. The leaf shall swing clear and provide an unobstructed waterway.

The body cover shall be located and sized to allow the valve flap to be removed and the seat to be inspected without removing the valve.

Each non-return valve shall have an extended spindle, minimum grade 316 stainless steel, fitted with an adjustable counterweight.

The knife gate valve shall be constructed in accordance with the following:

(a) the design shall include an enclosed bonnet;

(b) the spindle shall be of the non-rising type;

(c) valves shall be clockwise closing;

(d) the gland around the spindle shall be adjustable or formed by a double O- ring;

(e) flange jointing shall be rubber O-rings; and

(f) seating shall be achieved by flexible seats which shall be designed in a manner that will allow easy replacement. The material of the seat is to be nominated.

All assembly bolts and nuts shall be fitted with fibre or nylon isolating washers to prevent bimetallic corrosion where required.

Each valve spindle shall be fitted with a cast steel or forged steel spindle guard secured to the valve spindle with a gun metal set screw or a handwheel secured to the spindle with gun metal set screw and washer.

Valves shall be drilled and threaded, where required, in accordance with AS 2129.

(9) Testing and commissioning of pump station

The Contractor shall test and/or inspect all materials, equipment, installation and workmanship to prove compliance with the sub-section requirements. The submission to the Superintendent of satisfactory test results constitutes a hold point. The approval of the Superintendent is required prior to the release of the hold point.

Tests and inspections shall comply with relevant Australian Standards.

Testing shall include pre-commissioning, field testing and performance testing of each part of the whole installation.

Pre-commissioning is the preparation of plant or equipment so that it is in a safe and proper condition and ready for commissioning and operation. It includes all aspects of plant operation such as safety, electrical, mechanical and instrumentation.

The Contractor shall conduct pre-commissioning in a logical sequence in accordance with the programme prepared by the Contractor and approved by the Superintendent.

The Contractor shall prepare pre-commissioning record sheets for each item of equipment to ensure results of tests are satisfactorily recorded and that all necessary checks or tests have been performed.

Specific requirements for pre-commissioning shall include, but are not limited to:

(a) initial charges of lubricant in addition to any special lubricant requirements for initial flushing or treatment of the system or for “running in”;

(b) physical checks and tests such as completeness of assembly, rotational tests (including checking that the rotation of electrical motors is in the correct direction), alignment checks, balancing and vibration checks, temperature, pressure and flow measurements, clearances, belt alignment and tension, etc., depending on the type of equipment;

(c) electrical and instrument installation tests, including motor insulation tests and checking instruments against certified instruments and correcting as necessary;

(d) tests of the correct functioning of automatic and manual control and protection equipment, including simulating danger conditions, mal-operations or failures, to check that all instruments and controls function correctly. These tests shall also include adjusting instrument set points and alarm settings and proving correct operation of alarms; and

(e) equipment and system operating tests. The Contractor shall certify compliance of each item and submit a signed copy to the Superintendent prior to commissioning.

The Contractor shall carry out pre-commissioning tests to the satisfaction of the Superintendent and shall record the results of the tests on the appropriate Pre- commissioning Record Sheet.

Refer to TCC24 clause 28.1.11 for electrical test documentation requirements.

The Contractor shall furnish the Superintendent with one signed copy of each completed Pre-commissioning Record Sheet countersigned by the Superintendent's Representative who witnessed the test.

Commissioning is the running of the plant and equipment to ensure flow through the pumping system, carrying out any necessary testing and adjustments until it is ready and suitable for normal starting and running under service conditions.

The Contractor shall give the Superintendent 5 working days notice of the Contractor’s intention to undertake commissioning and supply to the Superintendent the copies of each of the pre-commissioning record sheets and three copies of the operational and maintenance manuals at the time that notice of commissioning is given.

The Contractor shall conduct commissioning in a logical sequence in accordance with a programme prepared by the Contractor and approved by the Superintendent.

Throughout commissioning the Contractor shall be responsible for the test programme.

The Contractor shall provide continuous supervision by personnel experienced in the operation of the equipment and shall have qualified personnel in attendance to carry out all necessary adjustments and/or remedial work during the commissioning tests.

The Contractor shall prepare, schedules, test record sheets and programmes for approval by the Superintendent prior to each stage of the overall commissioning.

The Contractor shall carry out final testing and commissioning (min 1 day duration) of the electrical services in conjunction with the mechanical equipment (e.g. pump, etc) including setting and adjustment of equipment in accordance with SC6.4.3.21 Townsville water and planning design guidelines.

The Contractor shall arrange for all testing, commissioning and any adjustments.

(10) Practical completion of pump station

The Contractor shall fulfil the following requirements before the Certificate of Practical Completion can be issued which constitutes a hold point:

(a) receipt by the Superintendent of a certificate of approval from the relevant statutory authorities;

(b) pump station is in working order as demonstrated by the testing and commissioning;

(c) approval by the Superintendent of operating and maintenance manuals; and

(d) receipt by the Superintendent of as-built drawings of the pump station.

(11) Telemetry

The Contractor shall make provision for equipment to link the pump station to the existing telemetry network to be provided by Townsville Water and Waste at the Contractor's expense. Refer to TCC24 clause 17.1, 28.2, Appendix B2 and Appendix C.

The pump station shall be capable of being operated automatically by control signals from the existing or proposed telemetry system. In addition, either one or any combination of pumps may operate at any one time by control signals from the telemetry system..

(12) Operation and maintenance manuals

(a) Manuals shall contain the following information:

(i) contractor’s name, address and telephone number;

(ii) client’s contract number, job name; and

(iii) pump station general arrangement drawing showing pumps, motors, valves, pipework, switchboard and electrical installation.

(b) Manuals for pumps shall contain the following information:

(i) manufacturer;

(ii) type and model number;

(iii) serial number;

(iv) dimensioned general arrangement drawing of pump and motor;

(v) sectional arrangement drawing with parts and list; and

(vi) dimensioned sectional arrangements detailing:

(A) maximum and minimum shaft/bearing clearance (radial);

(B) maximum and minimum impeller/bowl clearance (radial);

(C) maximum and minimum impeller/bowl clearance (axial);

(D) impeller/bowl wear rings;

(E) motor/pump coupling – type, make and model number; and

(F) mechanical seals where applicable.

(c) Manual for motors shall contain the following information:

(i) manufacturer;

(ii) type and model number;

(iii) serial number;

(iv) dimensioned general arrangement drawing;

(v) sectional arrangement drawing for submersible motor power cabling where applicable;

(vi) gland sealing arrangement drawing for submersible motor power cabling where applicable;

(vii) cables where applicable; and

(viii) terminal block arrangement drawing where applicable.

(d) Manuals for electrical equipment shall comply with TCC24 clause 23 and requirements for electrical drawings are described in TCC24 clause 22.

(e) Manuals for valves shall contain a dimensioned sectional arrangement drawing with parts and material list for all valves.

(f) Manuals shall contain the following test curves:

(i) pump witnessed test curves;

(ii) motor test curves; and

(iii) motor torque/speed/efficiency characteristic curves.

(g) The operating and maintenance manual shall include:

(i) safe working procedures - for switching and isolating the supply and distribution system;

(ii) comprehensive description of operation, including flow charts detailing each operational activity (e.g. manual pump operation, routine test procedures);

(iii) maintenance procedures - recommended maintenance periods and procedures;

(iv) tools - particulars of maintenance equipment and tools provided, with instructions for their use;

(v) equipment - a technical description of the equipment supplied, with diagrams and illustrations where appropriate;

(vi) dismantling - where necessary, procedures for dismantling and reassembling equipment; and

(vii) spare parts - a list of the spare parts provided.

Trouble shooting instructions shall be included for pumps, motors, valves and SCA.

Step by step procedures for dismantling and reassembly of pumps, motors and valves using any special tools shall be detailed together with step by step procedures for replacement of wearing parts such as bearing, seals, wear rings, etc.

SC6.4.6.3.6 Construction compliance

(1) Work-as-executed details and operation and maintenance manuals

The Contractor shall submit to the Superintendent work-as-executed design drawings showing the actual location and alignment of pipelines, maintenance holes and junctions, all pump station details together with operating and maintenance manuals.

Details shall include the size, type, levels, grade of pipelines, maintenance hole, and maintenance shaft location, types and cover details, easement requirements for maintenance, pump details, switchboard equipment details and station structural details. The Contractor shall record on work-as-executed design drawings the area of side fill which should not be disturbed in future without special precautionary measures where side fill construction is part of the structural integrity of a constructed pipeline of a diameter more than 225 mm.

The Contractor shall ensure that a registered surveyor certifies the plans showing location and alignment.

The Contractor shall provide records, for Townsville Water and Waste's Asset Register, to the Superintendent at the time of practical completion of the Contract. The records are to be in a form consistent for inputting into the Asset Register as directed by the Superintendent.

(2) Video records

Unless advised otherwise by the Superintendent, the Contractor shall provide a video recording of the internal condition of all mains. The video recording shall be undertaken at the time of practical completion of the Contract.

SC6.4.6.4 Stormwater drainage

SC6.4.6.4.1 Introduction

(1) Introduction

Drainage works shall form a complete system carrying water through and away from the Works.
This is the general sub-section common and applicable to all types of drainage lines, open drains, kerb and channel, and drainage structures and shall be read in conjunction with drainage specifications:

(a) SC6.4.6.6 Pipe drainage;

(b) SC6.4.6.7 Precast box culverts;

(c) SC6.4.6.5 Drainage structures; and

(d) SC6.4.6.9 Open drains.

(2) General scope

The work to be executed under this sub-section consists of:

(a) preparation for stormwater drainage construction;

(b) temporary drainage during construction;

(c) siting of pipes, pipe arches and box culverts;

(d) all activities and quality requirements associated with excavation and backfilling; and

(e) all concrete work associated with stormwater drainage.

Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

(3) Extent of work

Details of the work are shown on the drawings. The extent of works under this specification is summarised as follows:

(a) pipe culvert stormwater drainage;

(b) precast box culvert stormwater drainage;

(c) drainage pits, headwalls, wingwalls and aprons;

(d) kerb and channel;

(e) open concrete dish drains;

(f) scour protection of open drains at outlets to drainage structures; and

(g) demolition and removal of existing redundant pipe culverts, headwalls and pits.

(4) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this policy sub-section are as follows:
SC6.4.6.10 Earthworks (construction)
SC6.4.6.28 Minor concrete works

(b) Australian Standards
AS 1289.5.4.1 - *Compaction control test - Dry density ratio, moisture variation and moisture ratio*
AS 1289.5.7.1 - *Compaction control test Hilf density ratio and Hilf moisture variation (rapid method)*

(c) Other
International Erosion Control Association (IECA), *Best Practice Erosion and Sediment Control*

SC6.4.6.4.2 Construction

(1) Temporary drainage during construction

(a) For each part of the drainage system, complete the erosion and sedimentation control measures before commencing the drainage works (except those parts of the drainage system forming part of the control measures). Measures for erosion and sedimentation control must be provided in accordance with the requirements of the accepted project erosion and sediment control plan and/or *Best Practice Erosion and Sediment Control* and make adequate provision for runoff flows at drainage works under construction or at surrounding areas/structure.

(b) The Contractor shall make adequate provision for runoff flows at drainage works under construction to avoid damage or nuisance due to scour, sedimentation, soil erosion, flooding, diversion of flow, damming, undermining, seepage, slumping or other adverse effects to the Works or surrounding areas and structures as a result of the Contractor's activities.

(c) The Contractor shall not implement any proposals to dam up or divert existing watercourses (either temporarily or permanently) without the prior approval of council by way of approved drawings or written instruction.

(d) The Contractor's material and equipment shall be located clear of all watercourses.

(2) Siting of culverts

(a) Before commencing construction of any culvert, the Contractor shall set out on site the culvert inlet and outlet positions to the location and levels shown on the drawings, and shall present this set-out for inspection by the Superintendent.

(b) The Superintendent may amend the inlet or outlet locations or designed levels or the culvert length to suit actual site conditions. Any such amendments must ensure no negative impacts on neighbouring land parcels and existing properties. Prior approval must be sought from council.

(c) Should the Contractor propose changes to the culvert location, length, designed levels, culvert strength, conditions of installation or cover to suit the construction procedures, the Contractor shall present the proposed culvert set-out in addition to the designed set-out for consideration by the Superintendent and council. No changes shall be made unless prior written approval from council is obtained.

(3) Excavation

(a) Before undertaking stormwater drainage excavation, topsoil shall be removed in accordance with SC6.4.6.10 Earthworks (construction).

(b) In undertaking trench excavation, the Contractor shall provide any shoring, sheet piling or other stabilisation of the sides necessary to comply with statutory requirements.

(c) Where public utilities exist in the vicinity of stormwater drainage works the Contractor shall obtain the approval of the relevant authority/corporation to the method of excavation before commencing excavation.

(d) Excavation by blasting, if permitted by council, shall be carried out to ensure that the peak particle velocity measured on the ground adjacent to any previously installed culvert or drainage structure does not exceed 25mm per second. The Contractor shall comply with other requirements concerning blasting operations in SC6.4.6.10 Earthworks (construction).

(e) Trench or foundation excavation for stormwater drainage works shall be undertaken to the planned level for the bottom of the specified bedding or foundation level. All loose material shall be removed by the Contractor.

(f) Any material at the bottom of the trench or at foundation level which the Superintendent deems to be unsuitable and inadequate to support the proposed drainage structure shall be removed and disposed in accordance with SC6.4.6.10 Earthworks (construction) by the Contractor and replaced with backfill material in accordance with the requirements of this sub-section and the sub-sections for particular culvert types. The bottom of the excavated trench or foundation, after any unsuitable material has been removed and replaced, shall be parallel with the specified level and slope of the culvert.

(g) The excavated material shall be used in the construction of embankments backfilling or spoiled in accordance with SC6.4.6.10 Earthworks (construction).

(4) Backfilling

Backfilling shall be carried out in accordance with the requirements of the relevant culverts or drainage structures sub-sections and to the compaction requirements specified in SC6.4.6.4.2(5) Compaction.

In situ concrete structures are not to be backfilled in accordance with Clause 6.4.6.5.2 8(a) unless otherwise directed by the Superintendent.

The shape of the culvert must be checked by the Contractor during backfilling to ensure that on completion of backfilling, the vertical and horizontal centreline dimensions of the pipe or structure do not vary from the manufacturer's specified dimensions by more than ± 2% for pipes and pipe arches.

(5) Compaction

Foundations, bedding (other than for pipe drainage) and backfilling shall be compacted to the following requirements when tested in accordance with AS 1289.5.4.1 or AS 1289.5.7.1 for standard compactive effort.

Refer to Table SC6.4.6.4.3 for details of compaction and moisture tolerances.

Compaction requirements adjacent to pipe drainage for concrete, steel or UPVC pipes are set out in sub-section SC6.4.6.6 Pipe drainage.

(6) Concrete work

For all concrete work, the Contractor shall comply with sub-section SC6.4.6.28 Minor concrete works in relation to the supply and placement of normal class concrete and steel reinforcement, formwork, tolerances, construction joints, curing and protection.

(7) Sprayed concrete

If sprayed concrete has been specified, shown on the drawings or directed by the Superintendent, it shall comply with requirements in sub-section SC6.4.6.28 Minor concrete works.

(8) Construction traffic

If proposing to move heavy construction plant or vehicles over pipe or box culverts structures, provide verification and certification of protective measures to the Superintendent for confirmation and approval of protection measure proposed.

SC6.4.6.4.3 Limits and tolerances

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.4.3below:

Table SC6.4.6.4.3 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	**Excavation by Blasting**		
	peak particle velocity	≤25mm/sec	SC6.4.6.4.2(3)
2.	**Relative Compaction (Standard)**		
	(a) Foundations or trench base to a depth of 150mm below foundation levels	95%	SC6.4.6.4.2(5)
	(b) Material replacing unsuitable material		
	(c) Bedding material		
	(d) Selected backfill and ordinary backfill material: • other than sub-grade (sand 70% Density Index) • other than sub-grade (other than sand) • at sub-grade level to 300mm below • in a pavement zone		
	(e) Backfill material within the selected material zone		
3.	**Backfill**		
	(a) Layers	≤ 150mm	SC6.4.6.4.2(5)
	(b) Moisture Content	>60%, <95%	SC6.4.6.4.2(5)

SC6.4.6.5 Drainage structures

SC6.4.6.5.1 Introduction

(1) Scope

(a) This policy sub-section provides standards, advice and guidelines for the construction of drainage structures and shall be read in conjunction with the sub-section SC6.4.6.4 Stormwater drainage, and other drainage specifications as applicable:

(i) SC6.4.6.6 Pipe drainage;

(ii) SC6.4.6.7 Precast box culverts; and

(iii) SC6.4.6.9 Open drains.

(b) This sub-section details the construction of headwalls, wingwalls, pits, gully pits, inspection pits, junction boxes/pits, drop structures, inlet and outlet structures, energy dissipators, batter drains and other supplementary structures.

(c) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

Editors note - A reference to drawings is a reference to construction drawings.

(2) Reference and source documents
Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this sub-section are as follows:
SC6.4.6.10 - Earthworks (construction)
SC6.4.6.4 - Stormwater drainage
SC6.4.6.6 - Pipe drainage
SC6.4.6.7 - Precast box culverts
SC6.4.6.9 - Open drains
SC6.4.6.28 - Minor concrete works

(b) Australian Standards
AS 3996 - *Access covers and grates*

SC6.4.6.5.2 Construction

(1) General

(a) Drainage structures shall be constructed in concrete and in accordance with sub-section SC6.4.6.28 Minor concrete works.

(b) All structures shall be constructed as soon as practicable and shall be completed not later than 28 days after the construction of the associated culverts, unless otherwise approved by the Superintendent.

(2) Alignment

(a) Unless otherwise shown on the drawings, headwalls and pits shall be constructed parallel to the road centreline and wingwalls at 120º to the headwall or as shown on the drawings.

(b) Where the culvert is laid skew to the road, the wingwalls and headwalls shall be splayed so that the front edge of the wing bisects the angle between the centreline of the culvert and the headwall.

(c) Energy dissipaters shall be constructed in accordance with the drawings and with centreline on the axis of the culvert.

(3) Headwalls and wingwalls

(a) The wingwalls shall be constructed to retain the batters effectively. Where the dimensioned drawings do

not satisfy this requirement the Superintendent shall be notified before the headwalls and wingwalls are constructed. The Superintendent shall direct the Contractor as to the action to be taken. Where rock is encountered at the bottom of excavations for wingwalls and headwalls, and after approval is given by the Superintendent, the depth of cut-off walls in uniform rock over the full width of the foundations may be reduced to less than that shown in the drawings, but must be not less than 150 mm into sound rock.

(4) Pits

(a) All new pits, including access covers, gully grates and frames complying with AS 3996, shall be constructed to the details shown on the drawings. Modification of existing pits is only to be carried out if shown on the drawings.

(b) Where the full depth of the excavation is in sound rock, and the Superintendent approves, part of the concrete lining of gully pits and sumps may be omitted, provided that a neatly formed pit of the required dimensions is constructed. In all such cases the wall of the pit adjacent to and parallel to the road shall be constructed of concrete

(c) Inlet and outlet pipes shall be integrally cast into the pit at the time of pouring the concrete for the pit walls.

(d) Step irons are not required.

(e) A subsoil drain where required shall be installed into the pit or headwall in accordance with the general requirements in sub-section SC6.4.6.6 Pipe drainage.

(5) Precast units

(a) Where precast units including kerb inlet lintels, are provided in the design they shall be handled and installed in accordance with the manufacturer's instructions.

(b) If the Contractor proposes to use precast units, detailed drawings and complete details of installation procedures shall be submitted for the approval of the Superintendent.

(c) The Superintendent is required to adopt pre-cast units which are in accordance with council’s standard drawings and specifications unless otherwise agreed by council.

(6) Jointing

Where drainage structures abut concrete paving, kerb and channel or other concrete structures, a 10 mm wide joint shall be provided between the structure and paving, or kerb and channel or other concrete structures. The joint shall consist of preformed jointing material of bituminous fibreboard.

(7) Mass concrete bedding

(a) Mass concrete bedding for reinforced concrete bases shall not be placed on earth or rock foundations until the foundations have been inspected and approved by the Superintendent. Following such approval, the surface of the foundation shall be dampened and a layer of concrete not less than 50 mm thick, shall be placed over the excavated surface and shall be finished to a smooth even surface.

(b) Unreinforced concrete bases may be cast on earth or rock foundations without the mass concrete bedding.

(8) Backfill

(a) Backfilling shall not commence until the compressive strength of concrete has reached at least 15MPa unless otherwise approved by the Superintendent.

(b) Selected backfill shall be placed against the full height of the vertical faces of structures for a horizontal distance equal to one-third the height of the structure.

(c) Selected backfill shall consist of a granular material in accordance with the requirements in sub-section SC6.4.6.6 Pipe drainage.

(d) Special care shall be exercised to prevent wedge action against vertical surfaces during the backfilling. Where the sides of the excavation are steeper than 4 horizontally to 1 vertically they shall be cut in the form of successive horizontal terraces at least 600 mm in width, as the backfill is placed.

(e) Backfill on both sides of the structure shall be carried up to level alternately in layers so as to avoid wedge action or excessive horizontal forces. Backfilling and compaction shall commence at the wall. Compaction shall be in accordance with sub-sections SC6.4.6.4 Stormwater drainage and SC6.4.6.6 Pipe drainage.

(9) Tolerances

(a) On the completed works shall be as detailed in subsection SC6.4.6.28 Minor concrete works.

SC6.4.6.5.3 Limits and tolerances

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.5.1 below.

Table SC6.4.6.5.1 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	**Cut-off Walls**		
	Depth into sound rock	>150mm	SC6.4.6.5.2(3)
2.	**Mass Concrete Bedding**	>50mm	SC6.4.6.5.2(7)

SC6.4.6.6 Pipe drainage

SC6.4.6.6.1 Introduction

(1) Scope

(a) This sub-section covers the supply and installation of pipe culverts and pipe arches for stormwater drainage.

(b) This sub-section should be read and applied in conjunction with sub-section SC6.4.6.4 Stormwater drainage.

(c) The work to be executed under this sub-section consists of supply of pipes and pipe arches, bedding, installation and backfilling.

(d) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

(2) Reference and source documents
Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this sub-section are as follows:
SC6.4.6.10 Earthworks (construction)
SC6.4.6.4 Stormwater drainage
SC6.4.6.5 Drainage structures
SC6.4.6.21 Subsurface drainage
SC6.4.6.28 Minor concrete works

(b) Australian Standards
AS 1141.11 - *Particle size distribution –sieving method.*
AS 5101.4 - *Unconfined compressive strength of compacted materials.*
AS/NZS 1254 – *PVC-U pipes and fittings for stormwater or surface water applications.*
AS 1289.3.3.1 - *Calculation of the plasticity index of a soil.*
AS 1289.5.4.1 - *Compaction control test - Dry density ratio, moisture variation and moisture ratio*
AS 1289.4.3.1 - *Determination of the pH value of a soil - Electrometric method.*
AS 1289.4.4.1 - *Determination of the electrical resistivity of a soil – Method for sands and granular materials.*
AS 1289.5.6.1 - *Compaction control test - Density index method for a cohesionless material.*
AS 1397 – *Continuous hot-dip metallic coated steel sheet and strip – coatings of zinc and zinc alloyed with aluminium and magnesium.*
AS 1646 - *Elastomeric seals for waterworks purposes.*
AS 1762 - *Helical lock-seam corrugated steel pipes - Design and installation.*
AS/NZS 2032 - *Installation of PVC pipe systems.*
AS/NZS 2041 - *Buried corrugated metal structures.*
AS/NZS 2566.1 - *Buried flexible pipelines - structural design*
AS/NZS 2566.2 – *Buried flexible pipelines - Installation*
AS/NZS 2666.1 - *Buried flexible pipes*
AS/NZS 3725 – *Design for installation of buried concrete pipes*
AS/NZS 3750.9 – *Paints for steel structures - Organic zinc-rich primer.*
AS/NZS 3750.15 - *Paints for steel structures - Inorganic zinc silicate paint.*
AS 4058 - *Precast concrete pipes (pressure and non-pressure).*
AS/NZS 4131 - *Polyethylene (PE) compounds for pressure pipes and fittings*.
AS 4139 - *Fibre reinforced concrete pipes and fittings.*
AS/NZS 4680 - *Hot-dip galvanised (zinc) coatings on fabricated ferrous articles.*
AS/NZS 5065 - *Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications.*
AS/NZS ISO 9001:2008 *(as amended) - Quality management systems - Requirements*.

(c) Department of Transport and Main Roads Technical Standards

MRS 25 - Manufacture of pre-cast concrete pipes (06/09)
MRS 26 - Manufacture of fibre reinforced concrete drainage pipes (10/12)

(d) Other
AASHTO Standard, *M190 - Bituminous coated corrugated metal culvert pipe and pipe arches.*
ASTM F2562/F2562M-08 - *Specification for steel reinforced thermoplastic ribbed pipe and fittings for non-pressurised drainage and sewerage*
Safety in Design CWPHESS

SC6.4.6.6.2 Common requirements

(1) General

(a) Pipes and/or pipe arches shall not be placed in position until the Contractor has produced documentary evidence to the Superintendent, that the manufacture of the products to be used in the works has complied with the Manufacturer's Quality Plan in accordance with ISO 9001.

(b) Documentation shall comprise a conformance certificate to AS 4058 or AS 4139 as appropriate for each batch of pipes or pipe arches to be included in the works, including manufacturer's installation recommendations. The above documentations certificates are to be supplied at least 24 hours in advance of dispatch to site.

Note—Table 3.6 of AS 4058 shall be replaced by Table 4-C of *MRS 25 - Manufacture of Precast Concrete Pipes* in determining the acceptability of pipe wall and joint surface defects.

(c) Each unit shall be marked at time of manufacture with:

(i) class and size;

(ii) manufacturer's name; and

(iii) date of casting.

(d) Where a Contractor wishes to use drainage pipe other than the pipes described in SC6.4.6.6.3(1) to (5) inclusive, the Contractor shall submit, for agreement by the Superintendent, full details in accordance with AS/NZS 2566.1 of the characteristics of the pipe materials and embedment and design loads, together with certification from the manufacturer of its suitability and quality for use in each particular application. Certification of the suitability of any pipe will address the bedding requirements, deflection, strength, buckling and any other considerations appropriate to the particular application. Upon agreement, the Superintendent must submit an application for a variation to the development consent for approval by council.

(e) The Contractor shall take all necessary steps to drain the excavation to allow the foundation, the bedding and any backfilling to be compacted to the specified relative compaction.

(f) Culverts shall be installed within 10mm of the grade line and within 50mm of the horizontal alignment specified on the drawings. The Contractor shall relay any culvert which is not within these tolerances. Where longitudinal gradients are less than 0.5 per cent, culverts shall be installed within +/- 6mm of the grade line'.

(g) Where shown on the drawings at the discharge end of culverts terminating at pits and headwalls a 3m length of 100mm diameter subsurface drain shall be laid in the trench 100mm above the invert level of the culvert and discharging through the wall of the pit or headwall at 100mm above the invert level of the culvert or headwall. The subsurface drainage pipe shall be sealed at the upstream end and shall be enclosed in a seamless tubular filter fabric in accordance with SC6.4.6.21 Subsurface drainage.

(h) Excavation and backfilling for pipe drainage shall be undertaken in a safe manner and in accordance with all statutory requirements. The Contractor must present to the Superintendent the installed pipe drainage upon completion of backfill to the top side of the side zone for inspection prior completion of backfill.

(i) Where the Contractor proposes to travel construction plant in excess of 5 tonnes gross mass over pipe drainage structures, the Contractor shall design and provide adequate protective measures for the crossings and shall submit the proposals to the Superintendent for prior approval.

(j) Upon completion of installation of pipe drainage, the Contractor shall submit relevant test results to demonstrate compliance to the requirements indicated on clauses

SC6.4.6.6.3 Precast reinforced concrete and fibre reinforced concrete pipes

(1) Pipes

(a) Precast reinforced concrete pipes shall comply with AS 4058 and shall be of the class and size as shown on the drawings.

Note—Table 3.6 of AS 4058 shall be replaced by Table 4-C of *MRTS2 - Manufacture of Precast Concrete Pipes* in determining the acceptability of pipe wall and joint surface defects.

(b) Fibre reinforced concrete drainage pipes shall comply with AS 4139 and shall be of the class and size as shown on the drawings.

(c) Unless specified otherwise, joints shall be flush type with external elastomeric bands complying with AS 1646 and as recommended by the manufacturer.

(d) Where precast pipes are to be installed into a marine or saline environment, the contractor is to ensure and provide documentation that the supplied pipes are “fit for purpose” and are suitable for the intended site application.

(2) Excavation

(a) Unless otherwise indicated on the drawings, or approved by the Superintendent, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition.

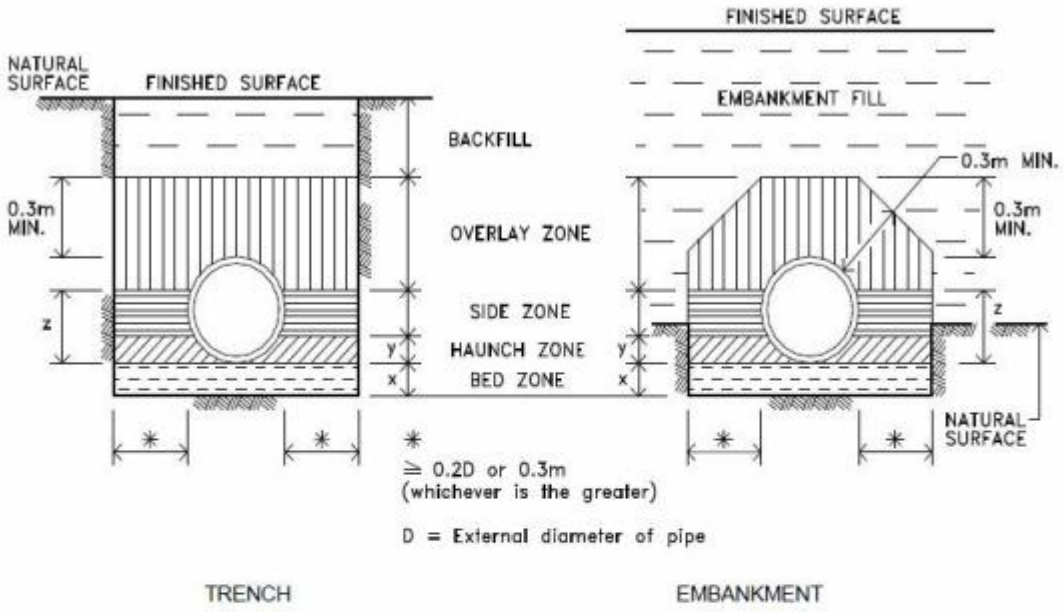
(b) For normal trench conditions, the pipe shall be laid in an excavated trench with bedding as specified in SC6.4.6.6.2(3). The trench shall be excavated to a width as specified in Figure SC6.4.6.6.1.

(c) Care is necessary to avoid laying pipe drainage in trenches excavated to excessive width. Pipes laid in wide trench conditions will be deemed to be in embankment conditions (positive projection). Wide trench conditions apply when, for a single pipe, the width of trench, $W \geq D + 0.6$ metre where D is the pipe diameter. For multi-cell pipes wide trench conditions apply when the width of trench, $W \geq \sum D + \sum S + 0.6$ metre where S is the square spacing between the pipelines. This definition of wide trench conditions as equivalent to embankment conditions relates to the size and geometry of the excavation utilised at construction. Pipes shown on the drawings to require trench conditions shall not be placed under embankment conditions without a design check for compliance of the pipe strength and trench support requirements in accordance with AS 3725.

(3) Bedding

(a) Bedding shall be in accordance with this sub-section, AS 3725 and AS 3725 Supplement 1 for the pipe support types as shown on the drawings. Where the pipe support type is not shown on the drawings, the support type shall be HS3 within road reserves (HS3 is recommended for high embankment fill) and H2 elsewhere.

(b) Figure SC6.4.6.6.1 below and Table 5 – Bedding factors for Working Dead Loads (U, H and HS Supports) in AS/NZS 3725 indicate the dimensions of bedding and backfilling for pipes laid in trench conditions and embankment conditions for all AS 3725 pipe support types.



		Pipe Support Type						
		U	H1	H2	H3	HS1	HS2	HS3
Dimension (minimum)	x	75 on rock Nil on soil	100 for D ≤ 1500 150 for D > 1500		0.25 D but >100	100 for D ≤ 1500 150 for D > 1500		
	y	—	0.1D	0.3D	0.3D	0.1D	0.3D	0.3D
	z	—	—	—	—	≥ 0.7D		

D = External diameter of pipe

Figure SC6.4.6.6.1 Pipe installation conditions

(c) Bedding material for the bed and haunch zones shall consist of a granular material having a grading, determined by AS 1141.11, complying with Table SC6.4.6.6.1 Bedding Material Grading Limits, and a Plasticity Index, determined by AS 1289.3.3.1 of less than 6. Select fill material in the side zones, for pipe support type HS, shall also comply with Table SC6.4.6.6.1.

Table SC6.4.6.6.1 Bedding material grading limits

Sieve size mm	Weight passing %	
	Bed and Haunch Zones	Side Zones/Overlay Zones
75.0	-	100
19.0	100	-
9.5	-	50 - 100
2.36	50 -100	30 - 100
0.60	20 - 90	15 - 50
0.30	10 - 60	-
0.15	0 - 25	-
0.075	0 - 10	0 - 25

(d) The Contractor shall advise the Superintendent of the source of bedding material.

(e) All material shall be compacted in layers not exceeding 150mm compacted thickness except where explicitly approved by the Superintendent, for the first placed layer above the pipe crown in the overlay zone, in order to protect the pipe from construction damage. Each layer shall be compacted to the relative compaction specified before the next layer is commenced. Cohesionless materials can be

compacted in one operation by saturation and vibration to achieve the minimum Density Index (DI) specified.

(f) At the time of compaction, the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content which, unless otherwise approved by the Superintendent, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.4.1 (standard compaction).

(g) Compaction of select fill material in the bed and haunch zones shall be to the appropriate pipe support requirements shown in Table 5 – Bedding factors for Working Dead Loads (U, H and HS Supports) in AS/NZS 3725, when tested in accordance with AS 1289.5.6.1. H3 Pipe Support includes concrete bedding. Concrete shall be grade N20 to AS 3600. Pipe shall be suitably reinforced in accordance with AS 3725 as standard elliptically reinforced pipe may not be adequate for H3 Pipe Support. Unless specifically selected pipes are nominated for use with H3 bedding, a design check shall be required to confirm the suitability of the proposed pipes.

(h) The top 0.1Dmm of the bedding and haunch material directly under the pipe shall be placed and shaped accurately to house the pipe after compaction is achieved in the bedding and haunch zone external to the area of direct pipe support.

(i) Where the impermeability of the natural ground and the slope of the drainage line is such that erosion of bedding material is considered by the Superintendent to be a likely problem, the Superintendent may specify cementitious stabilisation of the bedding material used in the bedding and haunch zones.

(4) Installation

(a) General

Pipes shall be laid with the socket (female) end placed upstream. Pipes which have marks indicating the crown or invert of the pipes shall be laid strictly in accordance with the markings. Unless specified, no individual length of pipe shall be shorter than 1.2m.

The contractor is to ensure that all trenching is to conform to the requirements of *Work Cover Queensland – Handbook Building and Construction Industry WHS Guide*.The contractor must ensure that if a person is entering a trench more than 1.5m deep, one of the following control measures is to be implemented:

(i) Has shoring or shielding in place;

(ii) The trench is benched not higher than 1.5m;

(iii) The trench is battered - angle not exceeding 45º and the bottom vertical face is not to exceed 1.5m high;

(iv) Is approved as a safe work place (in writing) by a suitably qualified geotechnical engineer.

Pipes can be stiffened temporarily by the use of timber structs, erected before filling is placed. Struts shall be of hardwood measuring at least 100mm by 100mm or 125mm diameter. One strut shall be placed in a vertical position at each pipe joint, thence at a spacing not greater than 1,200mm. Struts shall bear against a sill laid along the invert of the pipe and a cap bearing against the crown of the pipe. Both the sill and the cap shall be continuous throughout the length of the pipe. Struts shall be made to bear tightly against the pipe by the use of wedges between the top of the struts and the cap. Struts, sills and caps shall be removed on completion of the embankment, unless removal is ordered earlier.

Lifting holes in all pipes shall be sealed with plastic preformed plugs approved by the Superintendent, or a 3:1 sand:cement mortar, before the commencement of backfilling.
Bulkheads shall be constructed in accordance with SC6.4.6.5 Drainage structures on all lines where the pipe gradient exceeds 5 per cent.

The Contractor shall present the laid and jointed pipes for inspection by the Superintendent prior to commencement of trench backfilling.

(b) Joints in reinforced concrete pipes

(i) Rubber Ringed Joints

Before making the joint, the spigot and socket and the rubber ring shall be clean and dry.

The rubber ring shall be stretched on to the spigot end of the pipe, square with the axis and as near as possible to the end, care being taken that it is not twisted. The spigot end of the pipe shall then be pushed up to contact the socket of the pipe with which it is to join, and be concentric with it. The spigot end shall then be entered into the socket of the already laid pipe and forced home by means of a bar, lever and chain, or other method approved by the Superintendent.

The joint shall be tested to ensure that the rubber ring has rolled evenly into place.
Where wedge shaped “skid” rubber rings are prescribed the Manufacturer’s instructions, which include the use of lubricants, shall be followed.

(ii) Flush or butt jointsThe ends of the pipes shall be butted together so as to be as tight and as even as possible.

The joints shall be sealed externally with proprietary E.B bands, supplied and installed in accordance with the manufacturer's recommendations, care being taken that the bands are not twisted.

(c) Joints in fibre-reinforced cement pipes

(i) New Pipes
Joints shall be of a flexible type. Rubber rings shall be used to seal joints in both rebated and spigot and socket jointed pipes in the manner specified in SC6.4.6.6.3(4) Installation.
Alternatively, a jointing compound comprising plasticised butyl rubber and inert fillers may be used to seal such pipes in accordance with the manufacturer's instructions.

(ii) Direct Side Connections to Other Pipes
Direct side connections to other pipes shall be as detailed on the drawings.

(5) Backfill

(a) Select fill material to the side zones shall be compacted to the requirements shown in Table 5 – Bedding factors for Working Dead Loads (U, H and HS Supports) of AS/NZS 3725 when tested in accordance with AS 1289.5.4.1 for standard compactive effort.

(b) Ordinary fill to the side zones and overlay zones, for all pipe support types, except type HS shall consist of Selected Backfill as defined in SC6.4.6.10 Earthworks (construction) or alternatively cohesionless material in accordance with Table 6.4.6.6.1 Bedding material grading limits. It shall be placed around the pipe to the dimensions shown in Figure SC6.4.6.6.1 Pipe installation conditions.

(c) All material shall be compacted in layers not exceeding 150mm compacted thickness. Each layer shall be compacted to the relative compaction specified before the next layer is commenced, or compacted in one operation by saturation and vibration to achieve a minimum Density Index as specified in Table 5 – Bedding factors for Working Dead Loads (U, H and HS Supports) of AS/NZS 3725.

(d) At the time of compaction, the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content which, unless otherwise approved by the Superintendent, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.4.1 (standard compaction).

(e) The remainder of the trench to the underside of the subgrade, or selected material zone as specified in SC6.4.6.10 Earthworks (construction), shall be backfilled with material satisfying the requirements for embankment material as defined in SC6.4.6.10 Earthworks (construction). Where excavation is approved through the selected material zone, the section of trench within the select material zone shall be backfilled with selected material as defined in SC6.4.6.10 Earthworks (construction).

(f) When compacted adjacent to culverts or drainage structures, the Contractor shall adopt compaction methods which will not cause damage or misalignment to any culvert or drainage structure. Any damage

caused shall be rectified by the Contractor. Backfilling and compaction shall commence at the pipe or wall so as to confine remaining uncompacted material at commencement.

SC6.4.6.6.4 Steel pipes and pipe arches

(1) Nestable steel pipe and drainage units

(a) Nestable steel pipes and drainage units shall be supplied in accordance with AS 2041 and shall be of the class and size as shown on the drawings

(b) The galvanised steel sheets used in manufacture shall comply with AS 1397 for steel base grade G250 and a minimum coating Class of Z600.

(c) Where specified, the pipes and drainage units shall be given a protective coating over the steel, after assembly of a coal tar epoxy paint or equivalent as approved by the Superintendent, to a thickness of 400 microns.

(d) Field cut ends shall be carefully wire brushed to remove any scale followed immediately by two coats of zinc-rich organic primer complying with AS/NZS 3750.9 or two coats of inorganic zinc silicate paint complying with AS/NZS 3750.15.

(2) Helical lock-seam corrugated steel pipe

(a) Helical lock-seam corrugated steel pipe shall be supplied in accordance with AS 1761 and AS 1762 and shall be of the class and size as shown on the drawings.

(b) The galvanised steel sheet used in manufacture shall comply with AS 1397 for steel based grade G250 and a minimum coating Class of Z600.

(c) Unless otherwise approved by the Superintendent, no part of the pipe shall incorporate steel strips which have been joined by welding. Field cut ends shall be carefully wire brushed to remove any scale followed immediately by two coats of organic zinc-rich primer complying with AS/NZS 3750.9 or two coats of inorganic zinc silicate paint complying with AS/NZS 3750.15. Pipes and coupling bands shall be given a protective hot-dip coating of bitumen on both sides to AASHTO standard M190 or equivalent as part of the process of manufacturing.

(3) Bolted steel pipes, pipe arches and special shapes

(a) Bolted steel pipes, pipe arches and special shapes shall be supplied in accordance with AS 2041 and shall be of the class and size as shown on the drawings. The corrugated pipe or plate shall be hot-dip galvanised on both sides after fabrication in accordance with the requirements for coating thickness and mass for articles in AS/NZS 4680.

(b) Also, after assembly, all bolted steel pipes, pipe arches and special shapes shall be given a protective coating on the outside of the steel plate, of a coal tar epoxy paint complying with AS 3887 or equivalent paint approved by the Superintendent. Invert plates shall be coated on the outside before they are placed on the pipe bed. The plate surface shall be cleaned and degreased with a cleaning solution recommended by the protective coating manufacturer. The protective coating shall be applied to give a uniform minimum dry thickness of 400 microns. Any coating damaged shall be recoated by first cleaning any grease, mud or other foreign matter from the affected area. The area shall then be recoated so that the minimum dry thickness of the coating is 400 microns.

(4) Materials and surface treatment of steel pipes and pipe arches

All steel pipes and pipe arches will require an Engineer's certification that the pipe materials and surface treatments are adequate to provide for installation and in-service loading, as well as corrosion protection for a satisfactory design life of 100 years, unless indicated otherwise on the drawings. Such certification shall address the chemistry of the soil, groundwater, stream and backfill material as specified SC6.4.6.6.4(5).

(5) Materials against steel structures

(a) The severity of corrosive attack on steel structures will depend on the pH value and electrical resistivity of the soil surrounding the structure and the pH value of the water in the stream.

(b) Besides meeting the normal requirements of the bedding, selected backfill materials and the materials used for embankment construction above the steel structures and within a horizontal distance from the structure equal to the height of the filling over the structure, the pH and resistivity limits as shown in Figure SC6.4.6.6.2 will determine the level of corrosion protection required.

(c) Notwithstanding the height of fill, embankment material within 6m of the structure shall conform to these requirements.

(d) The pH and electrical resistivity of the material shall be determined in accordance with AS 1289.4.3.1 and AS 1289.4.4.1.

(e) The Contractor shall nominate the sources of the various materials and submit documentary evidence from a NATA registered laboratory that the representative samples conform to the requirements of this clause and the protective treatment provided. The samples shall be pre-treated if necessary so as to represent the condition and grading when compacted and in service.

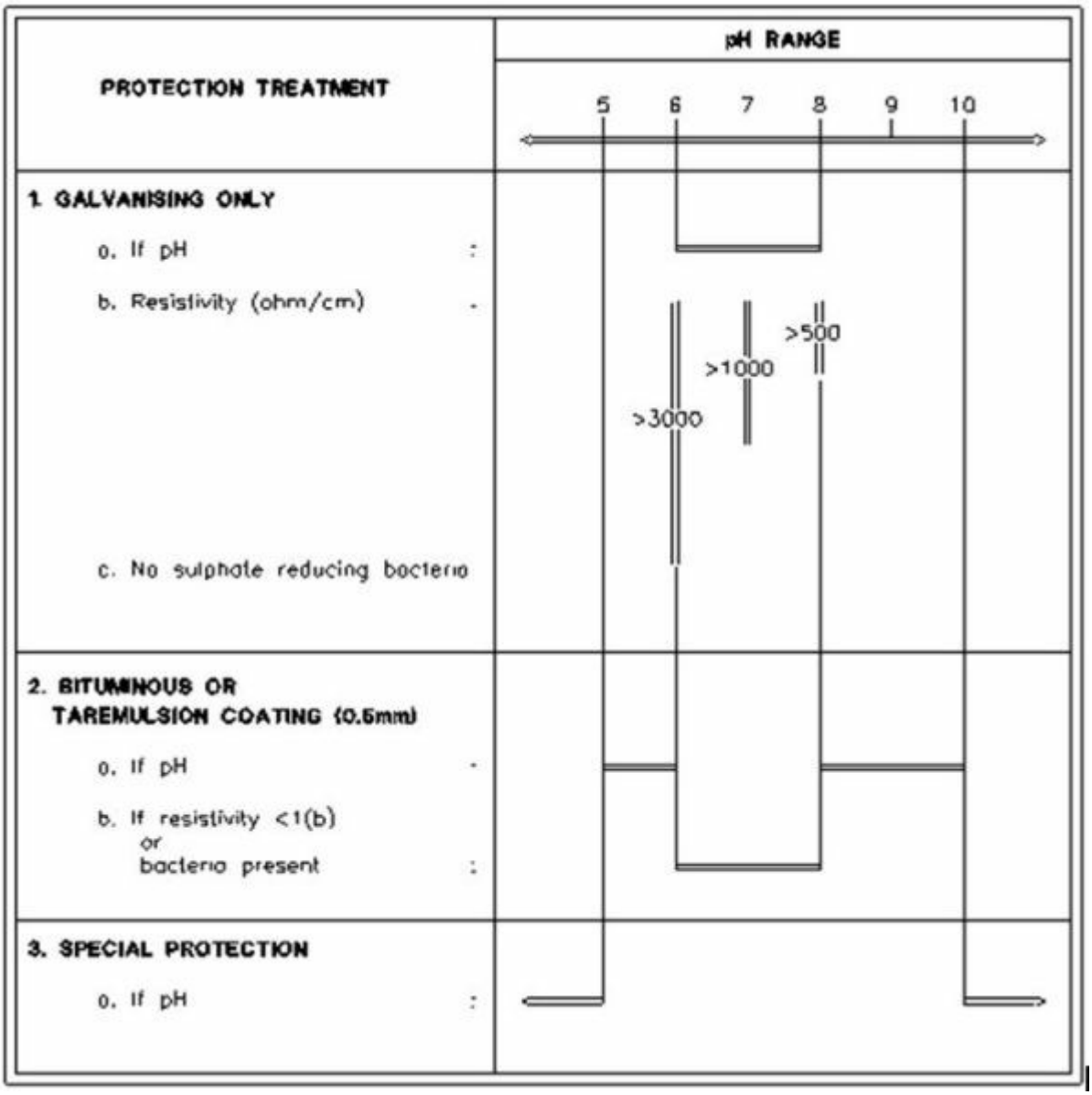


Figure SC6.4.6.6.2 Corrosion protection requirements for steel structures

(6) Excavation and foundation preparation

(a) Unless otherwise indicated on the drawings or approved by the Superintendent, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition.

(b) The trench shall be excavated to a level 75mm below the design invert and for a minimum width of 600mm on each side of the structure.

(c) Where unsuitable material, as determined by the Superintendent, is encountered at the foundation level,

it shall be removed to a depth approved by the Superintendent. The additional excavation shall be backfilled with material complying with, selected material as per SC6.4.6.10 Earthworks (construction).

(d) Where rock is encountered at the foundation level, the foundation shall be excavated for an additional depth of 250mm, or 0.25 times the structure width, whichever is the lesser and for a width equal to the width of the structure. The additional excavation shall be backfilled with material complying with, and compacted to, the requirements for HS3 pipe support as specified in SC6.4.6.6.3 3(b).

(7) Bedding

Bedding shall meet the requirements of SC6.4.6.6.3(3)(f). The thickness of uncompacted bedding material between the foundation and the outer surface of corrugation shall not be less than 75mm. The uniform blanket of loose material which provides the minimum 75mm thick bedding, shall be placed on the shaped, compacted selected material foundation to allow the corrugations of the structure invert to bed in and become filled with the material.

(8) Installation

(a) General

The assembly of all corrugated steel pipes and pipe arches as well as helical lock-seam corrugated steel pipes shall be carried out in accordance with the manufacturer's recommendations. These recommendations shall be submitted to the Superintendent before assembly or laying of the culverts is commenced.

If deemed necessary after consultation with the manufacturer, temporary bracing of corrugated steel pipes or pipe arches shall be carried out in accordance with the manufacturer's recommendations.

(b) Joints

Corrugated steel pipes or pipe arches shall be joined in accordance with the manufacturer's recommendations and AS 2041.

Where helical-lock seam corrugated steel pipes are to be joined, both ends of the join shall be rerolled with four annular corrugations of pitch 68mm. Coupling of the re-rolled ends shall be made in accordance with AS 1761 by using semi-corrugated bands. Rubber ring joint seals shall be used in conjunction with the coupling bands except where specifically indicated otherwise in the drawings.

All joints or lap joints in pipes or pipe arches (excluding rubber ring joint coupling bands) shall be covered with strips of non-woven geotextile material, of minimum 250mm width and of minimum mass 270 grams per square metre in accordance with the requirements for geotextile in SC6.4.6.20 Subsoil, foundation and pavement drains, to prevent loss of sand backfill or bedding into the pipe.

(9) Backfill

(a) Compaction of the material in the side support and overlay zones shall comply with the requirements of clause SC6.4.6.6.3(7) except that the required relative compaction in the side support and overlay zones shall be 95 per cent (AS 1289.5.4.1 standard compaction). Backfill shall be placed around the steel pipe or structure, to a minimum dimension equal to the pipe width, on both sides.

(b) All material shall be compacted in layers not exceeding 150mm compacted thickness. Each layer shall be compacted to the relative compaction specified before the next layer is commenced.

(c) At the time of compaction, the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content which, unless otherwise approved by the Superintendent, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.4.1 (standard compaction).

(d) The remainder of the trench to the underside of the subgrade, or selected material zone as specified in SC6.4.6.10 Earthworks (construction), shall be backfilled with material satisfying the requirements for embankment material as defined in SC6.4.6.10 Earthworks (construction). Where excavation is approved through the selected material zone, the section of trench within the select material zone shall be backfilled with selected material as defined in SC6.4.6.10 Earthworks (construction).

(e) The Contractor shall check the shape of the culvert during backfilling to ensure that on completion of backfilling, the vertical and horizontal centreline dimensions of the pipe or structure shall not vary from the manufacturer's specified dimensions by more than plus or minus 2 per cent for pipes and pipe arches.

(10) Invert protection of corrugated steel pipes and pipe arches

(a) Where shown on the drawings, the invert of corrugated steel pipes and pipe arches shall be protected using sprayed concrete.

(b) The sprayed concrete shall be placed to a thickness of not less than 100mm over the crest of the corrugations and to a width such that the bottom third of the pipe circumference is covered symmetrically about the invert of the pipe.

(c) All foreign material shall be removed from the surface to be protected. Where corrosion has occurred all loose scale shall be removed.

(d) The production, application and curing of sprayed concrete shall be in accordance with sub-section SC6.4.6.28 Minor concrete works.

(e) The sprayed concrete shall be reinforced with a fabric of hard drawn steel wire 4mm diameter with 200mm square mesh. The fabric shall be securely supported at a central location within the sprayed concrete by non-metallic supports.

(f) Laps in fabric shall be 300mm and a cover of 50mm of sprayed concrete shall be provided to the fabric at all edges.

(g) Immediately after placement of the sprayed concrete, all free water shall be removed and the surface coated with cement slurry.

(h) No water shall be allowed to flow over the surface of the sprayed concrete for twenty-four hours after the placement of sprayed concrete.

SC6.4.6.6.5 UPVC pipes

(1) Materials

(a) Unplasticised PVC (UPVC or similar material) Pipes and Fittings shall be manufactured in accordance with AS/NZS 1254 and shall be of the type and size as shown on the drawings. Where pipes with extreme external diameter are equal to or greater than 450mm (375mm nominal internal diameter) are proposed, a separate approval from the Superintendent and council is required.

(b) Embedment material in the bedding, side support and overlay zones shall be in accordance with bed and haunch zone material in SC6.4.6.6.3(7).

(c) Trench backfill material shall satisfy the requirements for embankment material as defined in SC6.4.6.10 Earthworks (construction).

(2) Excavation and bedding

(a) Unless otherwise indicated on the drawings or approved by the Superintendent, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition.

(b) Figure SC6.4.6.6.3 and Table SC6.4.6.6.2 indicate the dimensions of bedding and backfilling for pipes laid in trench conditions and embankment conditions, unless otherwise indicated on the drawings.

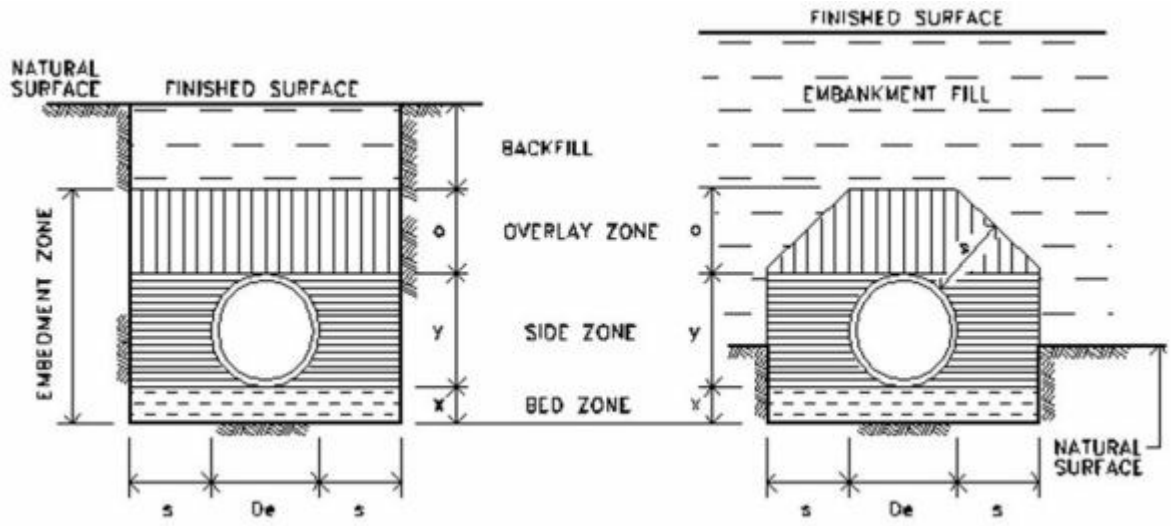


Figure SC6.4.6.6.3 Pipe installation conditions

Table SC6.4.6.6.2 Trench and embedment dimensions

Extreme External	Minimum Dimensions (mm)			
Dia (De)mm	x	s	o	y
³75 £150	75	100	100	Pipe dia.
>150 £300	100	150	150	Pipe dia.
>300 £450	100	200	150	Pipe dia.

Note - Where multiple pipes are laid side by side, the minimum distance between the pipes shall be dimension “s” for the larger of adjacent pipes.

(c) Bedding zone material shall be placed and compacted in accordance with the requirements in Table 5.5 of AS/NZS 2566.2.

(3) Installation

(a) Embedment of the UPVC pipe shall be in accordance with the requirements of AS/NZS 2566.2 and to the dimensions shown in Figure SC6.4.6.6.

(b) Pipe laying shall be in accordance with Part 7 of AS 2032 and solvent-cement pipe jointing shall be in accordance with Part 3 of AS 2032. Jointing may be performed with the pipes either in the trench or at ground level. All pipes, or jointed pipelines, shall be lowered into the trench without being dropped. Pipelines shall be placed so that joints are not strained.

(4) Backfill

(a) Compaction of the material in the side support and overlay zones shall comply with the requirements of SC6.4.6.6.3(7) for HS3 support type.

(b) All material shall be compacted in layers not exceeding 150mm compacted thickness. Each layer shall be compacted to the relative compaction specified before the next layer is commenced, or compacted in one operation by saturation and vibration to achieve a minimum Density Index as specified in Table 5.5 of AS/NZS 2566.2 – Buried Flexible Pipelines – Installation.

(c) At the time of compaction, the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content, which, unless otherwise approved by the Superintendent, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.4.1 (standard compaction).

(d) The remainder of the trench to the underside of the subgrade, or selected material zone as specified in SC6.4.6.10 Earthworks (construction), shall be backfilled with material satisfying the requirements for embankment material as defined in SC6.4.6.10 Earthworks (construction). Where excavation is approved through the selected material zone, the section of trench within the select material zone shall be

backfilled with selected material as defined in SC6.4.6.10 Earthworks (construction).

SC6.4.6.6.6 Limits and tolerances

The limits and tolerances for materials and product performance related to the various clauses in this sub-section are summarised in Table SC6.4.6.6.3 Summary of Limits and Tolerances below.

Table SC6.4.6.6.3 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
	Culvert Position	± 10mm	SC6.4.6.6.1(3)
	(a) Grade Line	± 6mm	
	(b) Grade line <0.5%		
	(c) Horizontal Alignment	± 50mm	SC6.4.6.6.1(3)
	Bedding		
	(a) Bed and Haunch Zone Compaction	Table 5 – Bedding factors for Working Dead Loads (U, H and HS Supports) of AS/NZS 3725	SC6.4.6.6.3(3)
	Backfill - Concrete Pipes	Table 5 – Bedding factors for Working Dead Loads (U, H and HS Supports) of AS/NZS 3725	SC6.4.6.6.3(5)
	(a) Side and Overlay Zone Compaction		
	Backfill - Steel Pipes		
	(a) Side and Overlay Zone Compaction	Table 5 – Bedding factors for Working Dead Loads (U, H and HS Supports) of AS/NZS 3725, HS3	SC6.4.6.6.4(9)
	(b) Pipe/Structure		
	(i) Horizontal and Vertical Variation	< 2% of specified dimensions	SC6.4.6.6.4(9)
	Sprayed Concrete		
	(a) Over crest of corrugations over bottom third of pipe circumference	> 100mm	SC6.4.6.6.4(10)
	Bedding Zone Compaction	DI 70	SC6.4.6.6.5(2)
	Backfill - UPVC Pipes		
	(a) Side and Overlay Zone Compaction	[3]95%, DI 70	SC6.4.6.6.5(4)

SC6.4.6.7 Precast box culverts

SC6.4.6.7.1 Introduction

(1) Scope

(a) This sub-section covers the installation of precast concrete box culverts and should be read in conjunction with sub-section SC6.4.6.4 Stormwater drainage.

(b) The work to be executed under this Specification consists of:

(i) preparation of foundations;

(ii) provision of bedding;

(iii) construction of base slabs

(iv) installation of precast culvert units;

(v) headwalls and wingwalls;

(vi) backfilling against structures;

(vii) provision and removal of coffer dams; and

(viii) excavation of inlet and outlet channels.

(c) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Supervision and construction guidelines.

(2) Reference and source documents
Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this sub-section are as follows:
SC6.4.6.10 Earthworks (construction)
SC6.4.6.4 Stormwater drainage
SC6.4.6.9 Open drains
SC6.4.6.12 Flexible pavements
SC6.4.6.28 Minor concrete works

(b) Australian Standards
AS1597.1 - *Precast reinforced concrete box culverts - Small culverts*
AS1597.2 - *Precast reinforced concrete box culverts - Large culverts*
AS/NZS ISO 9001:2008 - *Quality management systems - Requirements.*

(c) Other
Austroads, *Guide to Geotextiles*
Department of Transport and Main Roads
MRTS05 - *Unbound Pavements*
MRTS24 - *Manufacture of precast concrete culverts*

SC6.4.6.7.2 Materials

(1) Culvert units, link and base slabs

(a) The supply and testing of precast reinforced concrete box culvert units, link and base slabs shall be in accordance with MRTS24 with the following alterations or additional requirements:

(i) proof load testing shall be arranged by the Contractor in batches as specified in either AS 1597.1 or AS 1597.2 as appropriate;

(ii) proprietary lifting anchors shall be provided in the culvert units, link and base slabs;

(iii) delivery and unloading shall be the Contractor's responsibility; and

(iv) the supplier shall implement and maintain a Quality System in accordance with ISO 9001 to ensure materials, manufacture and proof load testing conform to the appropriate Standards.

(b) A conformance certificate, to MRTS24 shall be submitted to the Superintendent at least 3 working days prior to despatch.

(c) Each unit shall be marked at time of manufacture with:

(i) type and size;

(ii) casting date;

(iii) manufacturer's name; and

(iv) inspection pass and date.

(2) Handling, delivery and storage

(a) Ensure adequate equipment and load shifting machineries are available for safe handling and unloading

(b) Upon delivery of precast units, ensure that the following criteria have been achieved:

(i) 70% of the minimum concrete strength;

(ii) small culvert units: Cured to AS 1597.1 clause 2.6.3; and

(iii) large culvert units: Cured to AS 1597.2 clause 2.7.

(c) Prior inspection of the stored precast box culvert units is to be undertaken for dimensional accuracy and defects following delivery. Results of the inspections must show that the units conform to the following:

(i) small culvert unit: To AS 1597.1; and

(ii) large culvert unit: To AS 1597.2

(3) Concrete

The concrete and reinforcement for cast-in-situ base slabs shall comply with sub-section SC6.4.6.28 Minor concrete works.

(4) Selected backfill

The quality of selected backfill shall comply with the requirements in AS 1597.2, or alternatively comply with the requirements of side/overlay zone materials in Table SC6.4.6.6.1 *Bedding material grading limit* of sub-section SC6.4.6.6 Pipe drainage.

(5) Ordinary backfill

Ordinary backfill is material obtained from culvert excavations, cuttings and/or borrow areas which are in accordance with the requirements for the upper 0.3 m of embankment construction as detailed in SC6.4.6.10 Earthworks (construction).

SC6.4.6.7.3 Construction

(1) Coffer dams

(a) At some sites it may be expedient for the Contractor to construct a coffer dam. The construction of coffer dams shall be the responsibility of the Contractor.

(b) Coffer dams shall be sufficiently watertight to prevent damage of the concrete by percolation or seepage through the sides, and shall be taken sufficiently below the level of the foundations to prevent loosening of the foundation materials by water rising through the bottom of the excavation. Coffer dams shall be adequately braced and shall be so constructed that removal will not weaken or damage the structure.

(c) A coffer dam may be constructed to the actual size of the reinforced concrete invert slab and used as side forms for the concrete. The details of the coffer dam and formwork, and the clearances proposed shall be subject to the approval of the Superintendent, but the Contractor shall be responsible for the successful construction of the work.

(d) Coffer dams which have tilted or have moved laterally during sinking, shall be righted or enlarged to provide the clearances specified. This work will be at the Contractor's expense.

(e) No timber or bracing shall be left in the concrete or in the backfill of the finished structure. Coffer dams, including temporary piles, shall be removed at least to the level of the invert after completion of the

structure. Upon completion of works, remove coffer dams, including temporary piles, at least to the level of the culvert invert after completion of the structure. Ensure that no material associated with the coffer dam or dewatering can enter the culvert.

(2) Excavation

Excavation shall be carried out in accordance with the provisions in sub-section SC6.4.6.4 Stormwater drainage.

(3) Foundations

(a) Rock foundations shall be neatly excavated to the underside of the mass concrete or selected fill bedding shown on the drawings. All minor fissures shall be thoroughly cleaned out and refilled with concrete, mortar or grout. All loose material shall be removed.

(b) Where rock is encountered over part of the foundation only, or lies within 300mm below the underside of the mass concrete or selected fill, all material shall be removed to a depth of 300mm below the mass concrete or selected fill for the full width of the foundation over the length where the rock is encountered. This additional excavation shall be backfilled with ordinary backfill material.

(c) Over-excavation or uneven surfaces shall be corrected with mass concrete so as to provide a uniform surface at least 50mm above the highest points of rock.

(d) Earth foundations shall be finished to line and level to the underside of bedding shown on the drawings. Care shall be taken to avoid disturbing material below this level.

(e) All soft, yielding or unsuitable material shall be removed and replaced with ordinary backfill material as directed by the Superintendent and backfilled in accordance with sub-section SC6.4.6.4 Stormwater drainage.

(4) Bedding

(a) Cast-in-situ base slabs

No bedding material shall be placed until the foundations have been inspected and approved by the Superintendent.

Bedding shall be either mass concrete or lightly bound paving material which complies with the requirements of at least a Type 3, Subtype 3.3 material as defined in the Specification MRTS05 (04/11), whichever is shown on the drawings.

Mass concrete bedding blinding layer shall be 20 mpa compressive strength and shall not be less than 50mm thick over any point in the foundation. It shall be laid to the line and level of the underside of the base slab to a tolerance of ±10mm in level and ±50mm in line. The bedding shall be finished to a smooth surface. Where longitudinal gradients are less than 0.5 per cent, concrete blinding layers shall be installed with +/- 6mm of the grade line.

(b) Precast base slabs

Precast base slabs, U-shaped culvert units and one piece culvert units shall be supported on a bed zone of selected backfill of minimum compacted depth 150mm in accordance with AS 1597.2.

If suitable compaction of the trench subgrade cannot be achieved, it will be the responsibility of the developer to recommend an alternate solution to council to achieve the desired bearing capacity for the structure prior to construction.

(5) Cast-in-situ base slabs

(a) Cast-in-situ base slabs shall be constructed to the dimensions shown on the drawings and in accordance with the requirements of sub-section SC6.4.6.28 Minor concrete works. The invert levels shall be within -10mm to +10mm of the design level, grade 5mm in 2.5m (1 in 500) and plan position ±50mm. Where longitudinal gradients are less than 0.5 per cent cast insitu base slabs shall be installed within +/- 6mm of the grade line.

(b) Recesses or nib walls to accommodate the walls of the precast crown units shall be formed in the base

slab to the dimensions shown on the drawings.

(6) Installation of precast units

(a) Precast units shall not be installed until the base slab has attained a minimum compressive strength of 20 MPa.

(b) Precast crown units shall be placed on a bed of mortar either on the slab or in the recesses in the base slab. Any gaps between the side walls and the sides of the recesses shall be packed with cement mortar. Lifting holes and butt joints between units shall be packed or sealed with cement mortar or grout or flexible joint filler.

(c) Before placement of top slabs on U-shaped units or link slabs on adjacent crown units, the bearing areas of the supports shall be thoroughly cleaned and covered with a bed of mortar of minimum thickness 5mm after placement of precast unit.

(d) Lifting anchor recesses shall be filled to the surface with cement mortar.

(e) In the case of multi-cell culverts, a nominal 50mm gap shall be provided between adjacent cells. This gap shall be filled with cement mortar or grout.

(f) All mortar joints shall be protected from the sun and cured in an approved manner for not less than 48 hours.

(g) All external surfaces of vertical joints between precast crown units, shall be covered full length, and minimum 100mm width, with strips of denso tape or similar as an alternative to joint filling.

(7) Backfill

(a) All bracing and formwork shall be removed prior to backfilling. Prior to backfill placing, present to the Superintendent for inspection all seals, joints and levels.

(b) Selected backfill shall be placed in the side zones of the box culverts and wingwalls, and to a depth of 300mm in the overlay zone of the culverts, in layers with a maximum compacted thickness of 150mm in accordance with the backfilling and compaction requirements of AS 1597.2. Alternatively cohesionless materials can be compacted in one operation by saturation and vibration to achieve a minimum Density Index of 70. The remainder of the excavation shall be backfilled with ordinary embankment fill in accordance with SC6.4.6.10 Earthworks (construction).

(c) Backfill shall be placed against wingwalls, headwalls and retaining walls in accordance with SC6.4.6.28 Minor concrete works.

(d) Backfill layers shall be placed simultaneously on both sides of the culvert with a maximum 600mm level difference to avoid differential loading. Backfilling and compaction shall commence at the wall and proceed away from it.

(e) Where the slopes bounding the excavation are steeper than 4:1, they shall be cut in the form of successive horizontal terraces of at least 1m width before the backfill is placed.

(8) Excavation of inlet and outlet channels

(a) Excavation of inlet and outlet channels shall be carried out as shown on the drawings and shall extend to join the existing stream bed in a regular manner as detailed SC6.4.6.9 Open drains.

(9) Construction loading on culverts

(a) Construction vehicles and plant shall not pass over the culvert until 28 days after the casting of the base slab or until the cylinder compressive strength of the base slab concrete has reached 32 MPa.

(b) Construction vehicle loads on culverts for various design fill heights shall be in accordance with AS 1597.2.

SC6.4.6.7.4 Limits and tolerances

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.7.1 Summary of Limits and Tolerances below:

Table SC6.4.6.7.1 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Spec Clauses
1.	**Mass Concrete Correction**		
	a) Over highest points of rock	50mm	SC6.4.6. 7.3(3)
2.	**Mass Concrete Bedding**		
	a) Level	± 10mm	SC6.4.6. 7.3(4)
	b) Level where grade line <0.5%	+/- 6mm	
	c) Line	± 50mm	SC6.4.6. 7.3(4)
3.	**Culvert Location**		
	a) Invert Level	±10mm	SC6.4.6.7.3(5)(a)
	b) Invert where grade line is <0.5%	+/- 6mm	
	c) Grade	5mm in 2.5m (1 in 500)	SC6.4.6.7.3(5)(a)
	d) Plan Position	±50mm	SC6.4.6.7.3(5)(a)

SC6.4.6.8 Drainage mats

SC6.4.6.8.1 Introduction

(1) Scope

(a) The purpose of this policy sub-section is to provide standards advice and guidelines for the use and installation of drainage mats.

(b) Drainage mats shall be constructed where and as shown on the drawings or as directed by the Superintendent.

(c) This sub-section should be read in conjunction with SC6.4.6.21 Subsurface drainage.

(d) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in the SC6.4.5 Supervision and construction guidelines

(2) Terminology

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

(3) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this policy sub-section one as follows

SC6.4.6.21 Subsurface drainage
SC6.4.6.20 Subsoil, foundation and pavement drains

(b) Australian Standards

AS 1289.5.4.1 - *Compaction control test - Dry density ratio, moisture variation and moisture ratio.*

(4) Order of construction

(a) Type A drainage mats shall be constructed after the site has been cleared and grubbed and before commencement of embankment construction.

(b) Type B drainage mats shall be constructed after completion of the subgrade construction and before construction of the pavement.

SC6.4.6.8.2 Construction

(1) Type A mats

(a) Type A drainage mats shall be constructed under embankments as and where shown on the drawings or as directed by the Superintendent.

(b) After the embankment foundation has been trimmed and any necessary trench drains installed, a geotextile complying with the requirement of SC6.4.6.21 Subsurface drainage, shall be laid on the embankment foundation. The area of geotextile laid shall be sufficient to cover the area of the Type A drainage mat and an additional amount for enclosing the sides of the drainage mat after the filter material has been placed. Laps of minimum width of 500 mm shall be provided at each join in the geotextile.

(c) Type C filter material or Type D filter material, as shown on the drawings or as determined by the Superintendent, shall be placed on the geotextile and compacted to the satisfaction of the Superintendent. The minimum thickness of the compacted filter material shall be 300 mm plus an allowance for the expected consolidation of the embankment foundation under the embankment load or 500 mm if the amount of the expected total consolidation of the embankment foundation is not known.

The filter material shall be placed in two or more layers so that no layer, when compacted, has a thickness greater than 250 mm.

(d) After completion of placement and compaction of the filter material, geotextile shall be placed on top of and around the sides of the filter material so that the filter material is completely enclosed by geotextile. The geotextile shall be secured in such a manner as to prevent movement of the geotextile by wind or by construction plant placing subsequent layers of filter material or earth filling over the drainage mat.

(e) An additional layer of geotextile shall be placed on the drainage mat under the base of any rock facing which may be placed as part of the embankment construction. The additional layer of geotextile shall extend beyond the outside and inside faces of the bottom layer of rock.

(f) Care shall be taken not to damage the geotextile during the construction of the drainage mat or during placement of subsequent layers of filter material, earth filling or rock facing. Any geotextile so damaged shall be repaired or replaced by the Contractor to the satisfaction of the Superintendent. The cost of repairing or replacing such damaged geotextile shall be borne by the Contractor.

(g) Type A drainage mats shall extend 2 m beyond the toes of embankments and such extensions shall be covered by a 300 mm thick layer of Type C filter material or Type D filter material, as determined by the Superintendent. This protective layer shall be placed immediately after completion of construction of each drainage mat.

(h) Outlets from Type A drainage mats may be surface outlets at the toes of embankments or piped outlets connected to other drainage systems. Where piped outlets are constructed they shall conform to the requirements of SC6.4.6.21 Subsurface drainage.

(2) Type B mats

(a) Type B drainage mats shall be constructed in cuttings as and where shown on the drawings or as directed by the Superintendent. Type B drainage mats shall be constructed for the full width of cuttings and for the pavement width in other locations.

(b) After the subgrade material has been compacted and trimmed, a geotextile complying with the requirements of SC6.4.6.21 Subsurface drainage, shall be laid on the subgrade. Laps of minimum width of 500 mm shall be provided at each join in the geotextile.

(c) Slotted thick walled unplasticised PVC pressure pipe complying with AS 1477, shall be laid on the geotextile at a distance of 200 mm from and parallel to the longitudinal edges of the drainage blanket as shown in the drawings. Details of slot sizes and spacings are shown in SC6.4.6.20 Subsoil, foundation and pavement drains.

(d) Type A filter material shall be placed on the geotextile and compacted to achieve a relative compaction, determined by AS 1289.5.4.1, of at least 100 per cent (standard compaction). Alternatively, the Superintendent may approve the use of a coarser filter material having a maximum particle size of 75 mm and a maximum D90/D10 ratio of three.

(e) The thickness of the compacted filter material shall be as shown on the drawings or as directed by the Superintendent. If the required thickness of compacted filter material is greater than 250 mm, the filter material shall be placed in two or more layers so that no layer, when compacted, has a thickness greater than 250 mm.

(f) After completion of placement and compaction of the filter material, geotextile shall be placed on top of and around the sides of the filter material so that the filter material is completely enclosed by geotextile. The geotextile shall be secured in such a manner as to prevent movement of the geotextile by wind or by construction plant placing pavement layers over the drainage mat.

(g) Outlets from Type B drainage mats shall conform to the requirements of SC6.4.6.21 Subsurface drainage.

Table SC6.4.6.8.1 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	**Filter Material**		
	(a) Layer thickness	250 mm max	SC6.4.6.8.2(1) SC6.4.6.8.2(2)
	(b) Compaction (Relative) Type A filter material	100% Standard	SC6.4.6.8.2(2)
2.	**Type B Mats**		
	(a) Design level at top of mat	+0, -40 mm	SC6.4.6.8.2(2)

SC6.4.6.9 Open drains

SC6.4.6.9.1 Introduction

(1) Scope

(a) This policy sub-section provides standards, advice and guidelines for the construction, lining and protection of all types of open drains including the construction of rock filled wire mattresses and gabions associated with stormwater drainage infrastructure.

(b) This sub-section should be read in conjunction with SC6.4.6.4 Stormwater drainage, and other drainage sub-sections as applicable:

(i) SC6.4.6.6 Pipe drainage;

(ii) SC6.4.6.5 - Drainage structures; and

(iii) SC6.4.6.7 Precast box culverts.

(c) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Supervision and construction guidelines.

Editors note - A reference to drawings is a reference to construction drawings.

(2) Terminology

Open drains	are all drains other than pipe and box culverts and include catch drains, contour drains, diversion drains, table drains, batter drains, swales, channels, gutters and kerb and channel.

(3) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this policy sub-section are as follows:

SC6.4.6.4 Stormwater drainage
SC6.4.6.6 Pipe drainage
SC6.4.6.5 Drainage structures
SC6.4.6.21 Subsurface drainage
SC6.4.6.28 Minor concrete works
SC6.4.6.7 Precast box culverts
SC6.4.6.26 Landscaping

(b) Australian Standards

AS 1141.22 - *Wet/dry strength variation*
AS 1289.5.4.1 - *Compaction control test – Dry density ratio, moisture variation and moisture ratio*
AS 1289.5.7.1 - *Compaction control test Hilf density ratio and Hilf moisture variation (rapid method)*
AS 2758.4 - *Aggregate for gabion baskets and wire mattresses*
AS 2876 - *Concrete kerbs and channels (gutters) – Manually or machine placed*
AS/NZS 4534 - *Zinc and zinc/aluminium-alloy coatings on steel wire.*
AS/NZS 4680 - *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*

(c) Other

Austroads, *Guide to Pavement Technology, Part 4B – Asphalt (AGPT04B)*
Austroads, *Guide to Pavement Technology, Part 4G – Geotextiles and Geogrids (AGPT04G)*
ASTM International, ASTM A975 - *Standard specification for double-twisted hexagonal mesh gabions and revet mattresses (metallic coated steel wire or metallic coated steel wire with PVC coating)*
International Erosion Control Association (IECA), *Best Practice Erosion and Sediment Control*

SC6.4.6.9.2 Unlined open drains general

Open drains shall be designed and constructed in accordance with the relevant clauses in Chapter 9 of QUDM 2013. Locate and construct open drains to avoid recharging groundwater, a shallow water table and salinity degradation of

adjacent land.

Any unsuitable material must not be used for the bed and banks of the drain and must be removed from the site. Where a tree is marked for preservation, any drain must be diverted around it with sufficient clearance to avoid damage to the tree's root system.

Where open drains pass through private property, drainage easements of sufficient width to contain the flow and vehicular access for maintenance must be provided and registered as an encumberance on the title of the land through which the drain passes.

Prior to works commencing, temporary drainage measures must be implemented in accordance with the requirements of Best Practice Erosion and Sediment Control.

(1) Types

Catch drains shall be provided above the top and at the toe of embankments as part of the construction of the adjacent roadway. The edges of catch drains shall be positioned not less than 2 m from the tops of cuttings or the toes of embankments nor more than is necessary to maintain the fall of the drains unless otherwise approved.

Minor diversion and contour drains shall be constructed where shown on the construction drawings. Minor diversion drains shall have the same capacity as the nearest pipe culvert on the line of the drain unless otherwise approved by the Superintendent.

Table drains, swales and depressed medians shall be constructed to the line and level shown or calculated from the drawings. Their construction is deemed to be part of the earthworks.

(2) Inlet, outlet and diversion drains shall extend to join the existing stream bed and be of sufficient size to accommodate the design flows from the upstream catchment. The drain shall be excavated to the full width of the structure and care must be taken to ensure the stream bed can accommodate the additional flow with only minimal disturbance.

(3) Construction material excavated from drains shall be placed on the lower sides of the drains and formed as banks with slopes graded in accordance with QUDM Third edition 2013 – Provisional. This material shall be compacted in accordance with AS 1289.5.4.1 and shall be not less than 95 per cent for standard compactive effort.

The Contractor shall ensure that none of the activities associated with the work disturbs any watercourse outside the site. Any excavation below the level of the natural channel shall be backfilled with suitable material compacted to a density equal to and compatible with that existing naturally.

Any excess material shall be legally and responsibly disposed of by the Contractor.
Unlined drains and areas adjacent to open drains shall be treated and revegetated immediately after the drains are complete, in accordance with SC6.4.6.26 Landscaping.

SC6.4.6.9.3 Lined open drains general

(1) Contractors must only use proprietary products which are suited to the terrain and have been approved for use by council. This would include the use of

(a) organic fibre and vegetation mats installed in accordance with the manufacturer's instructions;

(b) rock filled wire mattresses; or

(c) concrete where there is insufficient width to accommodate the required water way area, or the flow velocity in the drain will exceed the non-scouring velocities or where the drail is likely to be used as a bikeway of footpath during dry periods. Lining shall conform to the profile of the drain and shall be provided as soon as possible after forming the drain.

Before placing any lining material, the foundation material shall be shaped and compacted to not be less than 95 per cent for standard compactive effort as determined by AS 1289.5.7.1 or AS 1289.5.4.1

This section does not include kerb and channel.

(2) Concrete lining

Concrete lining for open drains shall be cast-in-situ or sprayed concrete supplied and placed to a minimum thickness of 100 mm measured at right angles to the surface of the lining in accordance with sub-section SC6.4.6.28 Minor concrete works.

Weepholes shall be provided in the concrete at intervals of 2 m spacing with non-horizontal elements or as determined by the Superintendent.

Contraction joints in concrete lining, consisting of narrow transverse and vertical grooves, 5-10 mm in width, 20 mm deep, shall be formed neatly in the surface of the freshly placed concrete at intervals of 3 m unless otherwise specified by the Superintendent.

Expansion joints shall be placed at intervals not more than 15 m with a minimum width of 15 mm and shall consist of preformed jointing material of bituminous fibreboard or alternate approved material and shall be of sufficient depth to fill the joint.

(3) Stone pitching

Stone pitching shall consist of sound durable rock not less than 100 mm thick, properly bedded on approved loam or sand and mortared to present a uniform surface. The exposed surface of each stone or block shall be generally flat and not less than 0.05 square metres in area. Spaces between adjacent stones or blocks shall not exceed 20 mm in width.

(4) Batter drains

Batter drains shall be constructed using either half round steel pipes or precast nestable concrete units as shown and detailed on the drawings.

The units shall be installed in carefully excavated and template controlled trench to produce an even rim line of +0 mm to –50 mm from the batter line at the underside of topsoil.

Any over excavation and undulations in the batter line shall be backfilled and both sides of the drain compacted over the full length to form a firm shoulder against the rim of the batter drain.

When topsoil is placed it shall be tapered over a width of 1 m to zero thickness at the rim of the drain. Both sides of the drain shall then be turfed for minimum width of 1 m and pinned down as provided in SC6.4.6.26 Landscaping.

(5) Proprietary products

Unless shown on the drawings, proprietary products may only be used with the approval of the Superintendent. Where specified, they must be used strictly in accordance with the manufacturer’s instructions.

SC6.4.6.9.4 Rock filled wire mattresses and gabions general

(1) Prior to installation of rock filled wire mattress or gabion excavate so the mattresses finish flush and level with the surrounding ground. Rock-filled wire mattresses and gabions shall be placed at the locations shown on the drawings. Installation shall be in accordance with the manufacturer's instructions. A geotextile, as shown on the drawings, shall be placed between the wire cage and the material being protected.

Foundations of floors of gabions should ideally be within cut material, however if in fill areas or embankments then material must be compacted in layers not greater than 150 mm thick, to a relative compaction of 95 per cent when tested in accordance with AS 1289.5.4.1, for standard compactive effort.

(2) Materials

For wire mattresses and gabions, the galvanising requirements for wire of circular cross section cited in this Clause as "heavily galvanised", shall comply with the coating mass requirements for round wire, Class W10, in

AS/NZS 4534. The contractor must submit for approval the type of mattress/gabion proposed along with confirmation of compliance to ASTM A975 and a schedule of installation locations.

(a) Gabions

The gabions shall be of the sizes shown on the drawings and fabricated of woven heavily galvanised wire mesh and PVC coated where specified on the drawings. Each gabion shall be divided by diaphragms into cells whose length shall not be greater than the width of the gabions plus 100 mm. Gabions shall have a nominal mesh size of 80 mm x 100 mm and body wire shall be a minimum diameter of 2.7 mm heavily galvanised with an additional thickness of 0.4 mm PVC coating where specified on the drawings. The minimum core diameters of heavily galvanised selvedge wire and lacing wire shall be 3.4 mm and 2.2 mm respectively.

(b) Wire mattresses

Unless specified otherwise, the wire mattresses shall be supplied in units having dimensions of 6 m x 2 m x 230 mm, and shall be cut to suit areas as shown on the drawings. The mattresses shall be divided by diaphragms into cells of length not exceeding 600 mm. Unless otherwise specified, they shall be fabricated of woven heavily galvanised wire and PVC coated where specified on the drawings.

Mattresses shall have a mesh size of 60 mm x 80 mm and body wire shall be a minimum diameter of 2.0 mm heavily galvanised with an additional minimum thickness of 0.4 mm PVC coating where specified on the drawings. The minimum core diameters of heavily galvanised selvedge wire and lacing wire shall be 2.7 mm and 2.2 mm respectively.

(c) Geotextile

A chemically and biologically stable geotextile with a minimum strength rating (G) of 1350 and minimum mass of 180 grams per square metre, in accordance with Guide to Pavement Technology Part 4G Geotextiles, shall be used.

Samples, manufacturer's specification and instructions on installation shall be submitted to the Superintendent seven days before the intended use of geotextile.

(d) Rock Fill Material

The rock fill shall consist of clean hard rock complying with the requirements of AS 2758.4.
Rock fill for gabions shall have particle sizes between 100 mm and 250 mm. Rock fill material should be placed by hand and only when approved by the superintendent shall they be placed using a suitable mechanical device to ensure fill is tightly packed with a minimum of voids. Fill material shall be levelled off 25 mm to 50 mm above the top of the mesh to allow for settlement.
When the mattress is on a slope, rock fill material shall be placed into the units starting from the low end. Units shall be filled slightly overfull by 25 mm to 50 mm to allow for settlement and to provide an even tight and smooth surface of the required contour.

(3) Assembly and erection

Before laying out the gabions or wire mattresses, geotextile shall be placed on the founding material and against any surface that will be in contact with either drainage course or earth backfill.

Adjust the position of the diaphragms so that the sides hinge up on the thicker wire woven in the mesh. Lace the gabion boxes along all diaphragm points and edges at to all adjacent boxes. Internal bracing wires 4 per m at 330 mm centres to prevent distortion. Face bracing wires 4 per m of face.

Ensure star pickets are either driven or cut off level with the top of the mattress.

After tying diaphragms and adjacent units of mattresses/gabions on all three adjacent corners(rear, floor and front face), leave top edge untied to allow for securing along with the lid section. The end corners of wire mattress/gabion tied sections shall be firmly tied after galvanised star pickets are driven and stretched in place a minimum of 900 mm into the surrounding ground in the final location at one end.

Carefully secure the opposite end of the gabions without damaging or distorting the dimensions of the units to a suitable mechanical device and apply a stretching force to the assembled mattress/gabion section to be filled.

Whilst under tension, secure each corner of each unit using galvanised star pickets driven into foundation ensuring each unit is stretched tight in all directions.

(4) Filling

Fill whilst the gabion boxes are under tension. Place the rocks at the front face and other exposed faces by hand to produce a neat face free of excessive bulges, depressions and voids.

Redistribute the filling materials by hand to ensure that all diaphragm compartments are fully filled to produce a neat and level top surface. Overfill by 25 to 50 mm to allow for subsequent settlement.

Mechanical filling equipment may be used with caution ensuring to protect any PVC or galvanized coatings from abrasion. Release the tension on the mattress/gabion boxes only when fully laced so as to prevent any slackening.

The upstream edge of wire mattresses shall be folded down into a trench of minimum depth 300 mm and filled with rock fill. This edge shall be tied to star pickets.

Final lacing should be undertaken as soon as practicable after filling particularly if there is a storm or flood expected. Stretch lids tightly over the filling and lace down securely. The works should be inspected upon completion of lacing.

SC6.4.6.9.5 Summary of limits and tolerance

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.9.1 below.

Table SC6.4.6.9.1 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	**Open Drains - General**	Grade - QUDM 2013 Table 9.5.2	SC6.4.6.9.2(3)
	(a) Grading		
	(b) Depth	Based on hydraulic capacity of the channel	SC6.4.6.9.2
	(c) Freeboard	QUDM 2013 table 9.3.1 & Fig 9.8	SC6.4.6.9.2
	(d) Channel Side Slopes	QUDM 2013 Section 9.5.3	SC6.4.6.9.2(3)
	(e) Compaction	>95% (standard compaction)	SC6.4.6.9.2(3)
2.	**Open Drains - Lining**	>95% (standard compaction)	SC6.4.6.9.3(1)
	(a) Compaction of Foundation		
3.	**Stone Pitching**	>100mm thickness	SC6.4.6.9.3(3)
	(a) Rock Dimensions		
	(b) Exposed Surface Area	>0.05 sq m	SC6.4.6.9.3(3)
	(c) Spaces between Stones	<20mm width	SC6.4.6.9.3(3)
4.	**Batter Drains**	+0, -50 from batter line	SC6.4.6.9.3 (4)
	(a) Rim line		
5.	**Kerb and channel**		
	(a) Compaction of foundation	To AS 2876	SC6.4.6.9.3(6)
	(b) Level of gutter surface	Level ≤ ±6mm of design level	SC6.4.6.9.3(6)
	(c) Alignment	Level ≤ ±50mm of design alignment	
	(d) Surface uniformity	Deviation of kerb and channel surface from 3m straight edge ≤5mm	SC6.4.6.9.3(6)
	(e) Contraction Joints		
	(i) Area	≥50% of CS area	SC6.4.6.9.3(6)
	(ii) Groove Width	≥5mm	SC6.4.6.9.3(6)
	(f) Expansion Joint Interval	at all gully pits and associated structures	SC6.4.6.9.3(6)
	(g) Backfill behind Kerb		
	(i) Layer thickness	≤150mm	SC6.4.6.9.3(6)
	(ii) Compaction	>95% (standard compaction)	SC6.4.6.9.3(6)

Item	Activity	Limits/Tolerances	Clause
6.	**Rock Fill for Gabions and Wire Mattresses**	>100kN	SC6.4.6.9.4(2)(d)
	(a) Wet Strength		
	(b) Wet/Dry Strength variation	<35%	SC6.4.6.9.4(2)(d)
	(c) Particle size for Gabions	>100mm <250mm and preferably not greater than 200 mm	SC6.4.6.9.4(2)(d)
	(d) Fill Level	>25mm <50mm above top of mesh	SC6.4.6.9.4(2)(d)
	(e) Particle size for Wire Mattresses	Between 75 mm and two-thirds of the mattress thickness, or 250 mm, whichever is the lesser	SC6.4.6.9.4(2)(d)
7.	**Erection of Gabions and Wire Mattresses**	Depth in ground >900mm Spacing <1m	SC6.4.6.9.4(3)
	(a) Star pickets for ties		
	(b) Trench Depth for upstream edge	Depth >300mm	SC6.4.6.9.4(3)

SC6.4.6.10 Earthworks (construction)

SC6.4.6.10.1 Introduction

(1) Scope

(a) This sub-section provides standards, advice and guidelines for earthworks and associated construction, including:

(i) removal of topsoil;

(ii) all activities and quality requirements associated with site regrading, the excavation of cuttings, the haulage of material and the construction of embankments to the extent defined in the drawings and sub-section;

(iii) removal and replacement of any unsuitable material;

(iv) any spoil or borrow activities associated with earthworks; and

(v) any additional processing of selected material for the selected material zone.

(b) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

(2) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this sub-section one as follows:

SC6.4.6.30 Control of traffic
SC6.4.6.11 Clearing and grubbing
SC6.4.6.4 Stormwater drainage

(b) Australian Standards

AS 1141.11	*- Soil classification test – Determination of the particle size distribution of a soil – Standard method of analysis by sieving*
AS 1289.3.3.1	*- Calculation of the plasticity index of a soil.*
AS 1289.5.1.1	*- Determination of the dry density/moisture content relation of a soil using standard compactive effort.*
AS 1289.5.4.1	*- Compaction control test - Dry density ratio, moisture variation and moisture ratio.*
AS 1289.5.7.1	*- Compaction Control Test Hilf density ratio and Hilf moisture variation (Rapid Method).*
AS 1289.6.1.1	*- Determination of the California Bearing Ratio of a soil - Standard laboratory method for a remoulded specimen.*
AS 1289.7.1.1	*- Soil reactivity tests – Determination of the shrinkage index of a soil*
AS 2187.0	*- Explosives - Storage, transport and use - Terminology*
AS 2187.1	*- Explosives - Storage, transport and use - Storage*
AS 2187.1	*- Explosives - Storage, transport and use - Use of explosives*

(c) QLD Government Legislation

Environmental Protection Act 1994
Environmental Protection (Noise) Policy 2008
Explosives Act 1999
Explosives Regulation 2003
Sustainable Planning Act 2009
Work Health and Safety Act 2011

(d) Other

International Erosion Control Association (IECA), *Best Practice Erosion and Sediment Control*

Workplace Relations Ministers' council, *Australian Code for the Transport of Explosives by Road and Rail*

(3) Natural surface and earthworks materials

(a) Natural surfaces

The Contractor must verify the accuracy of the model by field surveys. If the Contractor considers any areas of the model not to be representative of the approved plans, the Contractor shall give not less than seven days notice, prior to commencement of Works to the Superintendent to allow checking. If the subsequent check survey reveals the ground model to be incorrect, any plans that are affected are to be resubmitted for approval.

(b) Earthworks materials

The Contractor shall be responsible for any assumptions made by the contractor in relation to the nature and types of the materials encountered in excavations and the bulking and compaction characteristics of materials incorporated in embankments.

The estimated quantity for general earthworks at any cutting includes all types of materials which may be encountered in the cutting.
Where material from excavations is acceptable for use in embankments, but the Contractor elects to:

(i) spoil it; or

(ii) use it for the Contractor's own purposes; or

(iii) use it as a source of pavement materials; or

(iv) construct embankments with dimensions in excess of those specified.

and a deficiency of material for embankment construction is thereby created, the Contractor shall make good that deficiency from sources of material meeting the quality requirements specified in clause SC6.4.6.10.6(2). The cost of making good such deficiency of material shall be borne by the Contractor.

(4) Protection of earthworks

The Contractor's responsibility for care of the Works shall include the protection of earthworks.
The Contractor shall install effective erosion and sedimentation control measures in accordance with accepted *Best Practice Erosion and Sediment Control* procedures, prior to commencing the earthworks, and shall maintain these control measures for the duration of the contract.

Details of the proposed sediment and erosion control measures and procedures are to be documented by a suitably qualified person in accordance with council's soil and sediment erosion control standards. The proposed measures and procedures are to be approved by council prior to implementation on site.

Adequate drainage of all working areas shall be maintained throughout the period of construction to ensure run-off of water without ponding, except where ponding forms part of a planned erosion and sedimentation control system.

When rain is likely or when work is not proposed to continue in a working area on the following day, precautions shall be taken to minimise ingress of any excess water into earthworks material. Ripped material remaining in cuttings and material placed on embankments shall be sealed off by adequate compaction to provide a smooth tight surface.

Should insitu or stockpiled material become wet as a result of the Contractor not providing adequate protection of earthworks, the Contractor shall be responsible for replacing and/or drying out the material and for any consequent delays to the operations.

(5) Setting out of earthworks

Before earthworks operations commence and after survey controls are in place, batter profiles shall be established by the Contractor and the necessary pegs driven at 25 m intervals, at each cross section shown on the drawings or at each change in batter slope, whichever is the lesser. The chainage/station, offset from control line and slope distance to finished surface level, shall be clearly marked on each peg.

The batter profiles shall be repositioned by the Contractor at each change in the slope of the batter and at intervals of not more than 5 m of vertical height.

All pegs and batter profiles shall be maintained in their correct positions. Additional pegs and profiles may be required to suit the Contractor. These shall not be painted with the same colours used for the specified setting out pegs and stakes.

The position and extent of all transitions from cuttings to embankments and foundations for shallow embankments shall be marked with clearly labelled stakes in accordance with Clauses SC6.4.6.10.3(5) and SC6.4.6.10.6(3).

(6) Stockpile sites

The Contractor shall obtain the written consent of the Superintendent to the use of any stockpile site which is not shown on the drawings. Proposals in this regard shall be submitted at least three working days before stockpiling is due to commence and shall specify the maximum dimensions of the proposed stockpile.

Any clearing and grubbing required for these sites shall be carried out in accordance with SC6.4.6.11 Clearing and grubbing. Temporary erosion and sedimentation control measures shall be taken in accordance with *Best Practice Erosion and Sediment Control.*

Restoration of stockpile sites following completion of the work shall be carried out in accordance with IECA *Best Practice Erosion and Sediment Control.*

SC6.4.6.10.2 Removal of topsoil

(1) Scope

Topsoil is surface soil which is reasonably free from subsoil, refuse, clay lumps and stones.

Removal of topsoil from any section of the Works shall only commence after erosion and sedimentation controls have been implemented and when clearing, grubbing and disposal of materials have been completed on that section of the works in accordance with relevant parts of *Best Practice Erosion and Sediment Control* and SC6.4.6.11 Clearing and grubbing.

Topsoil throughout the length of the Work shall be removed and stockpiled separately clear of the Work with care taken to avoid contamination by other materials. The work shall include the following:

(a) Cuttings

Removal of the topsoil to a depth quoted in SC6.4.6.10 Attachment A Earthworks supplementary information, or as directed by the Superintendent.

(b) Embankments

Removal of topsoil over the base of embankments up to the depth below the natural surface quoted in SC6.4.6.10 Attachment A Earthworks supplementary information, or as directed by the Superintendent. For those embankments or sections of embankment where the height of embankment from natural surface to underside of pavement is less than two metres, topsoil which is deeper than the depth quoted in SC6.4.6.10 Attachment A Earthworks supplementary information shall be removed to its full depth as directed by the Superintendent.

(c) Other locations

Removal of topsoil as directed by the Superintendent.

(2) Topsoil stockpiles

The maximum height of stockpiles shall not exceed 2.5 m and the maximum batter slope shall not exceed 2h:1v.

Topsoil stockpiles shall not contain any timber or other rubbish and shall be trimmed to a regular shape.

Keep topsoil and underburden stockpiles separate.

Stabilise stockpiles and batters that will remain bare for more than 28 days by covering with mulch or anchored fabrics or seeding with sterile grass.

Establish sediment controls around unstabilised stockpiles and batters. Locate stockpiles away from drainage lines, at least 10 m away from natural waterways and where they will be least susceptible to wind erosion.

To minimise erosion, stockpile batters shall be track rolled or stabilised by other means acceptable to the Superintendent.

Where seeding of stockpiles to encourage vegetation cover is specified, such work shall be carried out in accordance with SC6.4.6.26 Landscaping.

SC6.4.6.10.3 Cuttings

(1) Scope

Construction of cuttings shall include all operations associated with the excavation of material within the limits of the batters including benching, treatment of cutting floors and transition from cut to fill.

(2) Excavation

Materials encountered in cuttings shall be loosened and broken down as required so that they are acceptable for incorporation in the Works. In this regard, the Contractor's attention is drawn to clauses SC6.4.6.10.5 Unsuitable material, SC6.4.6.10.6(1) Scope and SC6.4.6.10.6(2) Embankment material.

Cuttings shall have batter slopes as shown on the drawings or as redetermined by the Superintendent on the basis of site inspection and investigation during the excavation.

The tops of all cuttings shall be neatly “rounded”.

In all cuttings, undulations in the general plane of the batter shall not be permitted except that batters may require progressive flattening at the ends of cuttings due to the presence of less stable material.

Cut faces shall be cleaned of loose or unstable material progressively as the excavation proceeds.

Where, after the removal of topsoil as specified in clause SC6.4.6.10.2(1) Scope, material of variable quality or moisture content is encountered, the Contractor shall adjust his excavation methods to ensure blending of the materials, to obtain material meeting the requirements of clause SC6.4.6.10.6(2) Embankment material.

(3) Batter tolerances

If the Contractor excavates the batter beyond the batter slope line and the tolerance applicable thereto, the Superintendent may authorise a minor change in the general slope of the batter to suit the convenience of the

Contractor, but such a change shall not be regarded as a redetermination of the batter slope under clause SC6.4.6.10.3(2) Excavation. Alternatively the Contractor shall submit details of the material and/or methods proposed to restore the specified slope and stability of the batter for the Superintendent's approval.

For batters steeper than 1:1, if any section of the batter up to a height of 3m above the table drain level has been over excavated beyond the tolerance limit specified, the Superintendent may direct that the batter be restored to the average batter slope using randomly mortared stone. The stone shall be similar to the sound rock in the cutting and the mortar shall be coloured to match the colour of the rock.

The tolerances for the excavation of batters, measured at right angles to the design grade line, are given in Table SC6.4.6.10.1 Excavation tolerances for batters.

Table SC6.4.6.10.1 Excavation tolerances for batters

Location	Tolerance (mm)	
	Slope 1:1 or flatter	Steeper than 1:1
Toe of batter and level of table drain	+ 0 - 150	+ 0 - 200
2 m above table drain and higher	+ 300 - 300	+ 300 - 600
Between level of table drain and 2 m above table drain	pro rata basis	pro rata basis

Note—tolerances are measured normal to the batter surface with (+) measured towards the roadway.

(4) Benching in cuttings

Cut batters shall be benched as shown on the drawings to provide drainage and erosion control. Notwithstanding the tolerances permitted under clause SC6.4.6.10.3(3) Batter tolerances, bench widths shall not be less than those shown on the drawings.

Benches shall be maintained and cleaned of loose stones and boulders regularly throughout the Contract period. The cost of such maintenance and cleaning of benches shall be borne by the Contractor.

(5) Subgrade of cuttings

The subgrade of cuttings shall be excavated, parallel to the designed grade line, to a designed subgrade level. The subgrade shall then be trimmed to a level of not more than ±50 mm from the designed subgrade level. Prior to ripping or removal of the cut material, the Contractor shall determine the CBR of the material in at the subgrade level in accordance with AS 1289.6.1.1, Plasticity Index AS 1289.3.3.1 and Shrink-Swell Index AS 1289.7.1.1. Sufficient tests shall be taken to represent all the various materials which may exist within the subgrade.

Adequate sampling and testing shall be undertaken to satisfy all necessary requirements to verify the intended pavement design. Where the Superintendent considers that any underlying material is unsuitable for pavement support, the Superintendent may direct that it be removed in accordance with clause SC6.4.6.10.5 Unsuitable material.

The Contractor shall rip or loosen all material in the subgrade to a minimum depth of 200 mm below the designed subgrade level for the width of the selected material zone (or subbase layer, where no selected material zone), including areas of rock. The maximum dimension of any particles in the ripped or loosened zone shall not exceed 150 mm.

After recompaction, the subgrade within cuttings shall be re-trimmed parallel with the finished wearing surface so that their levels do not vary more than ±50 mm from the designed subgrade level. It shall be recompacted in accordance with Clause SC6.4.6.10.7(1).

Horizontal tolerance – the width of the cutting at subgrade level for support of the pavement shall not be less than that specified.

Prior to placing any subsequent layers over the completed subgrade level, the Contractor shall present the completed surface to the Superintendent for inspection. The Contractor shall verify as part of the quality system that the completed surface has achieved full conformance with all respects to relevant specifications.

In placing subsequent layers, the Contractor shall use equipment and techniques to avoid surface heaving or other damage to the subgrade surface.

(6) Transition from cut to fill

After the removal of topsoil and before the excavation of any cutting commences the contractor shall survey and mark the position of the intersection line between cutting and embankment occurring at the underside of

the selected material zone or pavement subbase.

The contractor is to ensure that the transition from cut to fill is undertaken in accordance with best practice geotechnical procedures and guidelines.

SC6.4.6.10.4 Blasting general

(1) When explosives are permitted to be used by council, the contractor shall obtain all necessary licences from the appropriate authorities, and shall comply with all government and council regulations relating to transport, storage, handling and the use of explosives and also to the rules set out in AS2187.1 and AS2187.2. The transport of explosives shall be in accordance with the *Australian Code for the Transport of Explosives by Rail and Road. The requirements of the Explosives Act 1999* and *Explosives Regulation 2003* and Local laws, if applicable, shall be complied with.

The contractor shall be liable for any accident, damage or injury to any person, property or thing, resulting from the use of explosives.

Before the start of blasting operations, the contractor, in the presence of the superintendent, shall conduct a dilapidation survey to determine and record the existing condition of all structures likely to be affected by any blast.

The survey shall include all structures including public utilities within 500 m of any blast but shall be extended where the maximum instantaneous charge proposed is likely to produce peak particle velocities greater than allowable at structures more remote from a blast site. A written report of the survey, supported by photographs where necessary, together with a list of any existing defects in the structures, shall be submitted to the owner of each structure, to the superintendent and council before blasting commences.

The contractor shall advise the superintendent of the proposed maximum instantaneous charge and the contractor's validation of the adequacy of the proposed structural survey at least three working days before the survey is due to commence. The superintendent may direct amendments to the scope of the survey as a result of blast monitoring during the work. All costs associated with the surveys and reports shall be borne by the contractor.

Before each blasting operation, the contractor shall submit to the Superintendent written details of the proposed blasting procedure including the quantity and type of explosive to be detonated, the blasting pattern to be used and measures proposed to limit noise and to ensure that vibration from blasting does not adversely affect nearby structures.

Ground vibration caused by blasting shall not exceed the values of peak particle velocity listed in Table SC6.4.6.10.2 Limiting peak particle velocity.

Table SC6.4.6.10.2 Limiting peak particle velocity

Point of Potential Damage (within 1 km of blasting site)	**Peak Particle Velocity**
Completed and cured bridge structures or sub□structures (e.g. completed abutment)	25 mm/sec
Bridgeworks and structural retaining walls under construction	20 mm/sec
Residential premises, schools, hospitals and other buildings	5 mm/sec (with 10% not to exceed 10 mm/sec)
Buildings or monuments of historical significance	2 mm/sec

The contractor shall advise all residents within a radius of 1 km, by letter drop before blasting operations

commence, of the likely times, frequency and duration of blasting and precautions being taken to ensure that damage to property will not result.

Unless otherwise approved, blasting operations shall be confined to the periods Mondays to Fridays (excluding public holidays), 9am to 3pm.

When blasting operations are being carried out, precautions shall be taken relating to the safety of persons and animals and the road shall be closed to traffic and the appropriate signs erected in accordance with the sub-section SC6.4.6.30 Control of traffic. A standard warning procedure such as that given in the AS2187.2 shall be established and observed at all times.

(2) Presplitting

Where presplitting is carried out the spacing of presplit drill holes shall not exceed 750 mm centre to centre.

(3) Blasting records

The Contractor shall maintain accurate records of each blast showing the details listed below:

(a) date and time of blast;

(b) location, number and diameter of holes loaded;

(c) depth of each hole loaded;

(d) inclination of holes;

(e) maximum and minimum burden;

(f) types of explosives used;

(g) charge distribution in each hole;

(h) maximum instantaneous charge;

(i) delay periods and sequence;

(j) total amount of charges in the blast;

(k) length and type of stemming in each hole.

The records shall be prepared as holes are loaded and signed by the Powder man. A copy shall be provided to the Superintendent on the day of the blast.

(4) Control of air blast over-pressure

This clause shall apply only where a noise sensitive location exists within 1 km of the blasting site.

The Contractor's attention is drawn to the recommendations given in the *Environmental Protection (Noise) Policy 2008* or as amended - for the reduction of air blast over-pressure.

The noise emanating from blasting operations shall not exceed an over-pressure level of 115 decibels (linear peak) at any noise sensitive location (such as residential premises, schools or hospitals). Up to 10 per cent of the total number of blasts may exceed this value provided a level of 120 decibels is not exceeded at any time.

The Contractor shall arrange for the monitoring of air blast over-pressure to ensure compliance with the specified limits. All monitoring shall be carried out by personnel possessing current NATA registration for such monitoring. All test results shall be reported on NATA endorsed test certificates which shall include a clear statement as to compliance or non-compliance with the requirements of this sub-section. In general, a monitoring location will be near the perimeter of the noise sensitive location at the point closest to the maximum charge. The Contractor shall submit a copy of the monitoring record to the Superintendent.

In the event that the measured air blast over-pressure exceeds the specified limits, the Contractor shall suspend further blasting work and shall submit to the Superintendent proposals detailing any additional steps and precautions the Contractor shall take to ensure that for any future blast, the limiting over-pressure shall not be exceeded. The Contractor shall not resume any blasting until such proposals have been submitted.

(5) Control of ground vibration

The Contractor shall arrange for the monitoring of ground vibrations to ensure compliance with the peak particle velocity limits shown in Table SC6.4.6.10.2 Limiting peak particle velocity. All monitoring shall be carried out by personnel possessing current NATA registration for such monitoring. All test results shall be reported on NATA endorsed test certificates which shall include a clear statement as to compliance or non-compliance with the requirements of this part of the sub-section. In general a monitoring location shall be near the perimeter of the structure or building at the point closest to the maximum charge. The Contractor shall submit a copy of the monitoring record to the Superintendent.

To minimise the risk of peak particle velocity limits being exceeded, the Contractor shall develop a blasting site relationship between peak particle velocity, distance and blasting charge.

For the first blast, monitors shall be set up at not less than five points at varying distances away from the blasting site. The Maximum Instantaneous Charge for the first blast shall not exceed that calculated from the following formula:

$$MIC = 0.5\left[\frac{D}{\left[\frac{PPV}{1140}\right]^{-0.625}}\right]^2$$

where MIC = Maximum Instantaneous Charge in kilograms
D = Distance in metres from charge to the point of potential damage
PPV = limiting peak particle velocity from Table SC6.4.6.10.2.

A log-log (base 10) graph of measured peak particle velocity (vertical axis) versus Scaled Distance (horizontal axis) shall be plotted, where

$$\text{Scaled Distance} = \frac{D}{\sqrt{MIC}}$$

The mean regression line shall be obtained by the least squares method.

For subsequent blasts, the MIC and other aspects of blast design may be adjusted provided that further ground vibration monitoring is undertaken and the mean regression line redetermined to demonstrate that peak particle velocity limits are not exceeded. The Contractor shall make the regression line plots available to the Superintendent, if so requested.

SC6.4.6.10.5 Unsuitable material

Unsuitable material is that occurring below the designed floor level of cuttings and below the nominated depth for stripping topsoil beneath embankments, which the Superintendent deems to be unsuitable for embankment or pavement support in its present position. Unsuitable material also includes material in cuttings which the Superintendent deems to be unsuitable for embankment construction.

Such material shall be excavated to the extent directed by the Superintendent. Material removed as unsuitable, as directed by the Superintendent, shall be incorporated in embankments in accordance with SC6.4.6.10.6(2) Embankment material or spoiled in accordance with clause SC6.4.6.10.6(13) Spoil.

After removal of the unsuitable material, the floor of the excavation shall be re-presented to the Superintendent for inspection, prior to backfilling with replacement material, to determine whether a sufficient depth of unsuitable material has been removed. Prior to placing replacement material the excavated surface shall be compacted in accordance with SC6.4.6.10.7(1) Compaction and moisture requirements.

The unsuitable material which has been removed shall be replaced with material from cuttings, or with material borrowed in accordance with clause SC6.4.6.10.6(14) Borrow, of the quality specified in clause SC6.4.6.10.6(2)

Embankment materials. Replacement material is deemed to form part of embankment construction. It shall be placed in accordance with clause SC6.4.6.10.6(5) Placing Fill for embankment construction and compacted in accordance with clause SC6.4.6.10.8(1) Construction management.

Reworking or replacing any material which the Superintendent deems to have become unsuitable because of inappropriate construction activities shall be borne by the Contractor.

Excavate and dispose of all contaminated material in an environmentally responsible manner including the following:

(1) assay material uncovered on-site prior to disposal. If the wastes include putrescibles wastes, then also analyse leachate and landfill gases;

(2) excavate material in a manner which avoids off-site environmental problems;

(3) seal remaining contaminated material or wastes, where only part of the tip has been excavated, to ensure than there is no off-site effect now or in the future;

(4) transport odorous wastes in covered vehicles; and

(5) dispose of contaminated material in a landfill licensed to take the type of contaminated material or wastes uncovered.

SC6.4.6.10.6 Embankment construction

(1) Scope

Embankment construction includes all operations associated with the preparation of the foundation areas on which fill material is to be placed, the placing and compacting of approved material within areas from which unsuitable material has been removed in accordance with clause SC6.4.6.10.5 Unsuitable material, the placing and compacting of fill material and of materials of specified quality in nominated zones throughout the Works and all other activities required to produce embankments as specified to the alignment, grading and dimensions shown on the drawings. It also includes any pre-treatment such as breaking down or blending material or drying out material containing excess moisture.

(2) Embankment material

Material for embankment construction shall be obtained from the cuttings within the Works in accordance with clause SC6.4.6.10.3(2) Excavation supplemented by borrow in accordance with clause SC6.4.6.10.6(14) Borrow and from other sources as approved by the Superintendent if necessary. The material shall be free of tree stumps and roots, clay, topsoil, steel, organic material and other contaminants and shall be capable of being compacted in accordance with clause SC6.4.6.10.7(1) Compaction and moisture requirements.

The work shall be programmed so that material of the quality specified in clause SC6.4.6.10.6(5) Placing fill for embankment construction and SC6.4.6.10.6(9) Selected material zone for the upper zones of the formation is available when required.

(3) Foundations for embankments

(a) Following removal of topsoil in accordance with clause SC6.4.6.10.2 Removal of top soil, the embankment foundation area shall be made available for inspection by the Superintendent.
Where the Superintendent considers that any underlying material is unsuitable, the Superintendent may direct that it be removed and replaced in accordance with clause SC6.4.6.10.5 Unsuitable material.

(b) Foundations for Shallow Embankments
Shallow embankments are those embankments of a depth less than 1.0 metre from the top of pavement to natural surface. After removal of topsoil the Contractor shall survey and work out the extent of the area of shallow embankments.

Material in the foundations for shallow embankments which does not meet the requirements specified in SC6.4.6.10 Attachment A Earthworks – supplementary information, shall be deemed unsuitable in

accordance with clause SC6.4.6.10.5 Unsuitable material and shall be replaced by material of the specified quality.

Foundations for shallow embankments shall be prepared for embankment construction after removing topsoil and unsuitable material, by loosening the material exposed to a depth of 200 mm, adjusting the moisture content of the loosened material and compacting as specified in clause SC6.4.6.10.7(1) Compaction and moisture requirements. The Contractor shall use equipment and techniques to minimise surface heaving or other foundation damage.

(c) Other embankments

For all other embankments the foundation shall be prepared by grading and levelling the general area, adjusting the moisture content where necessary and compacting the top 200 mm as specified in clause SC6.4.6.10.7(1) Compaction and moisture requirements.

The bridging layer shall consist of free-draining granular material with or without geofabric interlayer as specified on the drawings. The granular material shall be end-dumped and spread in a single layer and in sufficient depth to allow the passage of earthmoving equipment with minimal surface heaving. The compaction requirements of clause SC6.4.6.10.7(1) Compaction and moisture requirements shall not apply to the bridging layer.

A bridging layer may also be employed, subject to the approval of the Superintendent, where ground water or seepage is encountered in the foundation area or where the Contractor demonstrates that it is impracticable to achieve the degree of compaction specified for the foundation in clause SC6.4.6.10.7(1) Compaction and moisture requirements. A bridging layer shall not be acceptable if its proximity to the pavement is likely to affect the pavement design. As an alternative to a bridging layer, approval of a working platform created by the chemical stabilisation of in situ material to conform with sub-section SC6.4.6.19 Stabilisation may be required.

(4) Hillside embankments

Where embankments are to be constructed on or against any natural slopes or the batters of existing embankments, the existing slope or batter, if it is steeper than 4 horizontal to 1 vertical in any direction, shall be cut in the form of horizontal terraces over the whole area to be covered by new filling. The existing slope or batter shall be stepped in successive terraces, each at least 1 metre in width, the terraces to be cut progressively as the embankment is placed. Wherever possible terraces shall coincide with natural discontinuities. Subsoil drainage may be required in some instances. Material thus excavated shall be compacted as part of the new embankment material.

(5) Placing fill for embankment construction

The methods of excavation, transport, depositing and spreading of the fill material shall be selected so as to ensure that the placed material is uniformly mixed.
The embankment shall be constructed so as to derive its stability from the adequate compaction of the fine material embedding the large rock pieces rather than mechanical interlock of the rock pieces. The fine material shall be compacted to meet the requirements of clause SC6.4.6.10.7(1) Compaction and moisture requirements.

Fill material for embankment construction shall be placed in layers parallel to the grade line and compacted in accordance with clause SC6.4.6.10.7(1) Compaction and moisture requirements. The layers shall be of uniform compacted thickness not exceeding 200 mm, except that where more than 25 per cent by volume of the filling consists of rock with any dimension larger than 150 mm, the Superintendent may approve an increase in the compacted layer thickness to 300 mm, provided that the relative compaction specified in clause SC6.4.6.10.8(1) Compaction and moisture requirements is attained.

The maximum dimension, measured in any direction, of rock pieces in the fill material for embankment construction shall not exceed two-thirds of the approved compacted layer thickness. Any larger rock pieces shall be reduced in size for incorporation in the embankment layers.

Rock material shall be broken down and evenly distributed through the fill material, and sufficient fine material

shall be placed around the larger material as it is deposited to fill the voids and produce a dense, compact embankment. Where the Superintendent considers insufficient fine material is present to fill the voids, additional fine material shall be obtained from other places in the work or by a change in the method of winning fill material.
Stony patches with insufficient fine material to fill the voids shall be reworked with additional fine material being blended in to achieve a dense, compact layer.

In placing embankment layers, the Contractor shall use equipment and techniques to avoid surface heaving or other damage to the foundations and underlying embankment layers.
After compaction, embankment material in the zone(s) below the selected material zone (or subbase layer, where no selected material zone) shall have a CBR value not less than that quoted in and for the depth(s) specified in SC6.4.6.10 Attachment A Earthworks Supplementary Information.

For the purpose of this clause, the CBR value of the material shall be determined by Test Method AS 1289.6.1.1.

The Contractor shall be responsible for determining suitable sources of material and for any processing to satisfy these quality requirements.

(6) Embankment batters

The batter slopes shown on the drawings represent the estimated requirements for the expected types of materials, and may be subject to redetermination by the Superintendent according to the Superintendent's assessment of the materials encountered.

When completed, the slope of embankment batter shall conform to those shown on the drawings and conform to the following tolerances:

(a) for a vertical distance to 1 m below the shoulder, no point on the completed batter to vary from the specified slope line by more than 150 mm when measured at right angles to the slope line;

(b) at distances greater than 1 m vertically below the shoulder, no point on the completed batter to vary from the specified slope line by more than 300 mm when measured at right angles to the slope; and

(c) in no case is the edge of the formation at the underside of the pavement to be nearer to the roadway than shown on the drawings and the batter slope at no point be steeper than the specified slope.

However, in no case shall the edge of the formation at the underside of the pavement be nearer to the roadway than shown on the drawings.
Undulations in the general plane of the batter shall not be permitted.

(7) Rock facing of embankments

Where shown on the drawings, embankment batters (including embankments at bridge abutments) shall be provided with a facing of clean, hard, durable rock.

The rock facing shall be built up in layers ahead of each layer of filling. Rock may be placed by hand or plant but shall be placed in such a manner that its least dimension is vertical and that mechanical interlock between the larger stones occurs. Any rock deposited in the rock facing which has an excess of fine material surrounding it shall be removed together with the excess fine material and replaced.

The Contractor shall adjust its working methods and programme the work so as to obtain hard and durable rock of the specified dimensions as it is required. The space between larger batter rocks shall be filled with progressively smaller rocks to form a 'graded filter' which prevents the leaching out of fines from the fill material but which does not overfill the voids between larger rocks, or cause the larger rocks to lose contact with one another. Fine material shall not cover the outside of the rocks on the face of the batter.

The Contractor shall exercise extreme caution whilst placing the rock facing. Where embankment material is placed above other roads in use the outer rock layer shall be placed in such a manner as to prevent spillage down the batter.

The Contractor shall ensure that, under no circumstances, could any rock be dislodged and roll onto any adjacent roadway or track in use.

(8) Trimming tops of embankments

The tops of embankments shall be trimmed parallel to the designed grade line at levels equal to the finished surface level less the thicknesses of pavement courses and the selected material zone.

The tops of embankments at these levels shall be compacted to meet the requirements of clause SC6.4.6.10.8(1) Compaction and moisture requirements and trimmed so that they do not vary by more than ±50 mm from the calculated level. The width of the embankment at subgrade level shall not be less than that specified

Prior to placing any subsequent pavement layers over the completed top of embankment filling, the contractor shall present the completed surface to the superintendent for inspection. The contractor shall verify as part of the quality system that the completed surface has achieved full conformance with all respects of the relevant specifications.

(9) Selected material zone

A selected material zone must be provided in accordance with the following quality requirements:

(a) it shall be free from stone larger than 75 mm maximum dimension and have no less than 50% passing the 19 mm AS sieve.

(b) a CBR value not less than the specified in SC6.4.6.10 Attachment A Earthworks Supplementary Information for the fraction passing AS 19mm sieve.

(c) Plasticity Index of 15 maximum

If chemical stabilisation is specified these requirements must apply to the selected material immediately prior to incorporating the stabilising agent.

The Contractor shall use working methods to yield material for the selected material zone by breaking down oversize rock or by other means, including processing through a crusher, to ensure that the resulting material conforms to the requirements of this clause.

The Contractor shall ensure that any material encountered of the quality specified for the selected material zone shall be either placed directly in the selected material zone or stockpiled at locations approved by the Superintendent for future use by the Contractor in the selected material zone until at least sufficient material is reserved to complete the selected material zone over the whole work. Should the Contractor fail to conserve material of the specified quality, the Superintendent may direct that material of equivalent quality be provided.

The selected material zone shall be placed and compacted in layers with the compacted thickness of each layer not exceeding 150 mm. The selected material shall be homogeneous and free from patches containing segregated stone or excess fines. There shall be no areas containing material which does not comply with the specified requirements of this clause and compaction shall be as specified in clause SC6.4.6.10.7(1) Compaction and moisture requirements.

The top of the selected material zone shall be compacted and trimmed parallel with the designed grade line at a level equal to the finished surface level minus the thickness of pavement layers adopted. The tolerances for the trimmed levels are given in SC6.4.6.10 Attachment A Earthworks – Supplementary Information.

Prior to placing any subsequent pavement layers over the completed select material zone surface, the Contractor shall present the completed surface to the Superintendent for inspection. The Contractor shall verify as part of the quality system that the completed surface has achieved full conformance with all respects of relevant Specification.

(10) Fill adjacent to structures

For the purpose of this clause, structures shall include bridges, precast and cast-in-place box culverts and retaining walls. Fill adjacent to other culverts and drainage structures to be provided in accordance with

SC6.4.6.4 Stormwater Drainage, SC6.4.6.6 Pipe Drainage, SC6.4.6.7 Precast Box Culverts and SC6.4.6.5 Drainage Structures.

No filling shall be placed against structures, retaining walls, headwalls or wingwalls within 21 days after placing of the concrete, unless the walls are effectively supported by struts to the satisfaction of the Superintendent, or when the contractor can demonstrate that 85 per cent of the design strength of the concrete has been achieved. This includes concrete in bridge decks and fill placement that impacts the position, stability and serviceability of bridge deck member bearings.

(11) Treatment at weepholes

Drainage adjacent to weepholes shall be provided by either a layer of broken stone or river gravel consisting of clean, hard, durable particles graded from 50 mm to 10 mm such that:

(a) the maximum particle dimension shall not exceed 50 mm; and

(b) no more than 5 per cent by mass shall pass the 9.5 mm A.S. sieve.

The broken stone or river gravel shall be continuous in the line of the weepholes, extend at least 300 mm horizontally into the fill and extend from 200 mm below to at least 450 mm vertically above the level of the weepholes, where practicable.

Alternatively the Contractor may provide a synthetic membrane (geotextile) of equivalent drainage characteristics. It shall be stored and installed in accordance with Manufacturer's instructions. The use of a synthetic membrane (geotextile) shall be subject to the Superintendent's approval.

(12) Selected backfill

(a) Selected backfill shall be placed adjacent to structures in accordance with Table SC6.4.6.10.3 Selected backfill, width and height. The selected backfill shall consist of a granular material having a maximum dimension not exceeding 50 mm and a Plasticity Index, determined by AS 1289.3.3.1, neither less than 2 nor more than 12.

Table SC6.4.6.10.3 Select backfill, width and height

Structure Type	Selected Backfill	
	Width	Height
Bridge abutments	2m	H
Cast-in-place Box Culverts and Precast Culverts	H/3	H + 300mm
Corrugated Steel Pipes and Arches	0.5m	H + 500mm
Retaining Walls	H/3	H

(Where H = height of structure)

The selected backfill shall be placed in layers, with a maximum compacted thickness of 150 mm. Layers shall be placed simultaneously on both sides of box culverts to avoid differential loading. Compaction shall start at the wall and proceed away from it, and shall meet the requirements of clause SC6.4.6.10.8(1) Compaction and moisture requirements.

The existing embankment slope behind the structure shall be cut in the form of successive horizontal terraces, each terrace being at least 1 metre in width, and the selected backfill shall be placed in accordance with clause SC6.4.6.10.6(5) Placing fill for embankment construction.

Where a bridge deck is being concreted adjacent to an abutment, no filling shall be placed against the abutment within 21 days after placing concrete in the bridge deck, unless approved by the Superintendent.

In the case of spill-through abutments, rocks shall not be dumped against the columns or retaining walls but shall be built up evenly by individual placement around or against such structures.

In the case of framed structures, embankments at both ends of the structure shall be brought up

simultaneously, the difference between the levels of the embankments at the respective abutments, shall not exceed 500 mm.

(13) Spoil

Spoil is surplus material from excavations which is not required to complete the Works as specified or other material from excavations whose quality the Superintendent deems to be unacceptable for incorporation in the Works.

Where there is surplus material the Superintendent may direct that flatter batter slopes be provided on embankments which have not been commenced, and/or direct that the excess material be used in the uniform widening of embankments, the surface of which shall be shaped so as to provide a tidy appearance and effective drainage. The surplus material shall be spread and compacted as specified in clauses SC6.4.6.10.6(5) Placing fill for embankment construction and SC6.4.6.10.8(1) Compaction and moisture requirements for material in embankments.

Alternatively, spoil shall be disposed of in the manner and at locations approved by the Superintendent within the specified working area for the Works or be removed and disposed of off site by the Contractor. Surplus material so deposited shall be compacted as specified in clause SC6.4.6.10.8(1) Compaction and moisture requirements for material in embankments or to such lesser extent as may be approved by the Superintendent.

(14) Borrow

Borrow will only be authorised by the Superintendent if, in constructing cuttings and embankments to the batter slopes specified or directed by the Superintendent or in providing materials of the quality specified, and not by reason of excess widening of embankments or wastage by the Contractor of material of the quality specified in clauses SC6.4.6.10.6(2) Embankment material, SC6.4.6.10.6(7) Rock facing of embankments, SC6.4.6.10.6(8) Trimming tops of embankments or SC6.4.6.10.6(10) Fill adjacent to structures, there is an overall deficiency in either the quantity or the quality of material required to complete the Works.

Where borrow material is required to complete the Works as specified, the location of borrow sites shall be as approved by the Superintendent, and the quality of material shall be acceptable to the Superintendent in accordance with clauses SC6.4.6.10.6(2) Embankment material, SC6.4.6.10.6(7) Rock Facing of Embankments or SC6.4.6.10.6(10) Fill Adjacent to Structures as appropriate. The edges of borrow sites shall be no closer than 3 metres from any fence line, or edge of excavation or embankment. Adequate clearance shall be provided for the construction of catch drains. Borrow sites shall have drainage outlets acceptable to the Superintendent, cut batter slopes not steeper than 4h to 1v, and shall be left by the Contractor in a tidy and safe condition (i.e. stabilising disturbed areas).

For borrow within the defined working area for the Works as specified, site preparation shall be in accordance with SC6.4.6.11 Clearing and grubbing and clause SC6.4.6.10.2 Removal of top soil. Restoration of borrow sites shall be carried out by Contractor in accordance with Best Practice Erosion and Sediment Control.

If borrow material is obtained by uniformly widening a cutting, the requirements of Clauses SC6.4.6.10.3(2) Excavation, SC6.4.6.10.3(3) Batter tolerances and SC6.4.6.10.3(5) Treatment of floors of cuttings as to the redetermination of batter slopes, the trimming of batters and the compaction of floors of cuttings respectively shall apply to the borrow area.

The Contractor shall be responsible for obtaining any permits required for entry on land and for the payment of any royalty for such borrow material. The Contractor shall also comply with any requirements of the *Sustainable Planning Act 2009* – as amended, Townsville City Plan, Local laws and land owners, as appropriate.

SC6.4.6.10.7 Acid sulfate soils

(1) Objective

To minimise disturbance to areas of potential acid sulphate soils (PASS) and/or actual acid sulphate soils (ASS). If disturbance of PASS/ASS cannot be avoided, appropriate treatment is required to minimise the potential for environmental harm.

PASS and ASS are soils that have the potential to generate acid through oxidation of iron sulphides when exposed to air. ASS and PASS are generally found in coastal areas, and generally in soils at an elevation of 5 m AHD or lower.

(2) References

Dept of Environment and Resource Management, *Nov 2002*
Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines
State Planning Policy
EF006: Daily Dredging Checklist Form
CE020: Regulated Waste Transport Procedure
QAF004 Incident, Hazard, Improvement reporting form

(3) Safety requirements

Works shall comply with provisions of the Work Health and Safety Act 2011 and subsequent regulations. Personnel are responsible for their own Personal Protective Equipment (PPE) and the safety of the surrounding workplace during works.

Care is to be taken when using hydrogen peroxide, including gloves and eye protection.

(4) Environmental Requirements

Compliance with Environmental Protection Act 1994 and subordinate legislation.
Compliance with *Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines*
Compliance with the State Planning Policy.
Compliance with all other environmental legislation.
Compliance with TCC Environmental Policy.

(5) Equipment and materials

Testing should be undertaken by a suitably qualified laboratory.

(6) Method

(a) Identifying ASS/PASS on site

The following points can assist in determining if soil has a likelihood of containing ASS/PASS. Affirmative answers to the following questions may indicate the presence of ASS/PASS. Field observations and tests should be complemented by laboratory testing.

(i) Is the site elevation 5m AHD or less?

(ii) Are mangroves, she-oaks or melalueca species (i.e. paper barks) present on site?

(iii) Is there other vegetation that is stunted or dying?

(iv) Does the soil have a dark grey to grey appearance?

(v) Is there a rotten egg smell (hydrogen sulphide) to disturbed soil?

(vi) Is there a mottled-yellow mineral present in the soil (Jarosite)?

(vii) Is there water bodies nearby that have a very clear blue-ish appearance, or does it appear to be reddish (rust) in colour?

(viii) Is the pH of the excavated sediment, or water, below 4?

(b) Managing and treating ASS and PASS

(i) Determine if works can be undertaken without disturbing ASS/PASS material.

(ii) If ASS/PASS is to be disturbed as a result of project activities then undertake testing to determine the severity of the potential acidification and extent of ASS/PASS material.

(iii) ASS/PASS material excavated on site must either be treated on site or transported to a treatment location. A treatment pad should be set up as per the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines.*

(iv) ASS material should be transported as regulated waste as it has the potential to be generating acid while exposed to the atmosphere.

(v) All treatment of PASS/ASS must be undertaken in compliance with the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines.*

(vi) ASS/PASS treatment must be undertaken as per the laboratory recommendations.

(c) Corrective/Emergency Actions

If PASS and/or ASS are identified through site inspection and confirmed through lab testing, follow procedure outline in (6) above.

If corrective actions are identified, an Incident, Hazard, Improvement Report is to be completed and subsequent review of this procedure undertaken in accordance with these guidelines.

(d) Waste Control

Treat PASS and ASS in accordance with guidelines (State Planning Policy

Ensure wastes generated as a result of field testing or work activities are disposed of correctly.

(e) Responsibilities

(i) Site foreperson/works controller is responsible for:

(A) monitoring and testing soils; and

(B) Minimising disturbance to PASS/ASS.

(ii) The Environmental Engineer is responsible for ensuring any environmental non-compliances are reported.

(iii) The Executive Manager Engineering Services is responsible for:

(A) notifying relevant personnel of changes to this procedure; and

(B) delivering training to personnel (if required).

(f) Monitoring and reporting

The foreperson will monitor and test soils prior to commencement of works and record results of field tests on daily dredging checklist.

SC6.4.6.10.8 Compaction and quality control

(1) Compaction and moisture requirements

In areas listed below, all layers shall be uniformly compacted to not less than the relative compaction specified before the next layer is commenced. Each layer of material shall be trimmed prior to and during compaction to avoid bridging over low areas. A smooth surface shall be presented at the top of each layer.

(a) The following areas shall be compacted to provide a relative compaction, determined by AS 1289.5.1.1 using AS 1289.5.4.1 or AS 1289.5.7.1 for standard compactive effort, of not less than 95 per cent.

(i) each layer of material replacing unsuitable material as detailed in clause SC6.4.6.10.5 Unsuitable material

(ii) each layer of material placed in embankments, up to 300 mm from the top of the sub-grade;

(iii) fill placed adjacent to structures up to 300mm from the top of sub-grade;

(iv) material in unsealed verges and within medians up to the level at which topsoil is placed;

(v) spoil (excluding unsuitable material); and

(vi) all other areas except those where a higher relative compaction is specified.

Unsuitable material shall be stockpiled as directed by the Superintendent and compacted by track rolling.

(b) The following areas shall be compacted to provide a relative compaction of not less than 97 per cent as determined by AS 1289.5.1.1 using AS 1289.5.4.1 or AS 1289.5.7.1 for standard compactive effort:

(i) foundations for shallow embankments;

(ii) foundations other than shallow embankments

(iii) the whole area on the floors of cuttings;

(iv) each layer of the embankment or cutting within 300mm from the top of sub-grade;

(v) each layer of the selected material zone as specified in clause SC6.4.6.10.6(9) Selected material zone;

(vi) any areas of material of specified quality which may be shown on the drawings or specified elsewhere behind kerbs and/or gutters or adjacent to rigid pavements; and

(vii) the fill material placed adjacent to structures as specified in clauses SC6.4.6.10.6(10) Fill adjacent to structures and SC6.4.6.10.6(12) Selected backfill in each layer within 300 mm from the top of the sub-grade.

Where the vertical alignment design is such that a substantial portion of the road is required to be built at or close to the natural surface, cut the prepared subgrade to a depth below natural surface of less than 0.5 m. Approval is required when shallow cutting conditions occur, the specified transition from cut to fill may be modified such that the depth of terrace excavation at the transition from cut to fill is reduced from 900 mm to 250 mm.

Treat the floor of shallow cutting as specified in clause SC6.4.6.10.3(5) Treatment of floors of cuttings and clause SC6.4.6.10.3(6) Transition from cut to fill and compact to provide a relative compaction of not less than 100% for a depth of 200 mm determined by AS 1289.5.4.1, for standard compactive effort.

At the time of compaction the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content which, unless otherwise approved by the Superintendent, is within the range set out in SC6.4.6.10 Attachment A Earthworks Supplementary Information of the optimum moisture content as determined by AS 1289.5.1.1 or AS 1289.5.7.1. Material which becomes wetted up after placement shall not be compacted until it has dried out so that the moisture content is within this range. The drying process may be assisted by aeration, or where approved by the Superintendent, by the use of hydrated or quick lime. Alternatively the Contractor may transport the wet material to a stockpile site for drying out and later use as fill material. If there is insufficient moisture in the material for it to be compacted as specified, water shall be added. The added water shall be applied uniformly and thoroughly mixed with the material until a homogeneous mixture is obtained.

Compaction shall be undertaken to obtain the specified relative compaction for the full depth of each layer in embankments and for the full width of the formation over the entire length of the work. Compaction shall be completed promptly to minimise the possibility of rain damage.

Any material placed by the Contractor that has attained the specified relative compaction but subsequently becomes wetted up so that the moisture content is greater than the apparent optimum, determined by AS 1289.5.4.1, shall be dried out and uniformly recompacted to the required relative compaction in accordance with this clause before the next layer of material is placed. Alternatively, the Contractor may remove the layer of wetted material to a stockpile site for drying and later re-use.

(2) Test locations

The specified compaction and moisture tests shall be taken at the random test locations established in each lot in accordance with the specified minimum testing frequency. Prior to testing the Contractor shall work the lot to ensure uniform moisture content and compaction of all material within the lot.

The test/s then taken shall be considered to represent the total volume of material placed within the lot.

Where the Superintendent considers that the material which is present has not achieved uniformity required by this clause or clause SC6.4.6.10.6(5) Placing fill for embankment construction, the Superintendent may take or

direct further testing. The Superintendent shall nominate the area represented by the additional testing.

If such testing confirms that material not conforming to the Specification, the Contractor shall carry out remedial work as necessary to achieve conformance to the requirements of clause SC6.4.6.10.8(1) Compaction and moisture requirements.

(3) Deflection monitoring

Following completion of the formation to the underside of the selected material zone in accordance with clause SC6.4.6.10.6(3) Foundations for embankments and SC6.4.6.10.6(5) Placing fill for embankment construction, completion of the selected material zone in accordance with clause SC6.4.6.10.6(9) Selected material zone and SC6.4.6.10.3(5) Treatment of floors of cutting, the Contractor shall make the work available in lots, for the Superintendent or council to carry out deflection monitoring.

A lot for deflection testing shall consist of a continuous length of formation, in compliance with council requirements, and a single carriageway width which is generally homogeneous with respect to material and appearance. The contractor shall identify the boundaries of each lot with stakes clearly labelled to the satisfaction of the Superintendent.

Prior to the release of the lot, a proof roll is to be performed with a single drive axle truck with an axle load of 8.2 t covering all lanes of carriage way including parking bays having no evident movement.

(4) Widening of formation

Road shoulders and formation shall be widened to accommodate footpaths, guard fence, streetlight plinths, emergency telephone bays and vehicle standing areas as shown on the drawings.

(5) Subgrade testing and treatment

Refer to SC6.4.4.2.4

SC6.4.6.10.9 Summary of limits and tolerances

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.10.4 Summary of limits and tolerances below.

Note—tolerances are measured at right angles to design surfaces.

Table SC6.4.6.10.9 Summary of limits and tolerances

Item	Activity	Limits/Tolerances
1.	**Batter Slopes**	± 300mm
	a) Excavation	
	b) Embankment	± 300mm
2.	**Subgrade**	Parallel to designed grade line. Tolerance is to be within ±50 mm of the levels specified.
	Vertical Tolerance	
	Horizontal Tolerance	The width of the cutting at subgrade level for support of the pavement shall not be less than that specified on the drawings or documentation.
3.	**Tops of Embankments**	Parallel to the designed grade line. Tolerance is to be within, ±50 mm from the levels specified
	Vertical Tolerance	
	Horizontal Tolerance	The width of an embankment at subgrade shall not be less than that specified on the drawings or documentation.
4.	**Selected Material**	SC6.4.6.10 Attachment A: Earthworks – Supplementary Information

SC6.4.6.10.10 Attachment A: Earthworks - supplementary information

Clause	Description	Value
SC6.4.6.10.2(1)	The depth below natural surface up to which the removal and measurement of top soil shall apply: (a) Cutting area (b) Embankment area	75mm
SC6.4.6.10.3(5)	Minimum CBR value in cutting floors used for design of pavement	3%
SC6.4.6.10.6(3)	Requirements of material in foundations for shallow embankment Moisture Content - within the range of 60% to 90% of optimum	
SC6.4.6.10.6(5)	Upper Zones of Formation and SC6.4.6.10.6 (9) Select Material Zone Material within each zone shall have a CBR value of not less than the following, under the nominated test conditions:	

Location	Minimum CBR Value	Depth	Nominated Soaking Period (Days)
a. Select Material Zone	10	200	4
b. Material below Selected Material Zone to 1.5 metre from top of pavement	3	N/A	4

SC6.4.6.10.6(9) Construction tolerances for selected material zones is to be ±50mm of the designed grade and crossfall profile

SC6.4.6.10.8(1) Moisture content of material placed in embankments:

(a) Material in upper zones of formation - within the range of 60% to 90% of optimum

(b) All other embankment material - within the range of 60% to 90% of optimum

SC6.4.6.11 Clearing and grubbing

SC6.4.6.11.1 Introduction

(1) Scope

This sub-section provides standards, advice and guidelines for the clearing of all vegetation, both living and dead, all minor man made structures (such as fences and livestock yards), all rubbish and other materials, including the chipping of the crowns of trees and the branches of shrubs, and the grubbing of trees stumps from the area. The work also includes the disposal, in accordance with clause SC6.4.6.11.3(2) Chipping of cleared vegetation and SC6.4.6.11.3(3) Disposal of materials, of all materials that have been cleared and grubbed.

(2) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Australian Standards

AS/NZS 4671(As amended) - *Steel reinforcing materials*
AS 1744 (As amended) - *Forms of letters and numerals for road signs (known as Standard alphabets for road signs).*

(3) General requirements

Site works shall take all measures to prevent damage to existing underground and overhead utility services.

Before commencing earthworks, locate and mark existing underground services in the areas to be affected by the works including clearing, excavating and trenching.

All existing utilities, natural landscape features, including natural rock outcrops, natural vegetation, trees to be preserved, soil and watercourses are to remain undisturbed.

Explosives shall not be permitted to be used in clearing, grubbing or other demolition activities.

Editor's note—DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, through which underground pipes and cables are located (possible within two working days). For more information go to the Dial 1100 Before you Dig website .

SC6.4.6.11.2 Clearing

(1) Clearing operations

The area within the limits of clearing shall be cleared of all vegetation, both living and dead, all minor man made structures (such as fences and livestock yards), all rubbish and other materials which, are unsuitable for use in the works with the exception of certain trees marked for preservation. The contractor shall plan clearing operations such that wherever possible, clearing is carried out progressively and only the minimum area of land is left disturbed at any time.

The contractor shall give the superintendent written notice of seven days of the intention to clear any area of the work. The superintendent shall mark or indicate to the contractor the trees that shall be preserved. The contractor shall arrange for an inspection by an authorised council officer and shall obtain council's approval to proceed with clearing and grubbing. The contractor must conform to the requirements of SC6.4.5.2(18) when protecting identified trees and bushland within or adjacent to the construction site.

The erection of structures, excavation and filling, changes to soil profiles, stockpiling of spoil, storage of other materials and driving or parking of any vehicle or machinery within 4 m of the trunks of trees to be retained shall not be permitted unless they form part of the works as approved by the council.

The Contractor shall plan all operations to ensure that there is no damage to any trees outside the limits of clearing specified or directed by the Superintendent. No growing trees shall be destroyed or damaged by the Contractor other than those specified and those indicated by the Superintendent.

Any tree remaining within the road reserve but outside the limits of clearing which is, in the opinion of the Superintendent, unsound and likely to fall upon the roadway shall be cleared and disposed of in accordance with clause SC6.4.6.11.3(2) Chipping of cleared vegetation, subject to prior approval of council.

If directed by the Superintendent, any branch, which overhangs the road formation, shall be cut back to within 0.5 m of the tree trunk and disposed of in accordance with clause SC6.4.6.11.3(2) Chipping of cleared vegetation.

(2) Fallen timber and tree damage

Every precaution shall be taken to prevent timber from falling onto private property. The Contractor shall dispose of any timber that has fallen onto private property or produce written consent from the property owner to its remaining there.

The cost of disposal of such fallen timber shall be borne by the Contractor. Prior to entering the private property, the Contractor shall obtain consent from the Superintendent and the property owner. Damage of any kind, including damage to trees, fencing, occurring during clearing operations shall be made good by the Contractor. The cost of making good such damage shall be borne by the Contractor. Any damage to trees or vegetation which in councils opinion, will require its removal, is to be in rectified in accordance with SC6.4.5.2.1(19)(d).

SC6.4.6.11.3 Grubbing

(1) Grubbing

All trees and stumps, on or within the limits of clearing, unable to be felled and removed by the clearing methods used by the Contractor shall be removed by grubbing.

Grubbing operations shall be carried out to a depth of 0.5m below the natural surface or 1.5 m below the finished surface level, whichever is the lower.

Holes remaining after trees and stumps have been grubbed shall be backfilled promptly with sound material to prevent the infiltration and ponding of water. The backfilling material shall be compacted to at least the relative density of the material existing in the adjacent ground.

(2) Chipping of cleared vegetation

The Contractor shall produce a wood-chip mulch derived from crowns of trees and branches of shrubs cleared under this sub-section. The wood-chip mulch produced shall be stockpiled for subsequent use or for use at other locations as appropriate.

The wood-chip mulch shall be produced from branches having a maximum diameter of 100 mm and the chipped material produced shall not have two orthogonal dimensions exceeding 75 mm and 50 mm.

(3) Disposal of surplus materials

Unless otherwise specified elsewhere, all surplus materials cleared and grubbed in accordance with this sub-section shall either be removed from the site or used for landscaping within the site in accordance with the approved plans and any conditions set by council.

Unless otherwise approved by council in writing, disposal of timber and other combustible materials by burning shall not be permitted.

SC6.4.6.12 Flexible pavements

SC6.4.6.12.1 Introduction

(1) Scope

This policy sub-section provides standards, advice and guidelines for the supply, spreading, compaction and trimming of base and subbase courses of flexible and semi rigid (bound) pavements.

Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Supervision and construction guidelines.

Editor's note - A reference to drawings is a reference to construction drawings.

(2) Pavement structures

Flexible or semi-rigid pavement material types and layer thicknesses shall be as per design requirements.

(3) Activity plan

Prior to commencement of work, the Contractor must provide the Superintendent a Pavement construction plan and detail the following activities:

(a) allocation of plant and personnel for the contract period;

(b) work programming to meet the constraints of all inspection points; and

(c) prepare and submit a Pavement construction plan for the flexible base and subbase construction consistent with the drawings and subject to direction by the Superintendent. Include the following:

(i) a time based program;

(ii) a drawn sectional plan showing lots and sequence;

(iii) site availability, assumptions on weather, plant and materials;

(iv) a list of activities requiring approvals or notification of local authorities, statutory bodies, and local residents; and

(v) off-site storage of plant, personnel and maintenance facilities.

(4) Inspection, sampling and testing

Inspection, sampling and testing of the pavement shall be undertaken by the Contractor in accordance with the requirements of this sub-section before, during and after the construction of the pavement. Testing shall be carried out by a NATA registered laboratory with appropriate accreditation and suitably qualified personnel.

The Contractor shall provide the Superintendent with written notice when testing is being carried out and copies of all test reports for approval to proceed.

Field density tests shall be carried out in accordance with AS 1289.5.3.1, or, with the Superintendent's concurrence, with a Nuclear Density Meter in accordance with Clause SC6.4.6.12.6(3).

(5) Terminology

Base material	materials designated as Base are of a suitable quality that form the uppermost structural element of a pavement and on which the surfacing may be placed.
Bound material	bound material incorporates binder/s to produce structural stiffness (UCS > 1.5 MPa at 7 days in accordance with TMR Test Method Q115).

Flexible pavement	a flexible pavement consists of a base and a subbase constructed of unbound granular materials obtaining its load spreading properties from intergranular pressure, mechanical interlock and cohesion between the particles of the pavement material.
Modified material	modified material incorporates small amounts of stabilising binder to improve the properties of the material without significantly affecting structural stiffness. A modified material must have sufficient stabilising binder to achieve a UCS range of 0.8 MPa - 1.5 MPa at 7 days in accordance with TMR Test Method Q115.
Subbase material	materials designated as Subbase are laid on the subgrade (or selected material), below the base, either for the purpose of making up additional pavement thickness, to prevent intrusion of the subgrade into the base, or to provide a working platform.
Unbound material	unbound materials are granular materials with no significant capacity to resist tensile stresses.

(6) Reference and source documents
Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this policy sub-section are as follows:
SC6.4.6.16 - Sprayed bitumen surfacing
SC6.4.6.19 - Stabilisation

(b) Queensland Department of Transport and Main Roads specifications
MRS05 - Unbound Pavement

(c) Queensland Department of Transport and Main Roads Test Methods
Q142A - Dry Density - Moisture Relationship (Standard Compaction).
Q115 - Unconfined Compressive Strength of Compacted Materials.
Q701 - Benkelman Beam Deflections.

(d) Australian Standards

AS 1141.14	*- Particle shape, by proportional calliper*
AS 1141.22	*- Wet/dry strength variation*
AS 1289.3.1.1	*- Determination of the liquid limit of a soil - Four point Casagrande method*
AS 1289.3.3.1	*- Calculation of the plasticity index of a soil*
AS 1289.3.6.1	*- Determination of the particle size distribution of a soil - Standard method of analysis by sieving*
AS 1289.3.6.3	*- Determination of the particle size distribution of a soil - Standard method of fine analysis using a hydrometer*
AS 1289.5.1.1	*- Determination of the dry density/moisture content relation of a soil using standard compactive effort*
AS 1289.5.3.1	*- Determination of the field density of a soil - Sand replacement method using a sand-cone pouring apparatus*
AS 1289.5.4.1	*- Compaction control test - Dry density ratio, moisture variation and moisture ratio*
AS 1289.5.8.1	*- Determination of field density and field moisture content of a soil using a nuclear surface moisture - density gauge - Direct transmission mode*
AS 1289.6.1.1	*- Determination of the California bearing ratio of a soil - Standard laboratory method for a remoulded specimen*

SC6.4.6.12.2 Materials

(1) General

The Contractor shall submit details of all constituents of the proposed base and subbase materials, including sources of supply and the proposed type and proportion of any binder. These details shall be submitted to the Superintendent, supported with test results from a nominated NATA registered laboratory confirming that the constituents comply with the requirements of this sub-section.

If the proposed base or subbase is a bound material, the Contractor shall submit a completed SC6.4.6.19 Attachment A Stabilisation mix design contained in the sub-section SC6.4.6.19 Stabilisation.

No material shall be delivered until the Superintendent has approved the source of supply.

If, after the Contractor's proposals have been approved, the Contractor wishes to make changes in any of the material constituents the Contractor shall inform the Superintendent in writing of the proposed changes. No delivery of material produced under the altered proposal shall take place without the approval of the Superintendent.

At least 2 weeks before placement of the material on site, the Contractor shall submit a Certificate from a laboratory with appropriate NATA registration demonstrating and stating that the unbound material or the mix and its constituents comply with the requirements of this sub section.

Ongoing testing of materials during delivery and construction shall be undertaken on samples taken from the site.

(2) Unbound base and subbase

Base materials shall comply with the requirements of type 2.1 materials as per clause 7.2 of MRTS05, grading B or C.

Sub-base materials shall comply with the requirements of type 2.3 materials as per clause 7.2 of MRTS05, grading B or C.

Lower sub-base shall comply with the requirements of type 2.4 materials as per clause 7.2 of MRTS05, grading B or C.

Unbound materials, including blends of two or more different materials, shall consist of granular material which does not develop significant structural stiffness when compacted. Material produced by blending shall be uniform in grading and physical characteristics.

(a) **Surface Evenness**

Townsville City Council reserves the rights to carryout the necessary test procedure and supply results to the Contractor.

(b) **Layer Thickness**

Unbound pavement material shall be laid at a minimum thickness of 125mm and a maximum thickness of 250mm.

(c) **Longitudinal Joins**

Longitudinal joins for paving runs for the top layer of the base courses shall be aligned to coincide with the position of the traffic lane markings, except where approved otherwise in writing by the Superintendent.

(d) **Segregation**

Segregation is the uneven distribution of particle sizes. The construction process shall minimise segregation. There shall be no visible signs of segregation on each lot. Samples shall be taken from each lot to check that segregation of the material in the lost has not occurred. Additional samples shall be taken from any areas which show visible signs of segregation. Each sample shall be tested in accordance with Test Method Q103A.

(3) Lime modified base and subbase materials

Modification of unbound base and subbase materials to meet the requirements of clause SC6.4.6.12.2(2) Unbound base and subbase by the addition of hydrated lime or quicklime shall be subject to approval by the Superintendent and to the additional requirements of this clause. After modification, the material shall meet the requirements of clause SC6.4.6.12.2(2) Unbound base and subbase.

Modification of materials must be by means of blending either hydrated lime through a stationary mixing plant or by hydrated lime or quicklime utilising in-situ operations.

Material requirements of hydrated lime and quicklime shall be in accordance with sub-section SC6.4.6.19 Stabilisation.

The method of incorporating lime through the stationary mixing plant shall ensure that the lime is mixed uniformly through the material.

In-situ operations shall be in accordance with sub-section SC6.4.6.19 Stabilisation.

The proportion of lime shall be not less than 1.5 per cent nor more than 4 per cent by mass. The material prior to lime treatment shall not contain any added pozzolanic material.

The lime treated material shall yield an unconfined compressive strength not exceeding 1.0 MPa, when tested in accordance with Test Method Q115 where sampling is undertaken within 24 hours of adding the lime and testing is after 7 days accelerated curing.

(a) **Curing Final Layer**

Moist curing process has the potential to "wash" the cementitious paste from the upper surface, which leaves an unbound, non-cohesive, soft pavement matrix with high embedment potential for the subsequent sealing aggregate. Therefore, the completed pavement shall not be moist cured within 72 hours of placing. After 72 hours, moist curing shall be carried out using equipment fitted with spray jets that deliver water to the pavement as a fine mist. The use of conventional spray bars or high pressure water nozzles with large aperture sprays holes will not be permitted. Conventional bituminous surface curing may be used within 72 hours.

(4) Insitu lime stabilisation of subgrade

Lime stablisitation of subgrade material shall be carried out as a two day operation to a minimum depth of 250mm, except for natural subgrades of CBR 0.5% where stabilisation depth shall be a minimum of 300mm. The stabilising agent shall be spread using a purpose built spreader and the stabilising agent and water shall be incorporated into the material using a reclaimer/stabiliser. Alternatively, a reclaimer/stabiliser with a calibrated integrated spreader/applicator may be used to incorporate the stabilising agent and water directly into the material to be stabilised. Where a reclaimer/stabiliser with calibrated integrated spreader/applicator is used, quicklime shall not be used as the stabilising agent.

Day 1: A single lime pass at a rate of up to half the required rate shall be applied. Where quicklime is spread over the subgrade, it shall be slaked in accordance with the requirements in this document. In situations where hydrated lime is used, slaking is not required mixing the stabilising agent into the soil. The hydrated lime or lime slurry formed from the slaking of quicklime shall then be mixed into the material in accordance with the requirements in this document. The depth of mixing shall not exceed 90% of the specified stabilisation thickness. The material shall be lightly rolled to seal the surface prior to the completion of work on that particular day.

Day 2: After the overnight amelioration period, the balance of the required lime shall be spread in accordance with the requirements in this document. Where quicklime is spread over the subgrade, it shall be slaked in accordance with the requirements in this document. In situations where hydrated lime is used, slaking is not required before mixing the stabilising agent into the soil. The hydrated lime or lime slurry formed from the slaking of quicklime shall then be mixed into the material in accordance with the requirements in this document. Notwithstanding this a minimum of two mixing passes shall be completed.

Lime shall be spread at a maximum spread rate of 12 kg/m2. The number of passes shall be calculated to comply with this requirement. The stabilising agent shall be uniformly spread over the insitu material at a controlled rate (mass per unit area, kg/m2). The total rate of spread shall be such that the stabilising agent spread rate for the compacted material is within the specified tolerances. Once the stabilising agent has been spread, no traffic, other than the construction plant employed for the stabilisation work, shall travel over it. After each spreading run at least one mixing run, and trimming and/or compaction as required, shall be completed. Further mixing operations between spreading runs shall comply with requirements in this document.

Quicklime shall be slaked with sufficient water to allow complete hydration such that the material remains friable after slaking and no further exothermic reaction occurs when further water is added to the lime. All through traffic shall be stopped during any slaking operation.

The entire stabilisation process shall not proceed in any of the following situations:

- during rainfall;
- when rainfall appears to be imminent;
- during periods when the wind is strong enough to cause particles of the stabilising agent to become airborne;
- during conditions that may result in the work causing nuisance or danger to people, property, the environment, or live stock;
- when the pavement temperature, measured 50 mm below the surface, drops below 10ºC; and
- when the air temperature, measured in the shade, exceeds 40ºC .

(5) Bound base and subbase materials (Including Modified Material)

Bound material for a UCS > 1.5 MPa (7 days) to be used as subbase generally or base layer may be supplied as a quarry product with stabilising agent and layed using a pugmill. Alternatively it may be produced by the in-situ stabilisation of natural or blended gravel where stabilisation is undertaken by mobile plant at the site.

Prior to stabilisation, the base layer material shall meet the requirements for subbase material.

Material requirements for the stabilising agent shall be in accordance with sub-section SC6.4.6.19 Stabilisation.

The stabilisation process shall meet the requirements of sub-section SC6.4.6.19 Stabilisation.

The unconfined compressive strength (UCS) of the material after 28 days curing as determined by Test Method Q115 shall be not less than 3.0 MPa for stabilised pavements and not less than 1.0 MPa for modified pavements. Sampling and test specimen compaction of the material shall be undertaken within one hour of the incorporation of the stabilising agent.

The maximum period between mixing cement with the gravel material and the completion of compaction shall be 3.5 hours.

(a) **Surface Evenness**

Townsville City Council reserves the rights to carryout the necessary test procedure and supply results to the contractor

(b) **Layer Thickness**

Bound pavement material (including Modified Material) shall be laid at a minimum thickness of 150mm and a maximum thickness of 250mm.

(c) **Longitudinal Joins**

Longitudinal joins for paving runs for the top layer of the base courses shall be aligned to coincide with the position with the traffic lane markings, except where approved otherwise in writing by the Superintendent.

(d) **Segregation**

Segregation is the uneven distribution of particle sizes. The construction process shall minimise segregation. There shall be no visible signs of segregation of the material in the lot has not occurred. Additional samples shall be taken from any areas which show visible signs of segregation. Given the

presence of cement additive in the material, the relevant test for segregation shall be as specified in AS 1289.3.6.1.

(e) **Curing Final Layer**
Moist curing process has the potential to “wash” the cementitious paste from the upper surface, which leaves an unbound, non cohesive soft pavement matrix with high embedment potential for the subsequent sealing aggregate. Therefore, the completed pavement shall not be moist cured within 72 hours of placing. After 72 hours, moist curing shall be carried out using equipment fitted with spray jets that deliver water to the pavement as a fine mist. The use of conventional spray bars or high pressure water nozzles with large aperture sprays holes will not be permitted. Conventional bituminous surface curing may be used within 72 hours.

SC6.4.6.12.3 Delivery, stockpiling and processing of pavement material

(1) Delivery to site
Materials must be supplied sufficiently damp to avoid segregation and loss of fines during transit.

(2) Stockpiling of unbound materials
Stockpile sites shall be located as shown on the drawings or as approved by the Superintendent.

Stockpile sites, which shall be cleared of all vegetation and extraneous matter, shall be shaped to form a crown so as to be free draining and compacted over the whole area to provide a relative compaction, determined by AS 1289.5.4.1 for standard compactive effort, of not less than 95 per cent.

Stockpiles and stockpile sites shall be maintained so as to prevent the stockpiled materials from becoming intermixed or contaminated with foreign material.

The total height of any stockpile shall not exceed 3 m.

Stockpiles shall be of uniform shape with side slopes neither steeper than 1.5h to 1v nor flatter than 3h to 1v.

The worked face of any stockpile shall be the full face of the stockpile. The stockpiled material shall be maintained at a moisture content sufficiently damp to avoid loss of fines.

At the completion of the works, stockpile sites shall be cleared of all surplus material and left in a clean and tidy condition.

(3) Delivery of modified or bound materials
Modified or bound materials shall be delivered in vehicles fitted with covers of canvas or other suitable material to prevent loss of moisture during transport.

The time between mixing and conveyance by delivery trucks to the site, shall be such as to allow incorporation into the works including trimming and compaction within the nominated field working period.

Each truck load of bound material shall be identified by delivery dockets, indicating the time and date of mixing and registration or fleet number of the delivery truck, and such dockets shall be made available to the Superintendent at the point of delivery.

Bound materials shall comply with the requirements of sub-section SC6.4.6.19 Stabilisation.

SC6.4.6.12.4 Spreading pavement materials

The contractor must present the underlying layer to the Superintendent prior to placement of subsequent layers and ensuring that moisture content does not exceed 90 per cent of the laboratory optimum moisture content as determined by AS 1289.5.1.1 or which has become rutted or mixed with foreign matter. The underlying layer shall be corrected to comply with this Sub-section before spreading of the next layer of pavement.

Where the underlying layer was constructed by the Contractor, or where the Contractor’s activities caused the underlying layer constructed by others to become non-complying with this sub-section, the correcting the underlying

layer to comply shall be the responsibility of the Contractor.

Each layer of material shall be deposited and spread in a concurrent operation and, after compaction, the finished surface levels on the base and subbase courses shall be within the permitted tolerances stated in Clause SC6.4.6.12.6(6)(c) Levels and surface trim without subsequent addition of material. The thickness of each compacted layer shall be neither less than 150 mm nor more than 300 mm for all pavement layer types, unless otherwise approved by the Superintendent.

At all work boundaries in bound materials the Contractor shall provide vertical faces to provide for transverse and longitudinal joints.

When spread for compaction processes the moisture content of the unbound and bound base or subbase materials shall be in the range of 60-90 per cent and 75-100 per cent respectively of laboratory optimum moisture content in accordance with AS 1289.5.1.1.

Bound materials with UCS > 1.5 MPa (7 days) shall not be spread when the ambient air temperature in shade is either below 5 °C or above 35 °C with a self-propelled paver. The working time shall not exceed 3 hours (i.e. materials must be trimmed and compacted within 3 hours from the time the cement is added to the material at the quarry). Where the materials are to be spread outside the required ambient air temperature range, the Contractor must submit a work proposal to the Superintendent for approval.

SC6.4.6.12.5 Trimming and compaction

(1) General requirements

Each layer of the base and subbase courses shall be uniformly compacted over its entire area and depth to satisfy the requirements of relative compaction set out in clauses SC6.4.6.12.6(3) Relative compaction and SC6.4.6.12.6(4) Compaction requirements and acceptance.

On sections of pavement with one way crossfall, compaction shall begin at the low side of the pavement and progress to the high side. On crowned sections, compaction shall begin at the sides of the pavement and progress towards the crown. Each pass of the rollers shall be parallel with the centreline of the roadway and uniformly overlap each preceding pass. The outer metre of both sides of the pavement shall receive at least two more passes by the compaction plant than the remainder of the pavement.

At locations where it would be impracticable to use self propelled compaction plant, the pavement material shall be compacted by alternative hand operated plant approved by the Superintendent.

Watering and compaction plant shall not be allowed to stand on the pavement being compacted.
If any unstable areas develop during rolling, the unstable material shall be rejected. The rejected material shall be removed for the full depth of the layer, disposed of and replaced with fresh material in accordance with clause SC6.4.6.12.6(8) Removal and replacement of rejected courses. This operation will be at cost to the Contractor.

The placement of subsequent layers shall not be allowed until the requisite testing has been completed and the test results for each layer have been accepted by the Superintendent and correct curing times for bound layers has been attained.

Any unbound material in a layer that has attained the specified relative compaction but subsequently becomes wetted up shall be dried out and, if necessary, uniformly recompacted and trimmed to meet the specified density requirements and level tolerances.

(2) Curing of bound materials

The curing of the surface layer of a lot shall commence after compaction is completed and must be in accordance with the SC6.4.6.19 Attachment A Stabilisation mix design.

The stabilised work shall be protected against rapid drying out by keeping it continuously wet or damp during the period prior to the provision of a subsequent layer or the application of a prime or primer-seal.

Moist curing of the final layer process has the potential to “wash” the cementitious paste from the upper surface, which leaves an unbound, non cohesive soft pavement matrix with high embedment potential for the subsequent sealing aggregate. Therefore, the completed pavement shall not be moist cured within 72 hours of placing. After 72 hours, moist curing shall be carried out using equipment fitted with spray jets that deliver water to the pavement as a fine mist. The use of conventional spray bars or high pressure water nozzles with large aperture sprays holes will not be permitted. Conventional bituminous surface curing may be used within 72 hours.

SC6.4.6.12.6 Acceptance of compaction

(1) Lots for acceptance

Acceptance of work, as far as compaction is concerned, shall be based on density testing of the work in lots. A lot shall be nominated by the Contractor, but shall conform to the following:

(a) cover only a single layer of work which has been constructed under uniform conditions in a continuous operation and not crossing any transverse construction joints; and

(b) for unbound materials, it may equal a day's output using the same material.

(2) Compaction assessment

The Superintendent shall assess compaction for each lot based on random sampling of test locations for in-situ dry density testing.

The Contractor shall arrange for testing to assess compaction on the basis of 10 tests per 5000 sq m with a minimum of three tests per lot, and present the results to the Superintendent for approval.

The elastic rebound deflection shall be taken as the maximum deflection in accordance with Test Method Q701 utilising the Benkelman Beam or equivalent. The average maximum deflection for any lot shall not exceed 1.0 mm, and the co-efficient of variation (CV) in recorded deflections shall not exceed 30 per cent.

Measurements shall be taken at the rate of 4 per 1000 square metres, with a minimum of ten measurements per lot.

Proof rolling shall be undertaken with the use of a single drive axle truck with an axle load of 8.2 t covering all lanes of carriage way including parking bays having no evident movement.

(3) Relative compaction

The relative compaction of pavement material at each location tested for in-situ dry density shall be calculated in accordance with AS 1289.5.4.1 as follows:

$$\text{Relative Compaction (per cent)} = \frac{\text{In-situ dry density}}{\text{Comparative dry density}} \times 100$$

Note—the comparative dry density shall be the maximum dry density determined in the laboratory.

The council Superintendent may approve some or all of the in-situ dry density testing to be carried out with a single probe Nuclear Density Meter in the direct transmission mode in accordance with AS 1289.5.8.1. Council reserves the right to request additional testing at the discretion of the Inspector.

Each day that material is produced for placement in a layer or layers, a sample of the material shall be taken by the Contractor for maximum dry density testing to represent that day's production.

For unbound layers, the sample shall be tested in accordance with AS 1289.5.1.1 to determine the maximum dry density (standard compactive effort) for the material.

For bound layers the sample shall be tested within two hours after the addition of stabilising agent to the mix in accordance with Test Method Q142A to determine the maximum dry density (standard compactive effort) for the material. This test method shall also be used to determine the standard optimum moisture content.

The maximum dry density so determined shall be used as the comparative dry density in relative compaction calculations for all like material from that lot or day's production placed in a single layer of work whichever is the lesser.

(4) Compaction requirements and acceptance

All compaction test results must exceed the minimum requirements in accordance with:

(a)	Unbound pavement	MRTS05
(b)	Insitu stabilised subgrade using lime	MRTS07A
(c)	Insitu stabilised pavement using cement	MRTS07B
(d)	Insitu stablised pavement using foam bitumen	MRTS07C
(e)	Plant mixed stabilised pavement	MRTS08

(5) Reworking of rejected unbound layers

Lots or areas of pavement that have been rejected in regard to compaction shall be reworked before resubmission for compaction assessment.

Material that has become degraded, segregated or otherwise reduced in quality by reworking shall be rejected. The rejected material shall be removed, disposed of and replaced with fresh material complying with this Sub-section in accordance with clause SC6.4.6.12.6(8) Removal and replacement of rejected courses. When a lot or area of pavement is resubmitted for compaction assessment, testing shall be carried out in accordance with clauses SC6.4.6.12.6(2) Compaction assessment and SC6.4.6.12.6(3) Relative compaction.

All corrective work shall be carried out by the Contractor before the resubmission of a lot for compaction assessment, including rewatering, rerolling, removal and replacement of material as well as reworking. All costs associated with corrective work carried out before the resubmission of a lot for compaction assessment, including rewatering, rerolling, removal and replacement of material as well as as reworking shall be borne by the Contractor.

(6) Tolerances

(a) General

The tolerances stated are the acceptable limits of departure from the dimensions shown on the drawings, which may occur during construction.

Areas for assessment of conformity with tolerance requirements shall be divided into lots and presented to the Superintendent together with survey reports covering line and level.

(b) Width

At any cross section without kerb and /or gutteringchannel or a dish drain, and for pavement layers extending under the kerb and channel or dish drain/or guttering , the horizontal dimension measured from the design centre line to the edge of the constructed pavement surface shall be neither less than 50 mm less than the dimension nor more than 300 mm greater than the dimension shown on the drawings. The average width of the layer determined from measurements at three sites selected at random by the Superintendent over any 200 m road length, or part thereof, shall be not less than the specified width.

(c) Levels and surface trim

The levels of the finished surface of the top of the unbound subbase course shall not vary from the design levels by more than ± (10) 15 mm.

Level tolerances at the top of the unbound base course shall not exceed those stated above for subbase. In addition, where kerb and channel exists or is being constructed, the level of the top of the base course adjacent to the kerb and channel shall not vary by more than ± 5 mm from the lip level of the gutter minus the design thickness of the wearing surface.

The design level of the top of the subbase course shall be determined from the design level of the finished road surface less the thickness of the base course and the wearing course, including an allowance for any flush seal layer in the pavement design.

The pavement surface after trimming and immediately prior to sealing shall be of a quality such that the deviation under a 3 m straight edge placed in any direction does not exceed 12 mm. Measurements for conformance shall be taken in accordance with the maximum lot size and minimum test frequencies in SC6.4.5 Construction management.

(7) Action on rejection

(a) Unbound materials

A lot that has not complied with the requirements for width or level tolerance as set out in clauses SC6.4.6.12.6(6)(b) Width and SC6.4.6.12.6(6)(c) Levels and surface trim respectively shall be rejected except as otherwise provided in this clause. Rejected lots shall be removed, disposed of and replaced with fresh material in accordance with clause SC6.4.6.12.6(8) Removal and replacement of rejected courses.

Notwithstanding the above, where the rejected lot can be corrected by further trimming, the Superintendent may allow the surface to be corrected without complete removal and replacement with fresh material. Such trimming shall be undertaken in a manner that produces a uniform, hard surface and shall be achieved by cutting only without filling. After any such cutting, the level tolerances in clause SC6.4.6.12.6(6)(c) Levels and surface trim shall apply.

The required surface correction or replacement work ordered in accordance with this clause including removal of material, disposal and supply and transport of replacement material, shall be borne by the Contractor.

(b) Bound materials

An area of bound material that has not complied with the requirements for width or level tolerance as set out in clauses SC6.4.6.12.6(6)(b) Width and SC6.4.6.12.6(6) Levels and surface trim respectively shall be rejected except as otherwise provided for in this clause. Rejected areas shall be removed, disposed of and replaced with fresh material in accordance with clause SC6.4.6.12.6(8) Removal and replacement of rejected courses.

The removal and disposal of rejected material and its replacement with fresh material shall be borne by the Contractor.

Notwithstanding the above, the Superintendent may allow the Contractor to rectify the area in the following cases:

(i) Where the cause for rejection is under clause SC6.4.6.12.6(6)(c) Levels and surface trim, the course is a subbase course and rejection is due to departures from design level being too far below the design level, the Contractor may increase the thickness of the base course to make up such deficiency in thickness.

(ii) Where the cause for rejection is under clause SC6.4.6.12.6(6)(c) Levels and surface trim, the course is a subbase course and rejection is due to departures from design level being too far above the design level, the Contractor may propose a regrading of the design level of the base course, to allow for its design thickness to be laid, up to a maximum of 20 mm above the original design level. Approval by the Superintendent shall be subject to the following requirements:

(A) the rate of change of grade from the original finished design surface level shall be less than 3 mm per metre;

(B) the regrading shall not interfere with the proper design functioning of the drainage system;

(C) the regrading shall not interfere with levels at the property boundary, or increase or decrease footpath or footpath crossover levels or grades beyond council's allowable design limits; and

(D) the regrading shall not interfere with clearances.

(iii) Where the cause for rejection is under clause SC6.4.6.12.6(6)(c) Levels and surface trim, the

course is a base course and rejection is due to departures from design level being too far above the design level, the Contractor may propose a regrading of the design level of the base course. Approval by the Superintendent shall be subject to the requirements of this clause in (ii) above.

(8) Removal and replacement of rejected courses
Sections of work that have been rejected by the superintendent are to be removed from the work site and replaced with fresh material.

Any rejected pavement sections are to be removed and replaced over the full length of the rejected lot for a minimum length of 20 m of the pavement layer. Any damage to underlying or abutting layers or structures shall be made good by the Contractor using methods approved by the Superintendent.

The Superintendent may approve removal for less than the full width as constructed if the cause of the rejection of the work can be isolated transversely to the Superintendent's satisfaction. In this case, the new longitudinal cold joint shall be formed and located along the centreline of the road pavement.
After removal of rejected base or subbase course material, the section shall be presented for inspection by the Superintendent before replacement work is commenced.

Materials used as replacement materials, and the subsequent spreading, compaction, trimming, curing and testing of the replacement materials, shall comply with the requirements of this sub-section.

The removal, replacement and correction of base and subbase courses required under this clause shall be the responsibility of the Contractor in respect of delays caused by such removals, replacements and corrections shall be borne by the Contractor.

All costs associated with the corrective work shall be borne by the Contractor.

(9) Maintenance before completion of wearing surface
Following the Superintendent's acceptance of any section of the work, the Contractor shall maintain the prepared surface of the base in the condition specified for acceptance until the wearing surface is completed. The preparation work shall be carried out in a manner which will promote the adhesion of the bituminous material to the surface of the pavement. Preparation work shall include:

(a) Removal of all foreign and loose material from the surface.

(b) Light watering on dray and dusty surface

Ball Penetration testing on inner and outer wheelpaths shall be carried out on all pavements before application of bituminous material. Where a ball penetration result exceeds 4.0mm the surface shall not be sprayed until Council is advised and approval to proceed granted.

The base course of sections of the accepted work shall be covered with a primerseal over the full width of pavement in accordance with sub-section SC6.4.6.16 Sprayed bitumen surfacing within 7 days of the date of the acceptance of such sections, unless otherwise approved by the Superintendent.

Should the pavement condition deteriorate before the application of the primerseal and consent to proceed with the bitumen surfacing work is withdrawn by the Superintendent, the Contractor shall re-prepare the pavement and re-present the pavement for inspection by the Superintendent.

The maintenance and re preparing areas of the deteriorated pavement shall be the responsibility of the Contractor.

The Contractor shall maintain adequate drainage of the pavement, and remove any ponded water within 12 hours of its creation if free drainage cannot be achieved, prior to the completion of the wearing course.

SC6.4.6.12.7 Opening pavement to traffic
General requirements

For unbound pavement layers, construction plant and vehicles not involved in the current construction or testing of the work shall not be permitted to use the pavement until the primerseal has been applied, unless otherwise approved.

For bound pavement layers, construction plant and vehicles not involved in the current construction or testing of the work shall not be permitted to use the pavement until the primerseal has been applied and seven days have elapsed since placement of the base. In any case only vehicles registered for legal road usage and loaded within legal limits will be allowed to use the pavement.

For bound pavement layers, traffic shall not be allowed to use the constructed pavement until a minimum of seven days after completion of the full pavement depth and the primerseal.

SC6.4.6.12.8 Limits and tolerances

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.12.1 below.

Table SC6.4.6.12.1 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	**Stockpile Sites**	(i) Relative Compaction >97%	SC6.4.6.12.3(2)
		(ii) Stockpile height <3m	SC6.4.6.12.3(2)
		(iii) Stockpile batter <1.5:1 and >3:1	
2.	**Spreading Pavement Materials**		
	(i) Compacted Layer Thickness	≥150mm (modified material) ≥125mm (unmodified material) ≤250mm (all material)	SC6.4.6.12.4
3.	**Compaction Acceptance**		
	Minimum value of all calculated relative compaction results	All compaction test results must exceed the minimum referenced requirements	SC6.4.6.12.6(4)
4.	**Width of Pavement**	-50mm to +300mm of dimensions on drawings	SC6.4.6.12.6(6)(b)
	(i) Design centre-line to edge of constructed pavement		
	(ii) Average Width	The average width determined from 3 random sites over any 200m road length, or part thereof, shall be not less than the specified width.	SC6.4.6.12.6(6)(b)
5.	**Surface Level**		
	(i) Subbase levels	<± 15mm from design level	SC6.4.6.12.6(6)(c)
	(ii) Base levels	<± 15mm from design level	SC6.4.6.12.6(6)(c)
	(iii) Base levels adjacent to kerb and channel	<±5mm from the lip levels of adjacent gutter minus design thickness of wearing surface.	SC6.4.6.12.6(6)(c)
	(iv) Shape	Deviation from a 3m long straightedge on base surface immediately prior to sealing shall be less than 12mm	SC6.4.6.12.6(6)(c)
	(v) Ball Penetration	>4.0mm	SC6.4.6.12.6(9)

SC6.4.6.13 Asphaltic concrete

SC6.4.6.13.1 Introduction

(1) Scope

(a) This policy sub-section provides standards, advice and guidelines for the production and placing of asphalt including the supply of materials, sampling, testing and any other operations necessary to provide asphalt. . The extent of the policy sub-section shall includes:

(i) manufacture/supply of the production mix;

(ii) provision of a testing laboratory;

(iii) preparation of the surface on which asphalt is to be placed;

(iv) transport of asphalt;

(v) laying and compaction of asphalt; and

(vi) sampling and testing.

(b) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

Editors note - A reference to drawings is a reference and construction drawings.

(2) Plant

The Contractor shall provide all the plant, equipment and labour necessary for carrying out the work in accordance with this sub-section.

All plant and equipment used on the work shall be in accordance with the submitted quality documentation and kept in good operating condition. The Contractor shall not use in the work any plant or equipment demonstrated to be faulty in operation so as to effect the product quality or unsafe in operation as assessed by the Superintendent.

All plant shall be registered and insured as appropriate to its use on a public road and shall comply with statutory environmental regulations.

(3) Protection of services and road fixtures

The Contractor shall take all necessary precautions to prevent asphalt or other material used on the work from entering or adhering to gratings, hydrants or valve boxes, access chamber covers, bridge or culvert decks and other road fixtures. Immediately after the asphalt has been spread the Contractor shall clean off or remove any such material as directed by the Superintendent and leave the services and road fixtures in a condition satisfactory to the Superintendent.

(4) Control of traffic

The Contractor shall provide for traffic control in accordance with the requirements of sub-section SC6.4.6.30 Control of traffic while undertaking the work.

The Contractor shall take all necessary steps to avoid or minimise delays and inconvenience to road users during the course of the work but without compromise to the safety of the road users or employees.

(5) Work records

Particulars of the work performed shall be recorded by the Contractor on the Asphalt Work Record at SC6.4.6.13 Attachment A Asphalt Work Record or as per the Contractor's own procedures where equivalent. The Contractor shall complete the Asphalt Work Record, which shall be countersigned by the Superintendent each day as a true record of the work performed. A copy shall be supplied to the Superintendent.

Delivery dockets stating the mass of each truck load of asphalt shall be attached to the Asphalt Work Record.

(6) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections

SC6.4.6.30 - Control of traffic

(b) Australian Standards

AS 1141.11	*- Particle size distribution by dry sieving*
AS 1141.14	*- Particle shape, by proportional calliper*
AS 1141.17	*- Voids in dry compacted filler*
AS 1141.18	*- Crushed particles in coarse aggregate derived from gravel*
AS 1141.22	*- Wet/dry strength variation*
AS 1141.42	*- Pendulum friction test (PAFV)*
AS 1160	*- Bitumen emulsions for the construction and maintenance of pavements*
AS 2008	*- Residual bitumen for pavements*
AS 2150	*- Hot mix asphalt*
AS 2758.5	*- Asphalt aggregates*
AS 2891.1	*- Sampling of Asphalt*
AS 2891.3.1	*- Bitumen content and aggregate grading - Reflux method*
AS 2891.5	*- Determination of stability and flow - Marshall procedure*
AS 2891.8	*- Voids and density relationships for compacted asphalt mixes*
AS 2891.9.3	- Determination of bulk density of compacted asphalt - Mensuration method
AS 2891.10	- Water and volatile oils content

(c) Queensland Department of Transport and Main Roads Specifications

MRS17 (11/11)	*- Bitumen*
MRS18 (11/11)	*- Polymer Modified Binder*
MRS21 (06/09)	*- Bituminous Emulsion*
MRS30 (06/13)	*- Dense Graded and Open Graded Asphalt*
MRS31 (06/13)	*- Heavy Duty Asphalt*

(d) Austroads

AGPT03-2009 *Guide to Pavement Technology Part 3 – Pavement surfacings*
AGPT04B-2007 *Guide to Pavement Technology Part 4B - Asphalt*

SC6.4.6.13.2 Materials

Materials and mix ingredients shall be in accordance with MRTS30. Binder shall be in accordance with MRTS17 and polymer modified binder in accordance with MRTS18.

SC6.4.6.13.3 Asphalt mix design

(1) Approved mix

The supply only of an approved mix in accordance with MRTS 30.

The Contractor shall not make any changes to the approved mix, or constituent materials without the prior written approval of the Superintendent.

Notwithstanding any approval given by the Superintendent to a proposed asphalt mix, the Contractor shall be responsible for producing asphalt which satisfies all requirements of this policy sub-section.

Asphalt produced in the plant and delivered to the site shall be known as the "production mix".

(2) Production

(a) Asphalt production shall comply with the requirements of MRTS30.
The Superintendent, upon provision of notice to the asphalt supplier or the supplier's representative, shall have access to the mixing plant for purposes of inspection to verify production procedures and the supplier's compliance with the Contractor's Quality Management Manual and Project Quality Plan. The Superintendent shall have the right to declare any non-conformance and shall be entitled to request

correction of either the Contractor's Quality Management Manual or the Project Quality Plan or both.

(b) Storage of asphalt
Asphalt may be stored in an insulated storage bin prior to delivery. Asphalt which has been stored for more than twenty four hours or is below the minimum temperature specified shall not be used. Binder manufacturer's instructions must be followed when polymer modified asphalt is stored.

(c) Contractor's laboratory
The Contractor shall maintain and operate an appropriately registered NATA testing laboratory at or near the mixing plant to control the quality of the asphalt produced.

The Contractor will make the laboratory available for inspection by the Superintendent at any time during the course of the works.

All documented test results shall be submitted to the Superintendent for inspection and approval in a format and to a timetable suitable to the Superintendent.

The Contractor shall be responsible for taking samples and shall supply all facilities, equipment and labour for that purpose. The samples shall be taken by the Contractor.

(d) Frequency of sampling
For the purpose of testing production mix the Contractor shall sample production lots at the minimum frequencies set in MRTS30. This testing frequency requirement shall apply to each asphalt mix type. The test results shall be related to production intervals with samples representing the full lot of production of the relevant mix for the production interval.

Test results from this production control sampling are acceptable as representative of deliveries made under this contract subject to the traceability of production from specific production intervals to the location at the paving site.

Such traceability shall include registration of lot number and time of production on the delivery docket system. The size of any production lot shall be limited to production from a 12 hour "shift".

Sampling shall be performed in accordance with Test Method Q301. Samples shall be identified so as to allow traceability of the mix to the paving site. Each sample or sample portion as appropriate sampled as a referee sample shall be stored in an airtight container labelled so as to be traceable to the job and paving site location.

Testing required shall be arranged by the Contractor at an appropriately registered NATA laboratory. Test reports will be made available to the Superintendent as soon as they are available and always within 7 days of delivery of material.

Dense graded asphalt that does not include modified bitumen may include a proportion of RAP up to but not exceeding 20 per cent by mass. The resultant asphalt shall meet all requirements for the Nominated Mix.

The RAP to be utilised shall be nominated by source and/or stockpile. Testing of the Nominated Mix shall include RAP sampled from the stockpile and of similar physical properties as that to be utilised for the contract. Any change in RAP supply shall be brought to the attention of the Superintendent prior to proposed usage in asphalt under this contract.

(3) Delivery
The bodies of haulage trucks shall be kept clean and coated with a thin film of an approved release agent to prevent asphalt sticking to the body of the truck. Any surplus release agent shall be removed before loading.

During transport asphalt shall be covered with a canvas or other suitable cover which is held down securely.

When transported to site until delivery to the hopper, the mix must be covered with a heavy duty canvas or similar waterproof cover which shall overlap the sides of the truck body by at least 250 mm and shall be tied

down securely. The bodies of all trucks shall be suitably insulated.

Delivery of the asphalt shall be at a uniform rate within the capacity of the spreading and compacting equipment.

The mass of all truck loads of asphalt shall be measured on a registered weighbridge.

(4) Placing

Placing of asphalt shall not be permitted when the surface of the road is wet or while rain appears imminent, or when cold winds chill the asphalt to such an extent that, in the opinion of the Superintendent, spreading and compaction will be adversely affected. The Superintendent may order work to cease temporarily on account of adverse weather, unsatisfactory pavement surface condition, or other circumstance which the Superintendent feels may adversely affect the subsequent operations.

(5) Preparation of pavement

The existing surface shall be dry, clean and free from any loose stones, dirt and foreign matter. The surface shall be swept beyond the edge of the proposed asphalt layer by at least 300 mm. Any foreign matter adhering to the pavement and not swept off shall be removed by other means. Any areas significantly affected by oil contamination shall be cleaned to the satisfaction of the Superintendent.

Surface preparation shall be in accordance with AS 2734. Thermoplastic linemarking or other linemarking, where indicated necessary by the Superintendent will be removed prior to paving. Raised pavement markers shall be removed prior to paving.

The Contractor, when paving over existing road pavement, shall be responsible for the recording of lane marking positions including the extent of barrier line. After paving the Contractor will mark up the pavement to re-establish such positions using conventions agreed with the Superintendent and to a standard adequate to allow accurate re-establishment of line marking.

The Contractor shall repair any damage to the existing pavement surface caused by the Contractor's activities. Affected areas designated by the Superintendent shall be removed and reinstated to the Superintendent’s satisfaction.

A corrector course shall be used to correct irregularities in an existing surface and/or modify the shape of an existing surface. Any surface depressions greater than 25 mm in depth and any uneven surface shall be brought to the general level of the surrounding pavement/deck surface. Where a corrector course is used to modify the shape of an existing surface, the course shall be laid to the reduced levels and/or shape specified in the documents.

The Contractor shall mark out, in the presence of the Superintendent, the areas where corrector course is to be applied and shall not lay corrector course prior to receiving acceptance of the proposed areas from the Superintendent.
The asphalt in these patches shall be compacted to comply with the general level of the existing surface to the Superintendent’s satisfaction.
Back filling and stress absorbing fabric strips is to be carried out in accordance MRTS30 where indicated on the drawings or directed by the superintendent.
Preparation of the prepared surface is to be to the satisfaction of the Superintendent. Subsequent inspection and Superintendent’s approval of surface condition shall be required prior to the release of the hold point.

(6) Tack coat

Only on multiple courses shall tack coat be used between each course unless directed otherwise by the Superintendent. The whole of the area to be sheeted with asphalt shall be tack coated with a light and even coat of bitumen emulsion. Bitumen emulsion shall comply with the requirements of MRTS21.

The bitumen emulsion shall be applied at a rate of between 0.10 litres per square metre and 0.20 litres per square metre of undiluted bitumen unless otherwise specified.

The bitumen emulsion shall be applied by a mechanical sprayer with spray bar. Where the areas to be sprayed are small, irregular or inaccessible to mechanical sprayers, such areas shall be tack coated by hand spraying or brushing.

The bitumen emulsion may be warmed or diluted with water to facilitate spraying. Adequate time shall be allowed for the emulsion to break before asphalt is laid. Over application of tack coat, due to surface depressions, shall be removed or dispersed by brushing.

All contact surfaces of kerbs and other structures and all cold joints shall be coated with a thin uniform application of tack coat.

Care shall be taken to ensure that bitumen emulsion is not sprayed on, or allowed to coat, any services or exposed fixtures including concrete kerbs, guardfence or bridge handrails. Appurtenances susceptible to overspray shall be protected with suitable paper.

When trucks or other vehicles are likely to move from tack coated areas onto adjacent finished surfaces, the Superintendent may require that the finished surfaces be suitably protected from carryover of bituminous material.

In locations of heavy pedestrian traffic, such as shopping areas, the Contractor shall take appropriate precautions in accordance with sub-section SC6.4.6.30 Control of traffic to keep pedestrians off tack coated areas.

(7) Laying

(a) Paver

The paver(s) shall be expected to have a minimum spreading capacity of 50 tonnes of asphalt per hour and be capable of spreading a width of at least 3.7 m to the requirements of this sub-section. It shall be expected to have automatic screed control operated from joint matching shoe, fixed line, travelling straight edge or levelling beam. The Contractor shall provide the Superintendent with notice of proposed pavers without these capabilities and obtain Superintendent's agreement to their use.

(b) Laying operations

The work shall be so arranged as to keep the number of joints, both longitudinal and transverse to a minimum.

The paver shall operate at a uniform speed and the delivery of asphalt shall match the output of the paver such that continuous laying of asphalt is achieved.

When laying asphalt in echelon the distance between pavers shall be such that the temperature of the asphalt at the edge of the asphalt laid by the advance paver is not less than 80 °C by the time the following paver matches the longitudinal joint.

In the event of faulty operation of the paver causing irregularities in the spread asphalt, work shall cease until the fault is rectified.

Unless otherwise approved by the Superintendent, asphalt shall not be spread by hand behind the paver. Workers shall not stand or walk on the hot surface until compaction has been completed except where necessary for correction of the surface.

The Superintendent may approve spreading asphalt by hand for minor correction of the existing surface and in areas inaccessible to mechanical pavers.

Asphalt shall not be placed when the surface of the pavement is wet or while rain appears imminent.

AS 2734 shall constitute a valid reference of good practice for asphalt laying practice.

(c) Laying temperature

Weather restrictions and minimum asphalt temperatures at the time of discharge into the paver shall be in accordance with MRTS30. Measurement may be made by calibrated infra-red thermometers when accepted by both Contractor and Superintendent.

The Superintendent may reject that part of any truck load which contains lumps of cooled asphalt which are liable to affect the quality of the finished surface.

The laying temperature shall be measured in the paver hopper. A suitable stem type thermometer readable and accurate to within plus or minus 2 °C with a range from at least 0 °C to 200 °C shall be used. The stem shall be inserted into the asphalt to a depth of approximately 200 mm at a location at least 300 mm from the side of the paver. The average of two readings shall be adopted as the temperature of the mix. Measurements of asphalt and road surface temperatures and wind velocity to comply with this Clause shall be recorded on the Asphalt Work Record Sheet.

(d) Level control

The minimum controls for level set out below shall be used. Additional controls may be necessary to obtain the required finished pavement properties.

Corrective courses shall be automatically controlled by programmed computer control of the paver, joint matching shoe or stringline sensor. Where the correction is only minor, the Superintendent may allow the use of levelling beams at least 10 m long.

Intermediate courses shall be automatically controlled by programmed computer control of the paver or a joint matching shoe.

The wearing course shall be controlled by levelling beams at least 10 m long and, as required by the Superintendent or a joint matching shoe. When identified in the Project Quality Plan and/or approved in writing by the Superintendent, small areas (as defined) may be paved as wearing course without the use of levelling beam to achieve target levels.

(e) Layer thickness

The compacted thickness of each course shall be as shown on the drawings. A course may comprise one or more layers. The nominal compacted layer thickness shall be in accordance MRTS30.

(8) Joints

(a) General

The location of longitudinal and transverse joints shall be as approved by the Superintendent and at the spacing nominated in the drawings. All joints shall be compacted and finished with a smooth, planar surface coinciding with, and being of similar appearance to the remainder of the layer.

(b) Longitudinal joints

An automatically controlled joint matching device shall be used to control the levels of adjacent runs. Care shall be taken to provide positive bond between adjoining runs. Longitudinal joints shall be:

(i) continuous and parallel;

(ii) coincident within 150 mm of line of change in crossfall;

(iii) offset by at least 150 mm from joints in underlying layers;

(iv) located away from traffic wheel paths; and

(v) located beneath proposed traffic linemarkings in the case of a wearing course.

Work shall be arranged to avoid longitudinal joint faces being left exposed overnight.

When pavers are laying asphalt in echelon, the hot joint so produced shall be constructed by leaving an uncompacted strip approximately 150 mm wide along the edge of the first run, and after the adjoining run has been spread, both sides of the joint shall be rolled simultaneously.

A joint shall be considered “cold” when the temperature of the asphalt has dropped below 60ºC for dense graded mix. Cold joints will require tack coating.

(c) Transverse joints

When the end of the asphalt layer has cooled due to disruption of the work, or when resuming work on the next day, a transverse joint shall be formed.

Transverse joints shall be at right angles to the direction of laying. They shall be staggered by at least 1 m between successive layers and between adjacent runs.

Runs shall end either against a timber bulkhead to ensure a straight vertical, well compacted edge or by feathering out and compacting. In the latter case, before continuing the run the feathered material shall be cut back to a line where the full layer thickness exists. The surface shape of the end of the run shall be checked by a straight edge to locate the line of cut. The end of the previous run shall be lightly tack coated before the laying of the next run proceeds.

When the asphalt layer is required to join and match the level of an existing pavement surface, bridge deck or other fixture, sufficient of the existing material shall be cut out to achieve the minimum layer thicknesses requirements.

SC6.4.6.13.4 Compaction

(1) Plant and equipment

The proposed compaction fleet and rolling pattern shall be adequate to achieve the specified compaction and finish.

The minimum number of rollers used for compaction of asphalt laid at various rates should be as shown in Table SC6.4.6.13.1 Minimum roller combinations for compaction.

For compaction of confined areas or patching works a small vibrating roller, or hand operated vibrating compactor acceptable to the Superintendent shall be used.

Table SC6.4.6.13.1 Minimum roller combinations for compaction

ASPHALT OUTPUT	ALTERNATIVE ROLLER COMBINATION		
	Dense Graded Asphalt		
Tonnes per hour per paver	Static Steel	Steel Vibrating	Pneumatic Tyred
Up to 45	1	-	1
	-	1	1
45 to 85	1	-	2
	-	1	1
85 to 120	1	-	3
	2	-	2
	-	2	1
Above 120	As for 85 to 120 plus additional rollers as determined by Compaction Trials		

Note— 1. At the discretion of the Superintendent, the minimum number of rollers may be decreased for layer thicknesses in excess of 60 mm.

2. Additional pneumatic tyred rollers to those specified may be required for backrolling asphalt.

(2) Dense graded asphalt

(a) Initial rolling

Initial rolling shall be carried out using steel rollers. Vibratory steel rollers may be used, but they shall be operated in the static mode for the first pass. On deep lift asphalt, pneumatic tyred rollers may be used.

Initial rolling shall commence as soon as possible after laying has commenced. Rollers shall be operated as close as possible to the paver.

The transverse and longitudinal joints and edges shall be compacted first.

The minimum asphalt temperature at the commencement of rolling shall be as detailed in MRTS30.

(b) Secondary rolling
Secondary rolling shall immediately follow initial rolling. In secondary rolling, static steel rollers or pneumatic tyred rollers shall be used. The tyre pressures of pneumatic tyred rollers should equal or exceed 550 kilopascals.

Rolling shall commence at the longitudinal joint side of the run.

Secondary rolling shall be completed before the mix temperature falls below 80 °C.

(c) Final rolling
Final rolling shall be carried out by a pneumatic tyred roller to eliminate all roller marks and to produce a uniform finish. If secondary rolling has been carried out with a pneumatic tyred roller, a steel roller may be used for final rolling instead of the pneumatic tyred roller specified.

Final rolling shall be completed before the asphalt temperature falls below 60 °C.

(3) Acceptance criteria for compaction
The acceptance for compaction shall be on a lot by lot basis where each day's work in one layer is generally one lot. Any defective areas which show cracking, bony material or exhibiting excessive binder shall be excluded from the lot and shall be rectified by the Contractor before being tested.

When directed by the Superintendent the Contractor shall arrange for the determination of the relative compaction of the lot by either of the following methods:

The acceptance for compaction on a lot shall be on the basis of characteristic value of relative compaction in accordance with MRTS30.

(4) Finished pavement properties
Each course of asphalt shall be finished parallel to the finished surface of the wearing course.

(5) Thickness
The thickness of asphalt shall be specified and/or measured in one of the following ways:

(a) No finished surface levels specified
When asphalt is placed over an existing pavement in one or more courses and no corrective course is applied, the calculated average compacted thickness of each course shall be in accordance with the course thickness specified in the Drawings and tolerances indicated in MRTS30.

(b) Finished surface levels specified
When asphalt is placed to specified levels, vertical tolerances and thicknesses shall be in accordance with MRTS30.

(6) Shape
The surface shall not deviate from the bottom of a 3 m long straightedge laid in any direction by more than 5 mm.

(7) Removal and replacement of rejected material
The sections of work that have been rejected under the preceding clauses of this sub-section or as otherwise determined by the Superintendent shall be removed within 15 days from the work and replaced with fresh asphalt mix material corresponding in grade and quality to that material specified in the Approved Mix unless otherwise approved by the Superintendent.

If removal of the single nonconforming pavement strata is impossible, the affected area as determined by the Superintendent shall be removed to subbase or subgrade depth as appropriate to provide a smooth level

surface on which to found the reinstated base and/or subbase course.

The perimeter of the nonconforming area shall be prepared in accordance with the practice pertaining to longitudinal and transverse cold joints (AS 2734).

In rejected sections the material is to be removed over the full length of the affected area except that a minimum length of 5 m and a minimum width equal to the paver width shall be removed.

The Superintendent shall have the right to alter the constitution, quality, grading, or other parameters of the "reinstatement pavement" if it is felt that reconstruction of the affected area with the Approved Mix would produce nonconforming pavement as a result of non-continuous pavement structure.

After removal of the rejected base or subbase course the area shall be made available to the Superintendent for inspection and approval to proceed with the works. Superintendent inspection and approval is required prior to release of hold point.

All materials used in the reinstatement of the nonconforming area shall comply with the requirements of this sub-section unless otherwise directed by the Superintendent.

SC6.4.6.13.5 Limits and tolerances

The limits and tolerances applicable to the various clauses of this sub-section are summarised in Table SC6.4.6.13.2 below:

Table SC6.4.6.13.2 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	Materials and mix ingredients and manufacture	DG Asphalt - MRTS 30 and current TMR supplementary specifications. Bitumen - MRTS 17 Polymer modified binder - MRTS 18	SC6.4.6.13.2
2.	**Preparation of Pavement** (a) Cleaning of Surface	>300mm beyond the edge of proposed layer	SC6.4.6.13.3(1)
3.	**Tack Coat** (a) Bitumen Emulsion	Application Rate > 0.10 and < 0.20 litres per square metre	SC6.4.6.13.3(1)
4.	**Laying**	>50 tonnes asphalt per hour	
	(a) Paver Capacity		
	(b) Spread Width	>3.7m	
	(c) Laying in Echelon	Distance between pavers is such that temperature of asphalt at edge (or laid by leading paver) is >80˚C when following paver matches the longitudinal joint.	
	(d) Laying Temperature		
	(i) Dense Grade AC	As per MRTS30	
	(e) Level Control	>10m length	SC6.4.6.13.3(7)(d)
	(i) Levelling Beam for Corrective Course		
	ii) Levelling Beam for Wearing Course	>10m length	SC6.4.6.13.3(7)(d)
	(f) Course and Layer Thickness	Nominal size mix and compacted layer thickness as per MRTS30.	
5.	**Longitudinal Jointing**	Within 150mm of line of change.	
	(a) Change in Crossfall		
	(b) Where Underlying Layers	Offset at least 150mm from joints in underlying layers.	
6.	**Transverse Jointing** (a) Where Underlying Layers	Stagger to be >1m between successive layers and adjacent runs.	

Item	Activity	Limits/Tolerances	Clause
7.	**Compaction**	Initial Rolling:	SC6.4.6.13.3(2)(c)
	(a) Dense Graded Asphalt	To be commenced before asphalt temperature falls below 115ºC for layer ≤40mm. Refer to MRTS30	
		Secondary Rolling:	SC6.4.6.13.3(2)(d)
		Tyre pressures on pneumatic rollers to be≥550kPa.	
		Rolling to be completed before the asphalt temperature falls below 80ºC.	
		Final Rolling:	SC6.4.6.13.3(2)(d)
		Rolling to be completed before asphalt temperature falls below 60ºC.	
	(b) Acceptance Criteria for Compaction	On bases of characteristic value of relative compaction as per MRTS30	SC6.4.6.13.3(4)
		DG 7 90%	
		DG 10 90%	
		DG 14 91% (92% > 50mm)	
		DG 20 93%	
8.	**Finished Pavement**	Max. compacted thickness tolerance as for	
	(a) Thickness	Table 12.3.3.2 of MRTS30	
		DG 7 ± 5mm	
		DG 10 ± 5mm	
		DG 14 ± 7mm	
		Where finished surface levels are specified, thickness and level shall comply with requirements of MRTS30. Reduced level primary tolerance ± 10mm.	
	(b) Shape	Shall not deviate from bottom of 3m straight edge by more than 5mm	SC6.4.6.3(6)

SC6.4.6.13 Asphalt Work Record

Click here to obtain a copy of the following form.

SC6.4.6.14 Mass concrete sub-base

SC6.4.6.14.1 Introduction

(1) Scope

This policy sub-section provides standards advice and guidelines for the construction, by mechanical or hand placement of mass concrete sub-base including trial sections and sub-grade beams.

Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

Editor's note - A reference to drawings is a reference to construction drawings.

(2) Thickness and levels of subbase

The sub-base thickness and levels shall be as per design requirement.

(3) Provision for base slab anchors

During construction of the sub-base, in advance of concrete base construction the Contractor shall make provision to permit construction of base slab anchors at the locations and to the dimensions shown on the design. Excavation of material, trimming of trenches, compacting of the bottom of the trench, disposal of surplus material and construction of the concrete anchors shall be carried out in accordance with sub-section SC6.4.6.15 Plain and reinforced concrete base as part of the concrete base construction.

(4) Reference and source documents

Documents referenced in this Sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this policy sub-section are as follows:

SC6.4.6.15 - Plain and reinforced concrete base

SC6.4.6.28 - Minor concrete works.

(b) Australian Standards:

AS 1012.1 - *Sampling of fresh concrete*

AS 1012.3.1 - *Determination of properties related to the consistence of concrete - Slump test*

AS 1012.4.2 - *Determination of air content of freshly mixed concrete - Measuring reduction in air pressure in chamber above concrete*

AS 1012.8 - *Method of making and curing concrete – Compression and indirect tensile test specimens*

AS 1012.8 - *Method of making and curing concrete – Flexure test specimens*

AS 1012.9 - *Determination of the compressive strength of concrete specimens*

AS 1012.13 - *Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory*

AS 1012.14 - *Securing and testing cores from hardened concrete for compressive strength*

AS 1141.11.1 - *Particle size distribution – Sieving method*

AS 1141.14 - *Particle shape, by proportional calliper*

AS 1141.22 - *Wet/dry strength variation*

AS 1160 - *Bitumen emulsions for the construction and maintenance of pavements*

AS 1379 - *Specification and manufacture of concrete*

AS 1478.1 - *Chemical admixtures for concrete, mortar and grout – Part 1: Admixtures for concrete*
AS 2758.1 - *Concrete aggregates*
AS 3582.1 - *Supplementary cementitious materials for use with portland and blended cement - Flyash*
AS 3799 - *Liquid membrane-forming curing compounds for concrete*
AS 3972 - *General purpose and blended cements*

(c) Other
Austroads, *Guide to Pavement Technology Part 4G: Geotextiles and Geogrids*

SC6.4.6.14.2 Materials for concrete

(1) Cement
Cement shall be Type GP Portland cement or Type GB blended cement complying with AS 3972. Cement shall be from a source approved under the Queensland Government's State Purchasing Policy.

When submitting details of the nominated mix in accordance with clause SC6.4.6.14.4(1) General the Contractor shall nominate the brand and source of the cement. On approval of a nominated mix by the Superintendent, the contractor shall use only the nominated cement in the work.

Documentary evidence of the quality and source of the cement shall be furnished by the Contractor to the Superintendent upon request at any stage of the work.

If the Contractor proposes to use cement which has been stored for a period in excess of three months from the time of manufacture, the Superintendent may require a retest to ensure the cement complies with AS 3972, before the cement is used in the work.

Cement shall be transported in watertight containers and shall be protected from moisture until used. Caked or lumpy cement shall not be used.

(2) Flyash
Flyash shall be from a source approved under the Queensland Government's State Purchasing Policy. The use and the quality of flyash shall comply with AS 3582.1.

When submitting details of the nominated mix in accordance with clause SC6.4.6.14.4(1) General, the Contractor shall nominate the powerhouse source of the flyash. On approval of a nominated mix by the Superintendent, the Contractor shall use only flyash from the nominated powerhouse.

Documentary evidence of the quality and source of the flyash shall be furnished by the Contractor to the Superintendent upon request at any stage of the work.

(3) Water
Water used in the production of concrete shall be potable, free from materials harmful to concrete or reinforcement, and be neither salty nor brackish.

(4) Admixtures
Chemical admixtures and their uses shall comply with AS 1478.1. Admixtures shall not contain calcium chloride, calcium formate, or triethanolamine or any other accelerator. Admixtures or combinations of admixtures other than specified below shall not be used. An air entraining agent may be included in the mix. If an air entrainer is used, the air content of the fresh concrete shall comply with Clause SC6.4.6.14.3(5) Air content.

Fresh concrete with an air content not complying with Clause SC6.4.6.14.3(5) Air content shall be rejected.

During the warm season (October to March inclusive), a lignin or lignin based ("ligpol") set retarding admixture approved by the Superintendent, shall be used to control slump within the limits stated in Clause

SC6.4.6.14.3(4) Consistency. The dosage shall be varied to account for air temperature and haul time in accordance with the manufacturer's recommendations. A copy of the NATA endorsed Certificate of Compliance with AS 1478.1 shall be submitted to the Superintendent, together with the proposed `dosage chart' in accordance with SC6.4.6.14.4(1) General.

If the Contractor proposes to vary the admixture between the warm and cool seasons such variation shall constitute a proposed change to an approved mix for the purposes of Clause SC6.4.6.14.4(2) Variations to approved mixes.

When submitting details of the nominated mix in accordance with Clause SC6.4.6.14.4(1) General, the Contractor shall nominate the proprietary source, type and name of each admixture to be used. Documentary evidence of the quality shall be furnished by the Contractor to the Superintendent upon request at any stage of the work.

(5) Aggregates

(a) General

(i) When submitting details of the nominated mix in accordance with clause SC6.4.6.14.4(1) General, the Contractor shall nominate the sources of aggregate to be used and shall submit details of the geological type of each aggregate.

(ii) Aggregates shall all pass the 37.5 mm AS sieve and shall comply with AS 2758.1 in respect of bulk density, water absorption (maximum 5 per cent), material finer than 75 micrometres, impurities and reactive materials. The proportion of misshapen particles (2:1 ratio) determined by AS 1141.14 shall not exceed 35 per cent.

(iii) When submitting details of the nominated mix, the Contractor shall submit to the Superintendent a NATA Certified Laboratory Test Report on the quality and grading of the aggregate proposed to be used. The grading shall be known as the "Proposed Grading".

(iv) If the Contractor proposes to blend two or more aggregates to provide the Proposed Grading the Test Reports for each constituent material shall be submitted separately and the Superintendent advised of the proportions in which the various sizes and constituents are to be combined. The aggregate from each source and the combined aggregate shall comply with the requirements of this clause.

(v) All aggregate used in the production of concrete shall be clean, hard, durable rock fragments free from the inclusion of mineral salts, oils, organic matter or other materials deleterious to the performance of concrete.

(b) Grading

(i) The grading of the combined aggregate used in the work, determined by AS 1141.11, shall not deviate from that of the proposed grading by more than the amounts shown in Table SC6.4.6.14.1 Aggregate grading deviation limits.

Table SC6.4.6.14.1 Aggregate grading deviation limits

Australian Standard Sieve	Maximum Deviation Per Cent Passing by Mass of Total Sample
37.5 mm	-5
19.0 mm	+ or -10
4.75 mm	+ or -10
1.18 mm	+ or -5
600 mm	+ or -5
150 mm	+ or -2

(c) Durability

Any fraction of any constituent and any fraction of combined aggregate shall conform to the following requirements:

(i) Wet Strength AS 1141.22 Shall not be less than 50 kN; and

(ii) 10 per cent Fines Wet/Dry Variation AS 1141.22 Shall not exceed 35 per cent.

(d) Storage

(i) Storage and handling facilities shall be such as to prevent the aggregates becoming intermixed or mixed with foreign materials, and to prevent segregation occurring.

(ii) The area surrounding the storage facilities and mixing plant shall be so constructed that delivery vehicles, loaders and trucks shall not be capable of introducing foreign matter to the aggregates at any time. If foreign matter is introduced or the area reaches a condition where, in the opinion of the Superintendent, foreign matter may be introduced to the aggregates, production of concrete and delivery of materials shall cease until the condition is corrected to the satisfaction of the Superintendent.

SC6.4.6.14.3 Quality requirements of concrete

(1) Cement and flyash content

When a cement and flyash blend is nominated the minimum acceptable range is 40 – 75 % by mass of the total cementitious material (cement and fly ash) in accordance with AS 3582.1.

(2) Compressive strength

The compressive strength of concrete shall be determined in accordance with AS 1012.9. The minimum compressive strength at 7 days shall be 4 MPa and at 28 days shall not be less than 5 MPa for flyash blended cement. The maximum compressive strength at 28 days shall be less than 15 MPa, with the exception that where the nominated mix demonstrates a 28 day shrinkage less than 400 microstrains, then the concrete achieving a strength less than 20 MPa shall be accepted.

(3) Shrinkage

The drying shrinkage of the nominated mix, determined by AS 1012.13 shall not exceed 450 microstrain after 21 days air drying. The drying shrinkage at the nominated slump plus 10 mm shall be taken as the average of the reading or readings within 5 per cent of the median of the three readings obtained in accordance with AS 1012.13.

(4) Consistency

The Contractor's nominated slump, determined in accordance with AS 1012.3.1, shall be neither less than 25 mm nor more than 40 mm for mechanically placed concrete and shall be neither less than 50 mm nor more than 65 mm for hand placed concrete. The compactibility index range shall be between 60 and 80 in accordance with AS 1012.3.4.

(5) Air content

If an air entraining agent is used, the air content of the fresh concrete, determined in accordance with AS 1012.4.2, shall be neither less than 3 per cent nor more than 7 per cent when discharged from the transport vehicle ready for placement.

SC6.4.6.14.4 Design and control of concrete mixes

(1) General

The Contractor shall submit, for approval by the Superintendent, details of the concrete mix or mixes and the materials, including source, to be used for each of mechanically placed and hand placed subbase, including nominated slump and moisture condition of the aggregates (oven dry, saturated surface dry, or other specified moisture content) on which the mix is based. Each such mix shall be known as a “nominated mix”.

The Contractor shall provide a Certificate from a laboratory with appropriate NATA registration stating that each nominated mix and its constituents meet the requirements of this Specification. All relevant test results shall accompany the Certificate. All phases of any particular test must be performed at one laboratory. The certificate shall confirm that the required testing has been carried out in the twelve month period before the date of submission to the Superintendent.

In the tests supporting the above certification, the compressive strength gain curve shall be submitted showing the compressive strengths at ages 3, 7, 10 and 28 days determined in accordance with AS 1012.9. Each of the results shall be based on three specimens of concrete produced from a batch of the nominated mix. The compressive strength shall be the average of individual results within 1.0 MPa of the median.

These details shall be submitted at least 21 days before using the nominated mix in the work.

(2) Variations to approved mixes
The Contractor shall not make any changes to the approved mix, its method of production or source of supply of constituents without the prior written approval of the Superintendent.

Where changes to an approved mix are proposed, the Contractor shall provide details of the nominated mix and materials, in accordance with clause SC6.4.6.14.4(1) General. If the variations to the quantities, qualities or sources of the constituents in the approved mix are less than 10 kilograms for Portland cement, 20 kilograms for other cementitious material and 5 per cent by mass for each other constituent, except admixtures, per yielded cubic metre of concrete, the superintendent may approve the changes without new trials being carried out.

Notwithstanding these tolerances, the minimum cement content shall be 90 kilograms per yielded cubic metre of concrete, the minimum flyash content shall be 100 kilograms per yielded cubic metre of concrete.

SC6.4.6.14.5 Conformance for concrete strength and thickness

(1) Concrete cylinders

(a) Test specimens
Test specimens for determining the compressive strength of concrete shall be standard cylinders complying with AS 1012.8.1. The Contractor shall supply a sufficient number of moulds to meet the requirements for the frequency of testing specified in this clause and shall also arrange for a laboratory with appropriate NATA registration to conduct the sampling of fresh concrete and the making, curing, delivery and testing of specimens. Copies of test results shall be forwarded to the Superintendent.

Samples of concrete for testing shall be taken in accordance with AS 1012.1. The selection of the batches to be sampled shall be taken randomly. The specimens shall be moulded from each sample so that they are as identical as practicable.

The method of making and curing specimens shall be in accordance with AS1012.8.1 with compaction by internal vibration.

The Contractor shall mark the specimens for identification purposes.

Specimens shall be inspected, capped and crushed in accordance with AS1012.8.1 and AS1012.9.

(b) Frequency of moulding of test specimens
Test specimens shall be moulded as follows:

(i) For the determination of the compressive strength at twenty eight days:
- For each lot of up to 50 cubic metres of concrete placed at the one time - One pair of specimens

(ii) For the determination of the compressive strength at seven days:
- For each lot of up to 50 cubic metres of concrete placed at the one time - One pair of specimens

(iii) For the determination of compressive strength for any early testing as deemed necessary by the Contractor:
- For each lot of up to 50 cubic metres of concrete placed at the one time - One pair of specimens

A lot is defined as a continuous pour of up to 50 cubic metres of concrete placed in the subbase.

(2) Compressive strength of concrete

(a) General

The compressive strength of the concrete represented by a pair of specimens moulded from one sample shall be the average compressive strength of the two specimens.

At the time of approving the mix design, the Superintendent shall nominate whether 7 day or 28 day compressive strength or both shall be the acceptance criteria for strength.

(b) Adjustment of test compressive strength for age of specimen

Should any specimen be tested more than 28 days after moulding the equivalent 28 day compressive strength shall be the test compressive strength divided by the factor applying to the age of the specimen at the time of the test shown in Table SC6.4.6.14.2 - Concrete age conversion factors.

For intermediate ages the factor shall be determined on a pro rata basis.

Table SC6.4.6.14.2 Concrete age conversion factors

Age of Specimen at time of test (days)	Factor
28	1.00
35	1.02
42	1.04
49	1.06
56	1.08
70	1.10
84	1.12
112	1.14
140	1.16
168	1.18
196	1.20
224	1.22
308	1.24
365 or greater	1.25

(c) Conformance for compressive strength

If the compressive strength of test cylinders for any lot is less than the criteria specified in Clause SC6.4.6.14.3(2) Compressive strength, the lot represented by the test cylinders shall be removed and replaced.

In case of non-conformance the Contractor may request permission of the Superintendent to core the in situ subbase for testing of the actual compressive strength to represent the particular lot. The locations for testing shall be nominated by the Superintendent. Such locations may be determined by the use of a nuclear density meter, or any alternative method. Testing shall be carried out at the request of the Contractor. Subbase concrete failing to reach the required in situ compressive strength shall not be retested for at least 72 hours after the determination of the value of the in situ compressive strength.

(3) Specimens cut from the work

(a) Specimens cut from the work shall be tested in a NATA registered laboratory nominated by the Contractor. Specimens shall be in the form of cylindrical cores of hardened concrete.

Cores shall be secured, accepted, cured, capped and tested in accordance with AS 1012.14 with the following amendments:

(i) The requirement that the concrete shall be at least 28 days old before the core is removed shall not apply. However, concrete must have hardened enough to permit removal without disturbing the bond between the mortar and the coarse aggregate.

(ii) The preferred dimension for cores shall be 100 mm diameter but in no case shall the diameter be less than 75 mm or two and one half times the nominal size of the coarse aggregate, whichever is the greater.

(iii) When inspected in the uncapped state, cores shall be rejected if any diameter departs by more than 5 mm from the mean diameter.

(iv) Cores shall be rejected where the length of the core when ready for capping is less than the diameter. The test strength determined shall be adjusted for form by a factor in accordance with Table SC6.4.6.14.3 Core strength factor.

(v) Wet Conditioning only shall be used.

Table SC6.4.6.14.3 Core strength factor

Length/Diameter Ratio	Correction Factor
2.00	1.00
1.75	0.98
1.50	0.96
1.25	0.93
1.00	0.89

Note—for intermediate form ratios, the factor shall be determined by interpolation.

Core cutting shall be carried out by the Contractor in the presence of and at the locations nominated by the Superintendent. The frequency of coring shall be such that a core is taken to represent each lot or the area of subbase placed between any two consecutive construction joints whichever is the lesser. The lot represented by each core shall be nominated by the Contractor at the time of sampling and duly recorded prior to testing.

Cores shall be despatched to arrive at the testing laboratory within 24 hours of the core being cut from the subbase. Wet curing shall commence within 24 hours of the receipt of the cores.

The cutting and transporting the cores to the testing laboratory and restoring all holes in the subbase shall be the responsibility of the Contractor. The method of restoration shall be approved by the Superintendent.

(4) Acceptance of cored concrete for compressive strength
Concrete shall achieve an in situ compressive strength of 5 MPa within 28 days of placement.
If the specimen cut from the subbase reaches 4 MPa for in situ compressive strength, base paving may proceed.

(5) Conformance for thickness

(a) General
No thickness measurements will be carried out if the surface of the subbase is within the level tolerances as specified in Clause SC6.4.6.14.7(5)(b) Surface tolerances.
If scabbling is required to achieve the level tolerance limits, the Superintendent may order thickness checks to be carried out. Where the survey ground model of the subgrade is available, subbase thickness shall be calculated from levels taken on a 5 m grid on the plan area. Alternatively, the Superintendent may authorise coring and measurement at the edges of the layer. Thickness measurements shall be rounded off to the nearest 5 mm.

(b) Thickness below specification
After making due allowance for the tolerances, subbase which is more than 20 mm below the theoretical thickness shall be rejected and removed from the site. The removal and disposal from the site shall be the responsibility of the Contractor.

Subbase which is 20 mm or less below the theoretical thickness may be accepted by the Superintendent providing that it represents isolated sections within a lot and such sections comprise less than 10 per cent of the area of the lot.

SC6.4.6.14.6 Productions, transport and consistency of concrete

(1) Production and transport of concrete

At least 3 weeks before commencing work under this sub-section, the Contractor shall submit, for the information of the Superintendent, details of the proposed methods of handling, storing and batching materials for concrete, details of proposed mixers and methods of agitation, mixing and transport.

(2) Handling, storage and batching materials

The methods of handling, storing and batching materials for concrete shall be in accordance with AS 1379, with the following additional requirements:

(a) certificates of calibration issued by a recognised authority shall be made available for inspection by the Superintendent, as evidence of the accuracy of the scales;

(b) cementatious material shall be weighed in an individual hopper, with the cement weighed first;

(c) the moisture content of the aggregates shall be determined at least daily immediately prior to batching. Corresponding corrections shall be made to the quantities of aggregates and water; and

(d) where a continuous type mixer is employed, the components shall be measured by a method of continuous weighing approved by the Superintendent, except for liquids which may be measured by volume or flow rate meter.

(3) Mixers and agitation equipment

Details of proposed mixers and agitation methods shall be in accordance with the plant and equipment sections of AS 1379, with the following additional requirement that in Appendix A of AS 1379 the maximum permissible difference in slump shall be 10 mm.

(4) Mixing and transport

Mixing and transport methods shall be in accordance with the production and delivery sections of AS 1379, with the following additional requirements:

(a) The mixer shall be charged in accordance with the manufacturer's instructions.

(b) For the purpose of conducting mixer uniformity tests in accordance with Appendix A of AS 1379 on a split drum mixer producing centrally mixed concrete, the whole of the batch shall be discharged into the tray of a moving vehicle. The concrete shall then be sampled from the tray of the vehicle at points approximately 15 per cent and 85 per cent along the length of the tray.

(c) For truck mixed concrete, addition of water in accordance with the batch production section of AS 1379 shall be permitted only within ten minutes of completion of batching and within 200 m of the batching facilities. The delivery docket must clearly indicate the amount of water added, but in no circumstance shall the water:cement ratio be exceeded. Mixing of the concrete shall be completed at that location.

(d) After addition of the cement to the aggregate, concrete shall be incorporated into the work within:

(i) one and a half hours, where transported by truck mixer or agitator; and

(ii) one hour, where transported by non agitating trucks.

Means of verification, satisfactory to the Superintendent, of the times of addition of cement to the aggregate shall be provided.

The times within which the concrete shall be incorporated into the work may be reduced if the Superintendent considers the prevailing weather, mix type, or materials being used warrant such a change.

(e) The size of the batch in an agitator vehicle shall not exceed the manufacturer's rated capacity nor shall it exceed 80 per cent of the gross volume of the drum of the mixer.

(5) Maximum mixing time

Where by reason of delay, it is necessary to hold a batch in the mixer, mixing may be continued for a maximum of 10 minutes except for split drum mixers where the maximum shall be 5 minutes.

For longer periods, the batch may be held in the mixer and turned over at regular intervals, subject to the time

limits specified for incorporation of the concrete into the work not being exceeded.

(6) Consistency

The consistency of the concrete shall be such as to allow the production of a dense, non segregated mass with bleeding limited so as to prevent bleed water flowing over the slab edge under the conditions of placement. If bleed water does so flow, the Contractor shall cease paving until the consistency of the mix is adjusted to prevent flow or the mix is redesigned and approved by the Superintendent. The edge produced shall maintain its shape and shall not sag or tear.

The Contractor shall provide all equipment, materials and labour for consistency testing and shall carry out tests in the presence of the Superintendent.

The consistency of the concrete shall be checked by use of a slump cone in accordance with AS 1012.3.1. The test shall be made on concrete samples obtained in accordance with AS 1012.1. The compactibility index range shall be between 60 and 80 in accordance with AS 1012.3.4. Check tests shall be done on each truckload of concrete or as directed by the Superintendent.

SC6.4.6.14.7 Placing and finishing concrete subbase

(1) General

At least four weeks before commencing work under this Specification, the Contractor shall submit as part of the Quality Plan, for the information of the Superintendent, full details of the equipment and methods proposed for placing and finishing the concrete subbase together with a paving plan showing proposed paving widths, sequence and estimated daily outputs.

The Contractor shall give the Superintendent 7 days written notice of the intention to commence construction of the subbase on any section of work (including the placement of the trial subbase in accordance with Clause SC6.4.6.14.11.

The surface on which concrete subbase is to be placed shall be clean and free of loose or foreign matter and in damp condition.

Submit the work-as-executed survey of the subgrade to the full extent of the works to the Superintendent for confirmation, and highlight any locations where the actual level is higher than the design levels. If the underlying layer is required to be spray sealed, take levels on the top of the seal and after removal of foreign or loose material such as aggregate. Report levels to the nearest millimetre and survey on 5.0 m grid on a plan area. In the case of non conforming levels, locally redesign the pavement levels as directed by the Superintendent.

Concrete shall not be placed either during rain or when the air temperature in the shade is below 5 °C or above 38 °C.

The temperature of the concrete placed in the work shall be neither less than 10 °C nor more than 32 °C.

(2) Rate of evaporation

When the value of Rate of Evaporation, determined from the graph in Figure SC6.4.6.14.1 Rate of evaporation, exceeds 0.50 kilograms per square metre per hour the Contractor shall take precautionary measures, satisfactory to the Superintendent, for the prevention of excessive moisture loss. If, in the opinion of the Superintendent, such precautionary measures prove to be unsatisfactory, the Contractor shall cease work while the evaporation rate is in excess of 0.50 kilograms per square metre per hour.

Should the Contractor elect to use an evaporation retarder to prevent excessive moisture loss, application shall be by fine spray after all finishing operations, except minor manual bull floating, are complete.

The Contractor shall be responsible for measuring and recording concrete temperature and wind velocity at the point of concrete placement, and for continuously measuring and recording air temperature and relative humidity daily, at the site throughout the course of the work. The Contractor shall provide and maintain all equipment and shall provide suitable personnel necessary for all such measuring and recording.

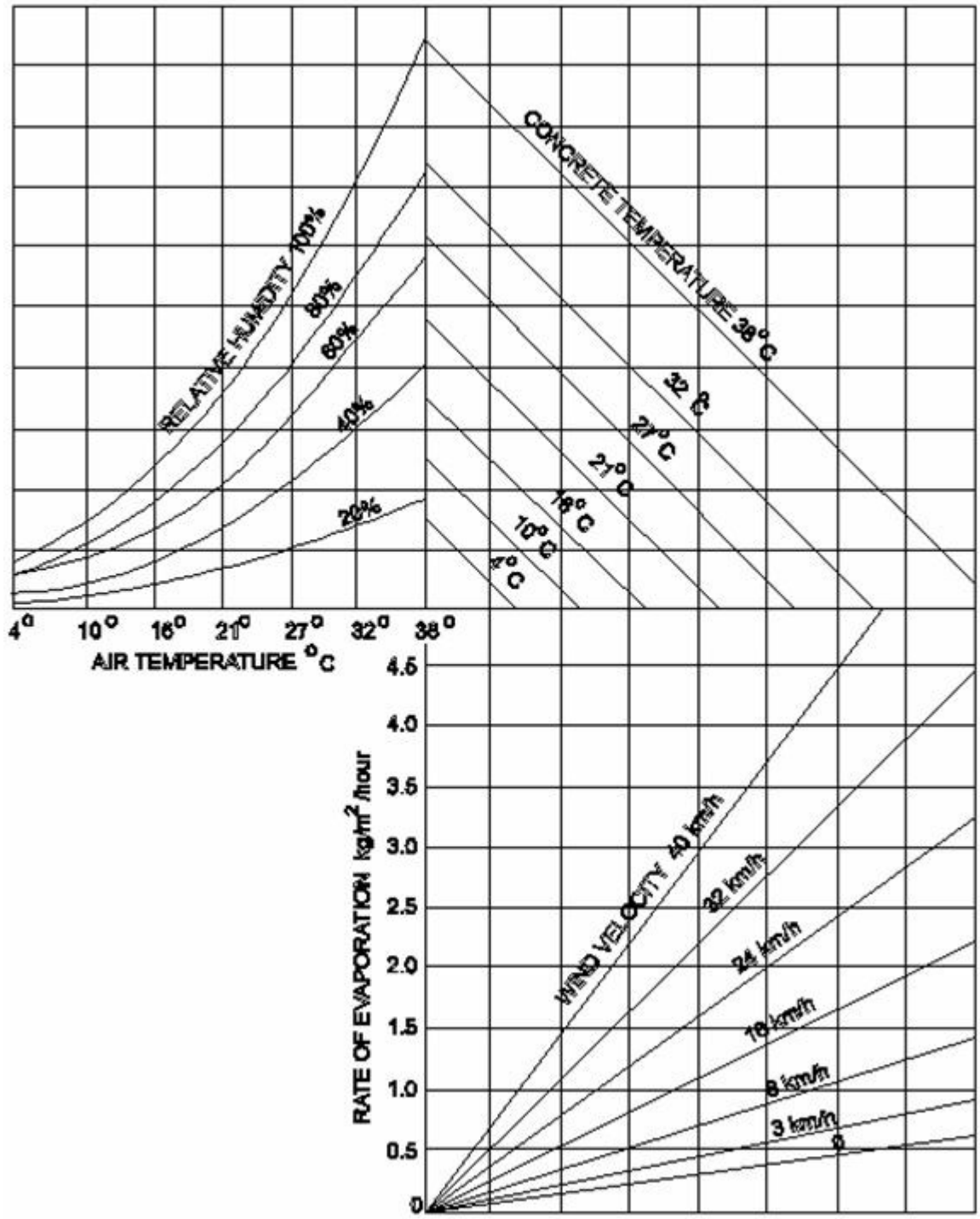


Figure SC6.4.6.14.1 Rate of evaporation

Note—the graph shows the effects of air temperature, humidity, concrete temperature and wind velocity together on the rate of evaporation of water from freshly placed and unprotected concrete.

Example:

- with air temperature at 27ºC
- with relative humidity at 40%
- with concrete temperature at 27ºC
- with a wind velocity of 26 km/h

the rate of evaporation would be 1.6 kg/m/hour.

To determine the evaporation rate from the graph, enter the graph at the air temperature (in this case 27ºC), and move vertically to intersect the curve for relative humidity encountered - here 40%. From this point move horizontally to the respective line for concrete temperature - here 27ºC. Move vertically down to the respective wind velocity curve - in this case interpolating for 26 km per hour - and then horizontally to the left to intersect the scale for the rate of evaporation.

(3) Mechanical paving

The mechanical paver shall be a self propelled machine with a gross operating mass of not less than 4 tonnes per lineal metre of paved width. It shall be capable of paving at a speed of one metre per minute or less as required to enable the continuous operation of the paver and obtain the required degree of compaction. It shall include the following features:

(a) an automatic control system with a sensing device to control line and level to the specified tolerances;

(b) means of spreading the mix uniformly and regulating the flow of mix to the vibrators without segregation of the components;

(c) internal vibrators capable of compacting the full depth of the concrete;

(d) adjustable extrusion screed and/or conforming plate to form the slab profile and produce the required finish on all surfaces; and

(e) capability of paving in the slab widths or combination of slab widths and slab depths shown on the drawings.

The mechanical paver shall spread, compact, screed and finish the freshly placed concrete in such a manner that a minimum of finishing by hand will be required. A dense and homogeneous concrete with a surface exhibiting low permeability shall be provided.

Surface texture shall be steel screed or float finish except that a hessian dragged finish shall be provided where the subbase is to be overlain by asphaltic concrete.

The supporting surface for the tracks of the paver, curing machine and any other equipment in the paving and curing train shall be in a smooth and firm condition.

Once spreading commences, the concrete paving operation shall be continuous. The mechanical paver shall be operated so that its forward progress shall not be stopped due to lack of concrete. If disruptions occur for any reason, the Superintendent may direct that a construction joint be formed before the recommencement of paving operations.

(4) Hand placing

Forms shall be so designed and constructed that they can be removed without damaging the concrete and shall be true to line and grade and braced in a substantial and unyielding manner. Forms shall be mortar tight and debonded to ensure non adhesion of concrete to the forms.

Concrete shall be delivered in agitator trucks and shall be deposited uniformly in the forms without segregation. The concrete shall be compacted by poker vibrators and by at least two passes of a hand guided vibratory screed traversing the full width of the slab on each pass. Any buildup of concrete between the forms and vibratory screed shall be prevented.

If disruptions occur for any reason, the Superintendent may direct that a construction joint be formed before the recommencement of paving operations.

A dense and homogeneous concrete with a surface exhibiting low permeability shall be provided.

Surface texture shall be steel screed or float finish except that a hessian dragged finish shall be provided where the subbase is to be overlain by asphaltic concrete.

(5) Alignment and surface tolerances

(a) Horizontal alignment tolerance

The outer edges of the subbase shall be square to the subgrade and shall be constructed 50 mm wider than the plan position of the base formation with a tolerance of 25 mm.

Where an edge of a slab is to form a longitudinal construction joint line, the allowable horizontal alignment tolerances shall comply with clause SC6.4.6.14.8(2) Longitudinal construction joints.

(b) Surface tolerances

The level at any point on the top of the subbase shall not vary by more than 0 mm above or 20 mm below that shown on the drawings or as directed by the Superintendent. Where the concrete is found to be above the level tolerance, it shall be removed. Where the concrete is found to be below level tolerance, it shall be made up with base concrete.

The top surface of the subbase shall also not deviate from a 3 m straightedge, laid in any direction, by more than 5 mm.

(6) Curing

The subbase shall be cured by the use of one of the following:

(a) chlorinated rubber curing compound complying with AS 3799 Class C Type 1D or resin-based curing compound complying with AS 3799 Class B, Type 1D or Type 2, if an asphalt base is used; or

(b) white pigmented wax emulsion curing compound complying with AS 3799 Class A Type 2, if a concrete base is used; or

(c) bitumen emulsion Grade CRS/170 complying with AS 1160 for either asphalt or concrete base.

The Contractor shall submit, for the information of the Superintendent, a current Certificate of Compliance for the curing compound from an Australian Laboratory, approved by the Superintendent, showing an Efficiency Index of not less than 90 per cent when tested in accordance with Appendix B of AS 3799.

The curing compound shall be applied using a fine spray immediately following texturing at the rate stated on the Certificate of Compliance or at a minimum of 0.2 litres per square metre, whichever rate is the greater. Bitumen emulsion shall be applied at a minimum rate of 0.35 litres of residual bitumen per square metre. When applied with a hand lance the rates should be increased by 25 per cent.

The average application rate shall be checked by the Contractor and certified to the Superintendent by calculating the amount of curing compound applied to a measured area representative of a lot and nominated by the Superintendent.

The curing membrane shall be maintained intact for seven days after placing the concrete. Any damage to the curing membrane shall be made good by handspraying of the affected areas.

Equipment and materials for curing operations shall be kept on site at all times during concrete pours.

(7) Protection of work

The Contractor shall ensure that the temperature of the concrete does not fall below 5 ºC during the first twenty four hours after placing. The Contractor shall provide, for the information of the Superintendent, details of procedures and equipment proposed to be used for the protection of sections recently placed in the event of low air temperatures. If the Contractor fails to maintain the temperature of the concrete at or above 5 ºC and if, in the opinion of the Superintendent, the concrete exhibits any deficiencies, due to failure to comply with this Specification, the concrete shall be rejected.

The Contractor shall protect the work from rain damage and shall provide, for the information of the Superintendent, detailed proposals fro procedures and equipment to be used for such protection.

Neither traffic nor construction equipment, other than that associated with testing, shall be allowed on the subbase until the strength of the subbase has reached at least 4.0 MPa. Thereafter, only construction equipment necessary for the following operations shall be permitted to traffic the subbase:

(a) bond-breaker and spall treatment; and

(b) concrete or asphalt paving;

(c) Notwithstanding the above, any damage caused to the subbase by the Contractor's operations shall be rectified to the Superintendent's satisfaction.

SC6.4.6.14.8 Joints

(1) Transverse construction joints
Transverse construction joints shall:

(a) be provided only at discontinuities in the placement of concrete determined by the Contractor's paving operations;

(b) be constructed normal to the edge line and to the dimensions shown on the drawings;

(c) not deviate from a 3 m straightedge placed along the joint by more than 10 mm; and

(d) cut back the edge of the previously placed concrete by sawing the concrete, to at least 1/3 the slab depth to expose an even, clean, sound, vertical surface, without disturbing the concrete that is to remain in place.

(2) Longitudinal construction joints
Longitudinal construction joints shall:

(a) be formed no closer than 300 mm of the base longitudinal joints as shown in the drawings, unless directed otherwise by the Superintendent;

(b) not deviate from the plan or nominated position at any point by more than 20 mm;

(c) not deviate from a 3 m straightedge placed along the joint by more than 10 mm, having made due allowances for any planned curvature; and

(d) be smooth across the joint.

SC6.4.6.14.9 Bond breaker and spall treatment

(1) General
Subbase to be covered by concrete base shall be provided with a wax emulsion bond breaker. The wax emulsion shall comply with AS 3799 Class A Type 2.

Where the base consists of asphaltic concrete, no bond breaker shall be used. In this case bond is essential and wax emulsion curing compounds shall not be permitted.

Subbase with spalled areas shall be treated, where directed by the Superintendent, prior to application of the bond breaker or asphaltic concrete.

(2) Preparation of subbase
Immediately prior to any spalled area treatment and the application of bond breaker, the subbase surface shall be cleaned to the satisfaction of the Superintendent of all loose, foreign and deleterious material.

(3) Treatment of spalling
Where directed by the Superintendent, spalled areas shall be treated before the application of the bitumen bond breaker or asphaltic concrete by infilling with 6:1 sand/cement mortar to provide a surface flush with the surrounding concrete. The area shall be wetted and sprinkled with neat cement before screeding the mortar into the patches.

A spalled area, if directed to be treated, shall have such treatment completed no earlier than five working days before the application of the bond breaker. Treated spalled areas damaged by the Contractor or others shall be made good by the Contractor.

(4) Application of bond breaker
The wax emulsion used as bond breaker should be the same as used for curing compound. This second application shall be applied at a minimum rate of 0.2 litres per square metre and not earlier than 72 hours before the placement of the base concrete.

The method of application shall conform to the requirements of Clause SC6.4.6.14.10(6) Curing.

(5) Treatment of unplanned cracks
The Superintendent shall direct treatment of unplanned cracks whose width exceeds 0.3 mm. This may take

the form of applying an approved 300 mm minimum width geotextile backed polymer modified bitumen strip *(reference Guide to Pavement Technology Part 4G: Geotextiles and Geogrids*) over the crack prior to placement of the first asphalt base layer or concrete base, or an extra application of wax emulsion for a width of 300 mm along the crack when a concrete base is required.

The Contractor shall install the Stress Alleviating Membrane strip in accordance with the manufacturer's instructions.

SC6.4.6.14.10 Subgrade beams

(1) General
Subgrade beams shall be provided below the subbase at expansion joints and isolation joints in the concrete base as shown in the drawings or as directed by the Superintendent. They shall extend the full length of joints unless otherwise indicated on the drawings.

(2) Excavation
Excavation for subgrade beams shall be to the dimensions shown on the drawings. All loose material shall be removed and the vertical faces trimmed to neat lines. The bottom of the trench shall be recompacted, where required, to the degree of consolidation of the adjacent undisturbed material. Excavated material shall be legally disposed of by the Contractor.

(3) Concrete
Concrete in subgrade beams shall comply with the requirements of sub-section SC6.4.6.28 Minor concrete works. The minimum compressive strength at 28 days shall be 32 MPa.

(4) Steel reinforcement
Steel reinforcement shall be of the type and size shown on the drawings and shall be supplied and installed in accordance with sub-section SC6.4.6.15 Plain and reinforced concrete base.

(5) Construction and protection
Subgrade beams shall be constructed before construction of the subbase. The top surface of the subgrade beam shall be level with the top of the subgrade. Any loose subgrade material shall be recompacted to the correct level. If the contractor elects to remove any loose material, the voids shall be filled with mortar or concrete and screeded to provide a surface flush with the top of the subgrade beam and the surrounding subgrade.

A steel float shall be used to produce a smooth surface finish, free of any texture.

The subgrade beams shall be protected from damage by plant, motor vehicles and the paving operation. Any damage shall be made good by the Contractor.

(6) Curing
The top surface of the subgrade beam shall be cured in accordance with clause SC6.4.6.14.7 Curing before placing the subbase.

(7) Bond breaker
The top surface of the subgrade beam shall be treated with a bond breaker which shall consist of a further application of curing compound neither less than twenty four hours nor more than seventy two hours before placing of subbase concrete.

SC6.4.6.14.11 Trial concrete subbase

Before the commencement of paving, the Contractor shall construct a trial section of concrete subbase on the carriageway to demonstrate to the Superintendent the Contractor's capability of constructing subbase in accordance with the sub-section. This section shall be constructed so that it may be incorporated in the finished work.

The trial subbase shall be constructed using the same materials, concrete mix, equipment and methods the Contractor intends to use for the remaining subbase work. The Contractor shall demonstrate the methods proposed to be used for texturing, the application of curing compound and the construction of joints.

The trial shall also be used to demonstrate that the Contractor's allowances for concrete strength, compaction and slab thickness are adequate to achieve the minimum requirements specified.

A trial length of between 100 m and 200 m or lesser length in compliance with council requirements for mechanical paving equipment or between 20 m and 50 m for hand placement is required. The trial length shall be the maximum width proposed to be laid, and shall be constructed in one continuous operation.

Unless advised by the Superintendent of any deficiencies in the trial concrete subbase, due to failure to comply with this sub-section, the Contractor may proceed with placing concrete subbase from a time five working days after the completion of the trial concrete subbase or such earlier time as the Superintendent may allow. In the event of deficiencies in the trial concrete subbase, the Superintendent may order the Contractor to construct a further length of trial concrete subbase which shall be treated as the first. If, after three trials, the subbase still is deficient in some way, the Superintendent may require the Contractor to justify to the satisfaction of the Superintendent why the work should be allowed to continue using that method and/or equipment and/or materials and/or personnel.

The Superintendent shall have the right to call for a new trial section at any stage of work under the contract when changes by the Contractor in the equipment, materials, mix, plant or rate of paving are deemed by the Superintendent to warrant such procedure or when concrete as placed does not comply with this sub-section.

SC6.4.6.14.12 Limits and tolerances

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.14.4 below:

Item	Activity	Limits/Tolerances	Clause
1.	**Materials for Concrete**		
	a. Misshapen Particles	2 : 1 ratio < 35 percent	SC6.4.6.14.3(5)(a)
	b. Aggregates Grading	Deviation from submitted sample not greater than Table C247.1	SC6.4.6.14.2(5)(b)
	c. Durability	Wet Strength > 50 kN 10% Fines < 35 percent	SC6.4.6.14.2(5)(c)
2.	**Concrete**	Drying Shrinkage <450 microstrain	SC6.4.6.14.3(3)
	a. Shrinkage		
	b. Consistency	Mechanically placed: >25mm<40mm Hand Placed: >50mm <65mm	SC6.4.6.14.3(4)
	c. Air Content	≥3, ≤7 percent	SC6.4.6.14.3(5)
	d. Thickness	Concrete shall be removed if thickness >20mm below specified thickness.	SC6.4.6.14.5(5)
	e. Mixing and Transport	After addition of cement to the aggregate, concrete shall be incorporated into the work within: (i) One and a half hours where transported by truck mixer or agitator. (ii) One hour where transported by non agitating trucks.	SC6.4.6.14.6(4)

Item	Activity	Limits/Tolerances	Clause
	f. Placing	Concrete shall not be placed when the air temperature in the shade is less than 5ºC or >38ºC. Temperature of concrete shall be >10ºC but <32ºC.	SC6.4.6.14.7(1)
		Concrete shall not be placed when the Rate of Evaporation exceeds 0.5kg per square metre per hour.	SC6.4.6.14.7(2)
3.	**Alignment and Surface Tolerances**	Outer edges not to deviate from plan position by more than ±25mm.	SC6.4.6.14.7(5)
	a. Horizontal Alignment		
	b. Surface	Level on top surface to be no more than +0mm or -20mm to that shown on the drawings.	SC6.4.6.14.7(5)
		The top surface shall not deviate from a 3m straightedge laid in any direction by more than 5mm.	SC6.4.6.14.7(5)
4.	**Joints**	Shall not deviate from a 3m straight-edge placed along the joint by more than 10mm.	SC6.4.6.14.8(1)
	a. Transverse Construction		
	b. Longitudinal Joint	(i) Shall not deviate from the plan or nominated position at any point by more than 20mm. (ii) Shall not deviate from a 3m straightedge placed along the joint by more than 10mm after allowing for any curvature.	SC6.4.6.14.8(2)
5.	**Bond Breaker**		
	a. Wax Emulsion	Minimum 0.2 litres per square metre, not earlier than 72 hours before placement of base.	SC6.4.6.14.9(4)

SC6.4.6.15 Plain and reinforced concrete base

SC6.4.6.15.1 Introduction

(1) Scope

(a) This policy sub-section provides standards, advice and guidelines for the construction, by mechanical or hand placement of plain or reinforced concrete, including trial sections, slab anchors and terminal slabs.

(b) The work also includes the construction of reinforced concrete approach slabs for bridge abutments and traffic signal approach slabs.

(c) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

(2) Thickness and levels of slab

The base thickness and levels shall be detailed on design and construction drawings.

(3) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this sub-section are as follows:
SC6.4.6.9 - Open drains - kerb and channel
SC6.4.6.20 – Subsoil, foundation and pavement drains
SC6.4.6.14 - Mass concrete sub-base

(b) Australian Standards

AS 1012.1 - *Sampling of fresh concrete*
AS 1012.3.1 - *Determination of properties related to the consistence of concrete - Slump test*
AS 1012.4.2 - *Determination of air content of freshly mixed concrete - Measuring reduction in air pressure in chamber above concrete*
AS 1012.8 – *Method of making and curing concrete*
AS 1012.9 - *Determination of the compressive strength of concrete specimens*
AS 1012.12.2 - *Determination of mass per unit volume of hardened concrete - Water displacement method*
AS 1012.13 - *Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory*
AS 1012.14 – *Method for securing and testing cores from hardened concrete for compressive strength*
AS 1141.11.1 - *Particle size distribution – Sieving method*
AS 1141.14 - *Particle shape, by proportional calliper*
AS 1141.18 - *Crushed particles in coarse aggregate derived from gravel*
AS 1141.22 - *Wet/dry strength variation*
AS 1141.24 – *Aggregate soundness – Evaluation by exposure to sodium sulphate solution*
AS 1160 - *Bituminous emulsions for the construction and maintenance of pavements*
AS 1379 - *Specification and supply of concrete*
AS 1478.1 - *Chemical admixtures for concrete, mortar and grout – Part 1: Admixtures for concrete*
AS/NZS 1554.3 - *Welding of reinforcing steel*
AS 2758.1 - *Concrete aggregates*
AS 3582.1 - *Supplementary cementitious materials for use with Portland and blended cenemt – Fly ash*
AS 3799 - *Liquid membrane-forming curing compounds for concrete*
AS 3972 – *General purpose and blended cements*
AS/NZS 4671 - Steel reinforcing materials.

(c) Queensland Department of Transport and Main Roads technical standard
MRTS40 - *Concrete Base in Pavements: Jointed unreinforced, Jointed Reinforced, Continuously Reinforced and Steel Fibre Reinforced Pavements (10/10).*

(d) Queensland Department of Transport and Main Roads Materials Testing Manual
Q461 - *Durability of Sealant*

Q462 - *Resistance of Vulcanised Rubber to the Absorption of Oil*
Q463A - *High Temperature Recovery of Preformed Polychloroprene Elastomeric Joint Seals*
Q463B - *Low Temperature Recovery of Preformed Polychloroprene Elastomeric Joint Seals*

(e) ASTM Standards
D792 – *Standard test methods for density and specific gravity (relative density) of plastics by displacement*
C793 – *Standard test method for effects of laboratory accelerated weathering on elastomeric joint sealants*
C794 – *Standard test method for adhesion-in-peel of elastomeric joint sealants*
D2240 – *Standard test method for rubber property - durometer hardness*
D2628 – *Standard specification for preformed polychloroprene elastomeric joint seals for concrete pavements*
D2835 – *Standard specification for lubricant for installation of preformed compression seals in concrete pavements.*

(f) US Military Specifications
MIL-S-8802 - *Sealing compound, temperature resistant, integral fuel tanks and fuel cell cavities, high adhesion*

SC6.4.6.15.2 Design and control of concrete mixes

(1) General - design and control of concrete mixes

(a) Details of the concrete mix (or mixes) and the materials, including source, to be used for each of any mechanically placed and/or hand placed base, including nominated slump and moisture condition of the aggregates (oven dry, saturated surface dry, or other specified moisture content) on which the mix is based. Each such mix shall be known as a “nominated mix”.

(b) Also, a certificate from a laboratory with appropriate NATA registration stating that each nominated mix and its constituents meet the requirements of this specification. All relevant test results shall accompany the certificate. All phases of any particular test must be performed at one laboratory. The certificate shall confirm that the required testing has been carried out in the twelve month period before the date of submission to the superintendent.

(c) In the tests supporting the above certification, the compressive strength gain curve shall be submitted showing the compressive strengths at ages 3, 7, 10 and 28 days determined in accordance with AS 1012.9. Each of the results shall be based on three specimens of concrete produced from a batch of the nominated mix. The compressive strength shall be the average of individual results within 2.0 MPa of the median. The compressive strength for 28 days shall not be less than 36.0 MPa.

(d) These details shall be submitted at least 21 days before using the nominated mix in the work.

(2) Variations to approved mixes

(a) The contractor shall not make any changes to the approved mix, its method of production or source of supply of constituents without the prior written approval of the superintendent.

(b) Where changes to an approved mix are proposed, the contractor shall provide details of the nominated mix and materials, in accordance with clause SC6.4.6.15.2(1) General – design and control of concrete mixes. If the variations to the quantities, qualities or sources of the constituents in the approved mix are less than 10 kg for portland cement and flyash and 5 per cent by mass for each other constituent, except admixtures, per yielded cubic metre of concrete, the superintendent may approve the changes without new trials being carried out.

(c) Notwithstanding these tolerances the minimum portland cement content shall be 270 kilograms per yielded cubic metre of concrete and the maximum flyash content shall be 50 kilograms per yielded cubic metre of concrete.

SC6.4.6.15.3 Materials for concrete

(1) Cement

(a) Cement shall be Type GP Portland cement complying with AS 3972 and shall be from a source approved under the Queensland Government’s State Purchasing Policy.

(b) When submitting details of the nominated mix in accordance with clause SC6.4.6.15.2(1) General – design and control of concrete mixes the Contractor shall nominate the brand and source of the cement. On approval of a nominated mix by the superintendent, the contractor shall use only the nominated cement in the work.

(c) Documentary evidence of the quality and source of the cement shall be furnished by the contractor to the superintendent upon request at any stage of the work.

(d) If the contractor proposes to use cement which has been stored for a period in excess of three months from the time of manufacture, a re-test shall be required to ensure the cement still complies with AS 3972, before the cement is used in the work.

(e) Cement shall be transported in watertight containers and shall be protected from moisture until used. Caked or lumpy cement shall not be used.

(2) Flyash

(a) Flyash shall be from a source approved under the Queensland Government's State Purchasing Policy. The use and quality of flyash shall comply with AS 3582.1.

(b) When submitting details of the nominated mix in accordance with clause SC6.4.6.15.2(1), the Contractor shall nominate the powerhouse source of the flyash. The Contractor shall use only flyash from the nominated powerhouse.

(c) Documentary evidence of the quality and source of the flyash shall be furnished by the Contractor to the Superintendent.

(3) Water

Water used in the production of concrete shall be potable, free from materials that may be deterimental to the production of concrete or reinforcement, and be neither salty nor brackish.

(4) Admixtures

(a) Chemical admixtures and their use shall comply with AS 1478.1. Admixtures shall not contain calcium chloride, calcium formate, or triethanolamine or any other accelerator. Admixtures or combinations of admixtures other than specified below, shall not be used. An air entraining agent shall be included in the mix and the air content of the concrete shall comply with clause SC6.4.6.15.4(5) Air content. Fresh concrete with an air content not complying with clause SC6.4.6.15.4(5) will be rejected.

(b) The dosage of admixtures shall be varied to account for air temperature and haulage times in accordance with the manufacturer's recommendations. A copy of the NATA endorsed Certificate of Compliance with AS 1478.1 shall be submitted to the Superintendent, together with the proposed 'dosage chart' in accordance with clause SC6.4.6.15.2(1).

(c) When submitting details of the nominated mix in accordance with clause SC6.4.6.15.2(1), the contractor shall nominate the proprietary source, type and name for each admixture to be used. Documentary evidence of the quality shall be furnished by the Contractor to the Superintendent upon request at any stage of the work.

(5) Aggregates

(a) General

(i) At least 40 per cent by mass of the total aggregates in the concrete mix shall be quartz sand. Quartz sand is aggregate having a nominal size of less than 5 mm and shall contain at least 70 per cent quartz, by mass. Where present, chert fragments will be regarded as "quartz" for the purpose of this specification, but the ratio of chert to quartz shall not exceed unity.

(ii) When submitting details of the nominated mix in accordance with clause SC6.4.6.15.2(1), the contractor shall nominate the sources of aggregate to be used in the concrete and shall submit details of the geological type of each aggregate.

(b) Fine aggregate

(i) Fine aggregate shall consist of clean, hard, tough, durable, uncoated grains uniform in quality.

Fine aggregate shall comply with AS 2758.1 in respect of bulk density, water absorption (maximum 5 per cent), with material finer than 2 micrometres and impurities and reactive materials. The sodium sulphate soundness, determined by AS 1141.24, shall not exceed the limits in Table SC6.4.6.15.1 Sodium sulphate soundness limits

Table SC6.4.6.15.1 Sodium sulphate soundness limits

Australian Standard Sieve	Per Cent Loss by Mass
4.75mm to 2.36mm	4
2.36mm to 1.18mm	6
1.18mm to 600µm	8
600µm to 300µm	12

(ii) In the case of a blend of two or more fine aggregates, the above limits shall apply to each constituent material.

(iii) The grading of the fine aggregate, determined by AS 1141.11, shall be within the limits given in Table SC6.4.6.15.2 Fine aggregate grading.

(iv) When submitting details of the nominated mix the contractor shall submit to the superintendent a NATA certified laboratory test report on the quality and grading of the fine aggregate proposed to be used. The grading shall be known as the "proposed fine aggregate grading".

(v) If the contractor proposes to blend two or more fine aggregates to provide the proposed grading then test reports for each constituent material shall be submitted separately and the superintendent advised of the proportions in which the various sizes and constituents are to be combined. The fine aggregate from each source and the combined aggregate shall comply with the requirements of this clause.

(vi) The grading of the fine aggregate used in the work shall not deviate from that of the proposed grading by more than the amounts in Table SC6.4.6.15.2 Fine aggregate grading.

(vii) Notwithstanding these tolerances, the fine aggregate used in the work shall comply with the limits shown in Table SC6.4.6.15.2 Fine aggregate grading.

Table SC6.4.6.15.2 Fine aggregate grading

Australian Standard Sieve	Proportion Passing (% of Mass of Sample)	Deviation from Proposed Grading (% of Mass of Sample)
9.50mm	100	± 3
4.75mm	90 - 100	± 10
2.36mm	65 - 95	± 10
1.18mm	40 - 80	± 10
600µm	24 - 52	± 5
300µm	8 - 25	± 2
150µm	1 - 8	
75µm	0 - 3	

(c) Coarse aggregate

(i) Coarse aggregate shall consist of clean, crushed, hard durable rock, metallurgical furnace slag or gravel. Coarse aggregate shall comply with AS 2758.1 in respect of particle density, bulk density, water absorption (maximum 2.5 per cent), material finer than 75 micrometres, weak particles, light particles, impurities and reactive materials, iron unsoundness and falling or dusting unsoundness. In all other respects, the coarse aggregate shall comply with this sub-section. If required, coarse aggregate shall be washed to satisfy these requirements.

(ii) The grading of the coarse aggregate, determined by AS 1141.11, shall be within the limits given in Table SC6.4.6.15.3 Coarse aggregate grading.

(iii) When submitting details of the nominated mix the Contractor shall submit to the Superintendent a NATA Certified Laboratory Test Report on the quality and grading of the coarse aggregate proposed to be used. The grading shall be known as the "proposed coarse aggregate grading".

(iv) If the contractor proposes to blend two or more coarse aggregates to provide the proposed grading

then test reports for each constituent material shall be submitted separately and the superintendent advised of the proportions in which the various sizes and constituents are to be combined. The coarse aggregate from each source and the combined aggregate shall comply with the requirements of this clause.

(v) The grading of the coarse aggregate used in the work shall not deviate from that of the proposed grading by more than the amounts in Table SC6.4.6.15.3 Coarse aggregate grading.

Table SC6.4.6.15.3 Coarse aggregate grading

Australian Standard Sieve	Proportion Passing (% of Mass of Sample)	Deviation from Proposed Grading (% of Mass of Sample)
26.50 mm	100	± 2
19.00 mm	95 - 100	± 5
13.20 mm	(accepted design mix)	± 5
9.50 mm	25 - 55	± 3
4.75 mm	0 - 10	
2.36 mm	0 - 2	

(vi) Notwithstanding these tolerances, the coarse aggregate used in the work shall comply with the limits shown in Table SC6.4.6.15.3.

(vii) The coarse aggregate shall also conform to the following requirements:

(A) Wet Strength - AS 1141.22.
Shall not be less than 80 kN for any fraction and/or constituent;

(B) 10 per cent Fines Wet/Dry Variation - AS 1141.22.
Shall not exceed 35 per cent for any fraction and/or constituent;

(C) Soundness - AS 1141.24
The loss in mass when tested with sodium sulphate shall not exceed 9 per cent for any constituent;

(D) Particle Shape - AS 1141.14
The proportion of misshapen particles (2:1 ratio) shall not exceed 35 per cent;

(E) Fractured Faces - AS 1141.18.
At least 80 per cent by mass of the particles shall have two or more fractured faces; and

(F) Material finer than 75 micrometres – AS 1141.12
Shall not exceed 1 per cent for any fraction and/or constituent.

(d) Storage

(i) Storage and handling facilities shall be such as to prevent the aggregates becoming intermixed or mixed with foreign materials, and to prevent segregation occurring.

(ii) The area surrounding the storage facilities and mixing plant shall be so constructed that delivery vehicles, loaders and trucks shall not be capable of introducing foreign matter to the aggregates at any time. If foreign matter is introduced or the area reaches a condition where, in the opinion of the superintendent, foreign matter may be introduced to the aggregates, production of concrete and delivery of materials shall cease until the condition is corrected to the satisfaction of the superintendent.

SC6.4.6.15.4 Quality requirements of concrete

(1) Cement and flyash content
The minimum Portland cement content shall be 270 kilograms per yielded cubic metre of concrete. The maximum flyash content shall be 50 kilograms per yielded cubic metre of concrete.

(2) Compressive strength
The compressive strength of concrete shall be determined in accordance with AS 1012.9. The minimum compressive strength at 28 days shall be 36 MPa.

(3) Shrinkage

The drying shrinkage of the nominated mix, determined by AS 1012.13, shall not exceed 450 microstrain after 21 days air drying. The drying shrinkage at the nominated slump plus 10 mm shall be taken as the average of the reading or readings within 5 per cent of the median of the three readings obtained in accordance with AS 1012.13.

(4) Consistency

The Contractor's nominated slump, determined in accordance with AS 1012.3.1, shall be neither less than 30 mm nor more than 40 mm for mechanically placed concrete and shall be neither less than 55 mm nor more than 65 mm for hand placed concrete.

(5) Air content

The air content of the concrete, determined in accordance with AS 1012.4.2, shall be neither less than 4 per cent nor more than 7 per cent, when discharged from the transport vehicle ready for placement.

(6) Relative compaction

The minimum relative compaction, determined in accordance with AS 1012.12.2, shall be 98 per cent.

SC6.4.6.15.5 Steel reinforcement

(1) Material

(a) The type and size of bars shall be as shown on the drawings.

(b) Steel reinforcement shall be free from loose or thick rust, grease, tar, paint, oil, mud, millscale, mortar or any other coating, but is not to be brought to a smooth polished condition.

(c) The Contractor shall supply evidence satisfactory to the superintendent that steel reinforcement complies with AS 4671 *Steel reinforcing materials*. Test certificates shall show the results of mechanical tests and chemical analysis of the reinforcing steel to be used.

(d) Where the material cannot be identified with a test certificate, samples shall be taken and testing arranged by the contractor. The samples shall be selected randomly and consist of three specimens each at least 1.2 m in length.

(e) Plastic bar chairs or plastic tipped wire chairs shall be capable of withstanding a load of 200 kg mass on the chair for 1 hour at 23 ± 5ºC without malfunction. The Contractor shall demonstrate that the proposed chairs conform with these requirements.

(2) Bending

Reinforcement shall be formed to the dimensions and shapes shown on the drawings. Reinforcement shall not be bent or straightened in a manner that will damage the material. Bars with kinks or bends not shown on the drawings shall not be used. Heating of reinforcement for the purposes of bending will only be permitted if uniform heat is applied. Temperature shall not exceed 450 ºC and the heating shall extend beyond the portion to be bent. Heated bars shall not be cooled by quenching.

(3) Splicing

(a) All reinforcement shall be furnished in the lengths indicated on the drawings. splicing of bars shall only be permitted with the approval of the superintendent and as shown on the drawings. The information shown on the drawings is to detail the location and method of splicing.

(b) The length of lapped splices not shown on the drawings shall be as follows for unhooked bars:
Plain bars, Grade 250 40 bar diameters;
Deformed bars, Grade 400 35 bar diameters; and
Hard-drawn wire 50 bar diameters.

(c) Splices in reinforcing fabric shall be measured as the overlap between the outermost wire in each sheet of fabric transverse to the direction of splice. This overlap shall not be less than the pitch of the transverse wires plus 25 mm.

(d) In welded splices, bars shall only be welded by an approved electrical method. Grade 400 deformed bars

shall not be welded.

(e) Welding shall comply with AS 1554.3. The welded splice shall meet requirements of tensile and bend tests specified for the parent metal.

(4) Storage

Reinforcement, unless promptly incorporated into the concrete, shall be stored under a waterproof cover and supported clear of the ground, and shall be protected from damage and from deterioration due to exposure.

(5) Placing

(a) Reinforcing bars and wire reinforcing fabric shall be accurately placed to the dimensions and details shown on the drawings. They shall be securely held by blocking from the forms, by supporting on concrete or plastic chairs or metal hangers, as approved by the superintendent, and by wiring together where required using annealed iron wire not less than 1.25 mm diameter. These supports shall be in a regular grid not exceeding 1 m and steel shall not be supported on metal supports which extend to any surface of the concrete, on wooden supports, nor on pieces of aggregate.

(b) Tack welding instead of wire ties may be used on reinforcing steel. Cold worked reinforcing bars shall not be tack welded. Tack welding must conform to AS 1554.3.

(c) The minimum cover of any bar to the nearest concrete surface shall be 50 mm unless otherwise shown on the drawings.

(d) Tie bars shall be placed in the pavement such that after placement they remain in their specified location. Tie bars shall not be placed through the finished upper surface of the pavement. Tie bars shall be placed either ahead of paving or by a bar vibrator into the edge of the joint or by an automatic tie bar inserter on the mechanical paver. Irrespective of the method of placement, tie bars extending from any side face of base concrete or gutter shall be anchored in a manner which will develop 85 per cent of the yield strength of the bar in tension.

(e) Placing and fastening of all reinforcement in the work shall be approved by the superintendent before concrete is placed and adequate time shall be allowed for inspections and any corrective work which the superintendent may require. Notice for the superintendent's inspection shall not be less than four working hours before the intended time of commencement of concrete pour or such time as determined by the superintendent. Council is to be advised no later than (48) hours before hand.

(f) Dowelled joints shall be provided as directed by the superintendent, parallel to the pavement surface and normal to the line of the joint, or as shown on the drawings. The dowels are to be installed ahead of paving by an approved dowel support assembly. One end of the dowel is to be sleeved which is to be placed on the same side of the joint for a distance of (L/2 + 25 mm) to make sure free movement of the concrete base slab (including temperature variations). The contractor is to check each dowels before placement and make sure the dowels are straight and free of irregularities including burrs and protrusions.

SC6.4.6.15.6 Production, transport and consistency of concrete

(1) Production and handling of concrete

(a) At least 4 weeks before commencing work, the Contractor shall submit, for the information of the superintendent, details of the proposed methods of handling, storing and batching materials for concrete, details of proposed mixers and methods of agitation, mixing and transport.

(b) The methods of handling, storing and batching materials for concrete shall be in accordance with AS 1379, with the following additional requirements:

(i) certificates of calibration issued by a recognised authority shall be made available for inspection by the superintendent, as evidence of the accuracy of the scales;

(ii) cementitious material shall be weighed in an individual hopper, with the Portland cement weighed first; and

(iii) the moisture content of the aggregates shall be determined at least daily immediately prior to batching. Corresponding corrections shall be made to the quantities of aggregates and water.

(c) Details of the proposed mixers and agitation methods shall be in accordance with the plant and

equipment sections of AS 1379, with the additional requirement that in Appendix A of AS 1379 the maximum permissible difference in slump shall be 10 mm.

(2) Mixing and transport

Mixing and transport methods shall be in accordance with the production and delivery sections of AS 1379, with the following additional requirements:

(a) the mixer shall be charged in accordance with the manufacturer's instructions;

(b) for the purpose of conducting mixer uniformity tests in accordance with Appendix A of AS 1379 on a split drum mixer producing centrally mixed concrete, the whole of the batch shall be discharged into the tray of a moving vehicle. The concrete shall then be sampled from the tray of the vehicle at points approximately 15 per cent and 85 per cent along the length of the tray;

(c) for truck mixed concrete, addition of water in accordance with the batch production section of AS 1379 shall be permitted only within ten minutes of completion of batching and within 200 m of the batching facilities. The delivery docket must clearly indicate the amount of water added, but in no circumstance shall the water:cement ratio be exceeded. Mixing of the concrete shall be completed at that location;

(d) admixtures shall be separately pre-diluted with mixing water and shall be incorporated by a method which ensures that no adverse interaction occurs;

(e) After addition of the cement to the aggregate, concrete shall be incorporated into the work within:

(i) one and a half hours, where transported by truck mixer or agitator; and

(ii) one hour, where transported by non-agitating trucks.

(f) the size of the batch in an agitator vehicle shall not exceed the manufacturer's rated capacity for the vehicle nor shall it exceed 80 per cent of the gross volume of the drum of the mixer; and

(g) concrete delivery dockets must be provided for each batch of mix. The docket must record the following delivery information:

(i) supplier name and location;

(ii) volume of material supplied;

(iii) product constituents; and

(iv) dispatch time and date.

(3) Mixing time

(a) Minimum mixing time will be as determined for the approved mix and verified when trial concrete base is constructed.

(b) Where by reason of delay, it is necessary to hold a batch in the mixer, mixing may be continued for a maximum of ten minutes except for split drum mixers where the maximum time shall be five minutes.

(c) For longer periods, the batch may be held in the mixer and turned over at regular intervals, subject to the time limits specified for incorporation of the concrete into the work not being exceeded.

(4) Consistency

(a) At all times between mixing and discharge, the slump of the concrete is to be within 10 mm for mechanically placed concrete and is to be within 15 mm for hand placed concrete.

(b) The consistency of the concrete shall be checked by use of a slump cone in accordance with AS 1012.3.1. The test shall be made on concrete samples obtained in accordance with AS 1012.1.

(c) The consistency of the concrete shall be checked within 30 minutes of adding cement to the aggregate. If the actual haul time exceeds 45 minutes, the consistency shall also be checked immediately prior to discharge. Concrete which is non-conforming in relation to consistency shall not be incorporated into the work. Check tests shall be done on each truck load of concrete.

SC6.4.6.15.7 Placing and finishing concrete base

(1) General

(a) At least 4 weeks before commencing work, the Contractor shall submit as part of the quality plan, to the superintendent, full details of the equipment and methods proposed for placing and finishing the concrete base together with a paving plan showing proposed paving widths, sequence, proposed jointing locations and estimated daily outputs.

(b) The Contractor shall give the superintendent seven days written notice of the intention to commence construction of the base on any section of work (including the placement of the trial concrete base in accordance with clause SC6.4.6.15.7(11) Trial concrete base. Submit work-as-executed survey details of the sub-base to the full extent of the works to the superintendent for confirmation of the constructed based. The survey should detail the locations where the constructed level is higher than the design levels. If the underlying layer is required to be spray sealed, the surveyor is to take levels on the top of the seal and after removal of foreign or loose material such as aggregate. The survey is to report as constructed levels to the nearest millimetre and survey on 5.0 m grid on a plan area that has been certified by a licensed surveyor. In the case of non-conforming locations and levels, the contractor is to locally reconstruct the pavement levels as directed by the superintendent and to the satisfaction of council.

(c) The sub-base surface shall be clean and free of loose or foreign or vegetative matter and is to be prepared in accordance with sub-section SC6.4.6.14 Mass concrete sub-base.

(d) Concrete shall not be placed either during rain or when the air temperature in the shade is below 5 ºC or above 38 ºC.

(e) The temperature of the concrete at the point of discharge from the transport vehicle shall be neither less than 10 ºC nor more than 32 ºC.

(f) Where required, slab anchors shall be constructed prior to construction of the base.

(2) Rate of evaporation

(a) When the value of rate of evaporation, determined from the graph in Figure SC6.4.6.15.1 Rate of evaporation, exceeds 0.50 kilograms per square metre per hour the contractor shall take precautionary measures to the superintendent's satisfaction, for the prevention of excessive moisture loss. If, in the opinion of the superintendent, such precautionary measures prove to be unsatisfactory, the contractor shall cease work while the evaporation rate is in excess of 0.50 kilograms per square metre per hour.

(b) Should the contractor elect to use an evaporation retarder to prevent excessive moisture loss, application shall be by fine spray after all finishing operations, except for minor manual bull floating.

(c) The contractor shall be responsible for measuring and recording concrete temperature and wind velocity at the point of concrete placement and for continuously measuring and recording air temperature and relative humidity at the site throughout the course of the work. The contractor shall provide and maintain all equipment and shall provide suitable personnel necessary for all such measuring and recording to accurately take place.

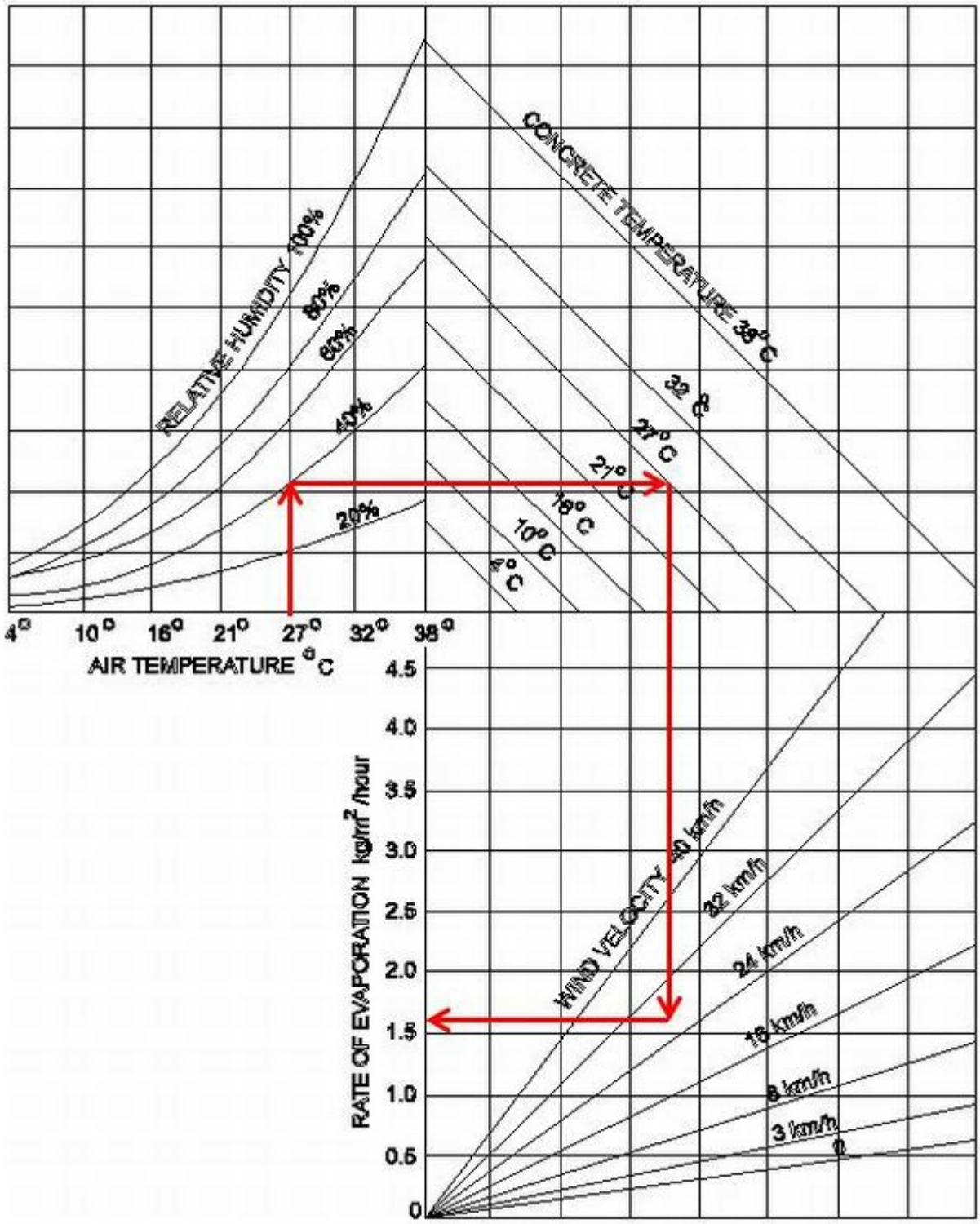


Figure SC6.4.6.15.1 Rate of evaporation

Note—the graph shows the effects of air temperature, humidity, concrete temperature and wind velocity together with the rate of evaporation of water from freshly placed and unprotected concrete.

Example:

- with air temperature at 27ºC
- with relative humidity at 40%
- with concrete temperature at 27ºC
- with a wind velocity of 26 km/h

the rate of evaporation would be 1.6 kg/m/hour.

To determine the evaporation rate from the graph, enter the graph at the air temperature (in this case 27ºC), and move vertically to intersect the curve for relative humidity encountered - here 40%. From this point move horizontally to the respective line for concrete temperature - here 27ºC. Move vertically down to the respective wind velocity curve - in this case interpolating for 26 km per hour - and then horizontally to the left to intersect the scale for the rate of evaporation.

(3) Mechanical paving

(a) The mechanical paver shall be a self-propelled machine with a gross operating mass of not less than 4 tonnes per lineal metre of paved width. It shall be capable of paving at a speed of one metre per minute or less as required to enable the continuous operation of the paver and obtain the required degree of compaction. It shall include the following features:

(i) an automatic control system with a sensing device to identify the control line and level – within the specified tolerances;

(ii) can spread the concrete mix uniformly and can regulate the flow of mix to the vibrators without segregation of the components;

(iii) has internal vibrators capable of compacting the full depth of the concrete;

(iv) has adjustable extrusion screeing and/or conforming plate to form the slab profile and produce the required finish on all surfaces; and

(v) has the capability of paving in the slab widths or combination of slab widths and slab depths shown on the drawings.

(b) The mechanical paver shall spread, compact, screed and finish the freshly placed concrete in such a manner that any finishing by hand is kept to a minimum. A dense and homogeneous concrete with a surface exhibiting low permeability is to be provided. It shall be textured in accordance with clause SC6.4.6.15.7(6) Texturing of surface.

(c) The supporting surface for the tracks of the paver, curing machine and any other equipment in the paving and curing train shall be in a smooth and firm condition.

(d) Once spreading commences, the concrete paving operation shall be continuous. The mechanical paver shall be operated so that its forward progress shall not be stopped due to lack of concrete. If disruptions occur for any reason, the superintendent may direct that a construction joint be formed before the recommencement of paving operations.

(e) Where an interruption to paving occurs, which is likely to result in a non-monolithic concrete mass, the contractor shall form a transverse construction joint in accordance with clause SC6.4.6.15.8(2) Transverse construction joints.

(f) Should subsequent testing at the location of an interruption indicate the presence of non-monolithic concrete, such concrete shall be removed and replaced in accordance with clauses SC6.4.6.15.11(1) General – Removal and replacement of base, SC6.4.6.15.11(2) Removal and disposal of base and SC6.4.6.15.11(3) Replacement of base.

(4) Hand placing

(a) Hand placement shall only be used in areas where mechanical placement is impracticable or where it has been approved by the superintendent prior to commencement of work.

(b) Forms shall be so designed and constructed so that they can be removed without damaging the concrete and shall be true to line and grade and braced in a substantial and unyielding manner. Forms shall be mortar tight and de-bonded to ensure non adhesion of concrete to the forms.

(c) Concrete shall be delivered in agitator vehicles and shall be deposited uniformly in the forms without segregation. The concrete shall be compacted by poker vibrators and by at least two passes of a hand guided vibratory screed traversing the full width of the slab on each pass. Any build-up of concrete between the forms and vibratory screed shall be removed.

(d) If disruptions occur for any reason, the superintendent may direct that a construction joint to be formed before the recommencement of paving operations. The cost of forming such construction joints shall be borne by the Contractor.

(e) A dense and homogeneous concrete with a surface exhibiting low permeability, shall be provided. It shall be textured in accordance with clause SC6.4.6.15.7(6) Texturing of surface.

(f) Where an interruption to placing of concrete occurs, which is likely to result in a non-monolithic concrete mass, the contractor shall form a transverse construction joint in accordance with clause SC6.4.6.15.8(2) Transverse construction joints.

(g) Should subsequent testing at the location of an interruption indicate the presence of non-monolithic

concrete, such concrete shall be removed and replaced in accordance with clauses SC6.4.6.15.11(1) General – Removal and replacement of base, SC6.4.6.15.11(2) Removal and disposal of base and SC6.4.6.15.11(3) Replacement of base.

(5) Alignment and surface tolerances

(a) Horizontal alignment tolerance

(i) The outer edges of the concrete base shall be square to the sub-base and shall not deviate from the plan position at any point by more than 10 mm.

(ii) Where an edge of a slab is to form a longitudinal joint line, the allowable horizontal alignment tolerances shall comply with clause SC6.4.6.15.8(7) longitudinal isolation joints.

(b) Tolerances and ride-ability

(i) The tolerance on thickness of the concrete base shall be zero below the specified thickness and in accordance with clause SC6.4.6.14.7(5)(b) for excess thickness.

(ii) The top surface of the base shall also not deviate at any measurement from a 3 m straightedge, laid in any direction, by more than 5 mm. Measurements for conformance shall be taken in accordance with the maximum lot size and minimum test frequencies in accordance with SC6.4.5 Construction management. Notwithstanding this requirement, the surface shall not pond water.

(6) Texturing of surface

Texturing of the concrete surface may be effected by use of a fine broom or hessian drag. The contractor shall submit to the superintendent details of the proposed texturing method and equipment.

(7) Curing

(a) The base shall be cured by the use of one of the following:

(i) Chlorinated rubber curing compound complying with AS 3799 Class C Type 1D or resin-based curing compound complying with AS 3799 Class B, Type 1D or Type 2, if an asphalt wearing surface is used, or

(ii) White pigmented wax emulsion curing compound complying with AS 3799 Class A Type 2, if no asphalt wearing surface is used, or

(iii) Bitumen emulsion Grade CRS/170 complying with AS 1160 for either asphalt wearing or no asphalt wearing surface.

(b) The contractor shall submit, for the information of the superintendent, a current certificate of compliance from an Australian laboratory, approved by the superintendent, showing an efficiency index of not less than 90 per cent when tested in accordance with Appendix B of AS 3799.

(c) The curing compound shall be applied using a fine spray immediately following texturing at the rate stated on the certificate of compliance or at a minimum of 0.2 litres per square metre, whichever rate is the greater. Bitumen emulsion shall be applied at a minimum rate of 0.5 litres per square metre. When applied with a hand lance the rates shall be increased by 25 per cent.

(d) The average application rate shall be checked by the contractor and certified to the superintendent by calculating the amount of curing compound applied to a measured area which is representative of a lot - and nominated by the Superintendent.

(e) The curing membrane shall be maintained intact for 7 days after placing the concrete. Any damage to the curing membrane shall be made good by handspraying of the affected areas.

(f) Equipment and materials for curing operations shall be kept on site at all times during concrete pours.

(8) Protection of work

(a) The Contractor shall protect the work from rain damage and shall provide, for the information of the superintendent, detailed proposals for procedures and equipment to be used for such protection.

(b) Neither traffic nor construction equipment, other than that associated with testing, sawcutting, groove cleaning or joint sealing, shall be allowed on the finished base until the joints have been permanently sealed and at least 10 days have elapsed since placing concrete, and the concrete has reached a

compressive strength of at least 20 MPa.

(9) Odd-shaped and mismatched slabs

(a) A slab is a portion of concrete base bounded by joints or free edges. A slab shall be considered to be odd shaped if the ratio of the longer dimension to the shorter dimension exceeds 1.6 or if the joint pattern produces an angle of less than 80 degrees between two adjacent sides. Slab dimensions shall be taken as the average dimension measured normal and parallel to the longitudinal joints. Slabs containing block-outs for drainage structures shall be considered as odd shaped.

(b) Where any joint meets a slab and is not continued across that slab, that slab shall be considered a mismatched slab.

(c) Unless otherwise shown on the drawings, odd shaped and mismatched slabs shall be reinforced with F82 reinforcing fabric placed with 50 mm to 60 mm cover to the surface of the base. Fabric shall be clear of all transverse and longitudinal joints by 50 mm to 100 mm.

(10) Terminal slabs

Terminal slabs shall be constructed adjoining bridge approach slabs and at changes from a rigid pavement to a flexible pavement. Terminal slabs shall be constructed to the dimensions and details shown on the drawings.

(11) Trial concrete base

(a) Before the commencement of paving, the contractor shall construct a trial section of concrete base on the carriageway to demonstrate to the superintendent the contractor's capability of constructing the concrete base in accordance with the specifications. This section shall be constructed so that it may be incorporated in the finished work.

(b) The trial base shall be constructed using the same materials, concrete mix, equipment and methods the contractor intends to use for the remaining base work. The contractor shall demonstrate the methods proposed to be used for texturing, the application of curing compound, the construction and sawing of joints and the placement of tie bars and dowels.

(c) The trial shall also be used to demonstrate that the contractor's allowances for concrete strength, compaction and slab thickness are adequate to achieve the minimum requirements specified.

(d) A trial length of between 20 m and 100 m for mechanical paving equipment or between 10 m and 30 m for hand placement is required. The maximum width proposed to be laid, shall be constructed in one continuous operation.

(e) Unless advised by the superintendent of any deficiencies in the trial concrete base, due to failure to comply with this sub-section, the contractor may proceed with placing the concrete base from a time ten working days after the completion of the trial concrete base or such earlier time as the superintendent may allow. In the event of deficiencies in the trial concrete base, the superintendent may order the contractor to construct a further length of trial concrete base which shall be treated as the first. If, after three trials, the base still is deficient in some way, the superintendent may require the contractor to justify to the satisfaction of the superintendent why the work should be allowed to continue using that method and/or equipment and/or materials and/or personnel.

(f) The superintendent shall have the right to call for a new trial section at any stage of work under the contract when changes by the contractor in the equipment, materials, mix, plant or rate of paving are deemed by the superintendent to warrant such a trial or when concrete as placed does not comply with this sub-section.

SC6.4.6.15.8 Joints

(1) General - joints

Joints shall be provided at locations indicated on the drawings or as approved by the superintendent.

(2) Transverse construction joints

(a) Transverse construction joints shall:

(i) be provided only at discontinuities in the placement of concrete determined by the contractor's

paving operations.

(ii) not be placed closer than 1.5 m to a transverse contraction joint. Where necessary, the superintendent shall authorise a change in the spacing and/or skew of transverse contraction joints to ensure that sufficient clearance is obtained;

(iii) be constructed normal to the control line and to the dimensions and details shown on the drawings. The tie bars shall comply with clauses SC6.4.6.15.5(1) Material and SC6.4.6.15.5(5) Placing;

(iv) be smooth across the joint before texturing; and

(v) not deviate from a 3 m straightedge placed along the joint by more than 10 mm.

(b) Prior to the placement of adjacent concrete, the surface of the concrete shall be roughened to expose coarse aggregate. The roughened surface and the projecting reinforcement shall be washed clean and all excess water and loose material removed.

(3) Transverse contraction joints

(a) General

(i) Transverse contraction joints shall be continuous across the full width of the concrete base and shall be sawn unless otherwise approved by the superintendent.

(ii) Where the concrete base is to be overlaid with asphalt wearing course, the superintendent may approve the joint to be formed with a suitable plastic joint inducing system.

(iii) Transverse contraction joints shall be constructed normal to the control line and to the dimensions and details shown on the drawings. Where necessary, the joint may be skewed to a maximum 1 in 12 to accommodate construction joints and slab anchors.

(b) Saw-cutting

(i) The Contractor shall ensure that saw-cutting be conducted between 6 and 24 hours after initial paving so as not to cause excessive ravelling of aggregate adjacent to the cut and so as to prevent cracking of the concrete baseother than at the bottom of the 3 mm saw-cut. The contractor shall use the type of blade and equipment and the method of control best suited to the hardness of the concrete being sawn and shall have sufficient standby equipment available on site to maintain continuity of sawing.

(ii) The line of the transverse contraction joint shall be without any discontinuities. No edge shall deviate from a 3 m straight edge by more than 10 mm.

(iii) The surface of the transverse contraction joint shall not exhibit more than 5mm of vertical or horizontal edge ravelling. The length of edge ravelling shall not be more than 300 mm in any 1m length of joint on each edge. Saw debris shall be washed from the joint and pavement immediately after sawing.

(iv) Saw-cuts, which do not conform to the requirements of this clause, shall be rejected by the superintendent. Rejected saw-cuts may be repaired by a method approved by the superintendent.

(c) Cleaning

Immediately after any sawing, the saw-cut shall be cleaned of all debris. The cleaning method used shall not damage the saw-cut nor leave any substance deleterious to the concrete or to the adhesion of the joint sealants. The method shall incorporate a pressurised liquid or liquid/air jet. Cleaning liquid shall not be gravity fed from tanks.

(d) Temporary sealing

(i) Immediately after cleaning following the second saw-cut, if the transverse contraction joint is produced by a two cut operation, the joint shall be temporarily sealed by a continuous closed cell polyethylene backer rod of diameter shown on the drawings or as required by the superintendent.

(ii) The top of the sealant shall be neither higher than nor more than 10 mm below the concrete surface. The backer rod shall pass over any longitudinal joint seal already in place.

(iii) The temporary sealant shall be maintained by the contractor until the joint is sealed permanently. Damaged or disturbed temporary sealants shall be removed, the transverse contraction joint is to

be re-cleaned to the satisfaction of the superintendent and a new temporary sealant inserted.

(e) Permanent sealing

(i) General – permanent sealing

(A) Within 10 days of initial sawing and immediately on removal of the temporary sealant, the permanent sealant shall be placed in the joint.

(B) The permanent sealant shall be either a neoprene compression seal or an in situ cast silicone sealant. The contractor shall submit for the approval of the superintendent, a full technical description of the proposed sealant, including its operating parameters and the method of installation recommended by its manufacturer.

(ii) Neoprene compression sealants

(A) Neoprene compression sealants shall comply with all the requirements of ASTM 2628. Test methods used to determine compliance with these requirements shall include test methods Q462, Q463A and Q463B.

(B) At least four weeks before installation of the sealant, the contractor shall submit to the superintendent a certificate of compliance from a NATA registered laboratory showing that the sealant meets all the requirements of ASTM 2628.

(C) At the time of installation, the sides of the neoprene sealant shall be coated with a clear or concrete coloured lubricant compound approved by the superintendent and complying with ASTM D 2835. The sealant shall be inserted into the joint by using appropriate equipment and procedures which shall not damage the sealant during its insertion. The maximum increase in length of the sealant after installation shall be 5 per cent of original length. Any sealant exceeding 5 per cent extension shall be rejected. The sealant shall be located in the transverse contraction joint in the design orientation without twist or buckle.

(D) The sealant shall be continuous between formed longitudinal joints. Where such a discontinuity occurs, the sealant shall be angle butt jointed by a method approved by the superintendent. The top of the sealant shall be neither less than 5 mm nor more than 7 mm below the surface of the base and shall overlay any longitudinal sealants.

(iii) Silicone Sealants

(A) Silicone sealants shall be formed using a silicone joint sealant complying with the requirements listed in Table SC6.4.6.15.4 Silicone joint sealant requirements. At least 4 weeks before the installation of the sealant, the contractor shall submit to the superintendent a certificate of compliance, from a NATA registered laboratory, showing that the sealant meets all the requirements of Table SC6.4.6.15.4.

(B) The silicone joint sealant shall be grey in colour and shall be stored and installed in accordance with the manufacturer's written instructions. Installation of a silicone sealant shall take place only when the side walls of the groove have been grit blasted and are surface dry.

(C) Immediately before introducing the silicone sealant into the groove, any foreign or disturbed material shall be cleaned from the joint and from the top of the backer rod by dry air jet. The backer rod shall then be depressed to the depth such that the bottom of the silicone sealant shall be at the planned location and of the correct shape.

(D) If the backer rod is damaged in any way it shall be replaced for the full length of the joint.

(E) The method to be used for permanent sealing with silicone sealant shall be approved by the superintendent before permanent sealing commences. Notwithstanding any approval given by the Superintendent to a proposed method, the contractor shall be responsible for producing a permanent seal complying with all requirements of this specification.

Table SC6.4.6.15.4 Silicone joint sealant requirements

Test Method	Test	Requirements
ASTM-D-792	Specific Gravity	1.1 to 1.55
MIL-S-8802	Extrusion Rate	90 to 250 g per min
MIL-S-8802	Tack Free Time	30 to 70 min
ASTM D 2240	Durometer	10 to 25
Q461	Durability	Extension to 70% Compression to 50%
ASTM C794	Adhesion to Concrete	35N minimum average peel strength
ASTM C 793-7	Accelerated Weathering at 5,000 hours	No cracks, blisters or bond loss

(4) Transverse isolation joints

(a) Transverse isolation joints shall be provided at bridge approach slabs and at slab anchors where shown on the drawings and where directed by the superintendent.

(b) Transverse isolation joints shall be continuous across the full width of the concrete base normal to the control line and shall be constructed in accordance with the drawings.

(c) Transverse isolation joints shall not be placed closer than 2 m to other transverse joints. Where necessary, the superintendent shall authorise a change in the spacing and/or skew of adjacent transverse contraction joints to ensure that sufficient clearance is obtained.

(d) Joint filler shall consist of preformed jointing material of bituminous fibreboard and the joint sealant shall comply with the silicone sealant requirements of clause SC6.4.6.15.8(3) Transverse contraction joints. They shall be installed in accordance with the drawings and in a manner conforming to the manufacturers recommendations except that any reference to backer rods will not apply.

(e) The line of the isolation joint shall not deviate from a 3 m straightedge more than 10 mm.

(5) Longitudinal tied joints

(a) General – Longitudinal tied joints

(i) Longitudinal tied joints shall be provided at the locations shown on the drawings or where directed by the superintendent. The joints shall be parallel to the control line and/or to the dimensions and details shown on the drawings.

(ii) Longitudinal tied joints shall be formed or induced either by sawing or by machine insertion of a crack inducer ribbon.

(iii) The ties shall be 12 mm diameter deformed steel bars Grade 400Y, 1 m long and shall be inserted in accordance with clause SC6.4.6.15.5(5) Placing. Tie bars shall be located and spaced as shown on the drawings. All parts of any tie bar shall lie within 50 mm of its designed position. Tie bars shall be omitted within 500 mm of a transverse joint. The epoxy to be used when installing tie bars in existing concrete shall be hydrophilic epoxy resin. The setting system used shall develop an anchorage strength at least 85 per cent of the yield strength of the bar.

(iv) The line of longitudinal tied joints shall not deviate from the designed position at any point by more than 10 mm. The line shall also not deviate from a 3 m straight edge by more than 10 mm having made due allowance for any planned curvature.

(v) Where the longitudinal tied joint is formed or slip-formed, the joint face shall be corrugated in accordance with the details shown on the drawings.

(vi) Where the multi-lane width is greater than 18 m, a longitudinal isolation joint shall be constructed at each location shown on the drawings and in accordance with clause SC6.4.6.15.8(7) Longitudinal isolation joints.

(b) Sawn-induced joints

(i) Sawn longitudinal tied joints shall be provided to the dimensions shown on the drawings. Saw-cutting shall comply with clause SC6.4.6.15.9(3)(b) Saw-cutting.

(ii) Within 24 hours of sawing, the longitudinal tied joint shall be thoroughly cleaned of all debris and a neoprene backing rod, shall be inserted in accordance with the details shown on the drawings.

(iii) The sealant shall be coated with a lubricant adhesive compound approved by the superintendent. The compound shall have a colour compatible with the pavement colour. The sealant shall be inserted into the groove by means of suitable equipment which shall not damage the sealant during insertion. The maximum increase in length of the sealant after installation shall be 10 per cent of the original length, otherwise the sealant shall be rejected.

(iv) Joints in the sealant shall be kept to a minimum and shall be cemented together by an adhesive recommended by the manufacturer. The top of the sealant shall be neither less than 5 mm nor more than 7 mm below the surface of the concrete base, except where the sealant is depressed to lie under the transverse joint sealant.

(c) Ribbon-Induced Joints

(i) Ribbon induced longitudinal tied joints shall be provided to the dimensions and details shown on the drawings. The inducer ribbon shall be machine inserted so that the top of the ribbon does not protrude above the surface of the base, nor shall it lie below the surface of the base by more than 3 mm.

(ii) The inducer ribbon shall be a minimum of 0.5 mm thick. When placed, it shall be within 5º of the vertical plane. Any inducer ribbon that curls on placement when cut into the concrete base and is found to be curved in the transverse section by more than 3 mm its straight alignment, will be rejected.

(iii) At transverse construction joints, the inducer ribbon shall be carried through the joint sufficiently to allow a connection using strong stapling, or another method as approved by the superintendent. When a join, during paving, is necessary within the inducer ribbon - the inducer ribbon on the new spool shall be similarly joined to the tail of the inducer ribbon on the old spool.

(d) Treatment of sawn longitudinal tied joints prior to asphalt overlay

Where asphalt surfacing over sawn longitudinal tied joints is specified, the sealant shall be depressed to a depth below the concrete surface of not less than 10 mm and, following thorough cleaning, the joint shall be sealed flush with the concrete surface with a bituminous rubber compound, approved by the superintendent, which is to be compatible with the narrow groove.

(6) Longitudinal joint with kerb and/or channel

(a) Where kerbs and/or channel are to be constructed within the shoulder of a concrete base, they shall be formed directly onto the concrete sub-base and they may be cast either integrally with the concrete base or separately.

(b) Where constructed separately, they shall be tied to the concrete base by 12 mm diameter deformed steel tie bars grade 250S or 400Y, 1000 mm long at 1 m centres.

(c) The longitudinal joint shall be constructed parallel to the control line (parallel to the centre line for kerb ramps) and to the dimensions shown on the drawings. The tie bars shall be inserted in accordance with the drawings and clause SC6.4.6.15.5(5) Placing.

(d) The face of the longitudinal joint need not be scabbled however the joint does not need to be sealed.

(e) The line of the longitudinal joint shall be constructed to the tolerances specified for longitudinal tied joints in accordance with clause SC6.4.6.15.8 Longitudinal tied joints.

(f) The construction of kerb and/or channel shall be in accordance with kerb and channel sub-section SC6.4.6.9 Open drains regardless of method of construction except that the strength of the concrete used in the kerb and/or channel shall be 36 MPa.

(7) Longitudinal isolation joints

(a) Longitudinal isolation joints shall be provided where shown on the drawings and where directed by the superintendent.

(b) The line of the longitudinal isolation joint shall not deviate from the specified position by more than 10 mm. The line of the joint shall not deviate from a 3 m straight edge by more than 10mm.

(c) The joint filler shall consist of pre-formed jointing material of bituminous fibreboard and the joint sealant shall comply with the silicone sealant requirements of clause SC6.4.6.15.8(2) Transverse construction joints. They shall be installed in accordance with the drawings and in a manner conforming to the manufacturer's recommendations except any reference to backer rods will not apply.

SC6.4.6.15.9 Slab anchors

(1) General

(a) Slab anchors shall be constructed normal to the control line, to the dimensions and at the locations shown on the drawings.

(b) Slab anchors shall extend over the full width of the concrete base and the associated transverse expansion joint shall not be placed closer than 2 m to other transverse joints. Where necessary, the superintendent shall authorise a change in the spacing of transverse contraction joints to ensure that this minimum clearance is obtained.

(2) Excavation

(a) Excavation of trenches for slab anchors shall be to the dimensions and details shown on the drawings.

(b) All loose material shall be removed and the vertical faces trimmed to neat lines. The bottom of the trench shall be re-compacted, where required, to the degree of consolidation of the adjacent undisturbed material.

(c) The Contractor shall dispose of excavated material at locations approved by the superintendent.

(d) Where a slab anchor is required at the junction of an existing flexible pavement, a straight saw-cut to the full depth of the asphaltic concrete or bituminous seal shall be made in the flexible pavement along the joint line. Excavation of the trench shall then take place as described above without disturbance or damage to the existing flexible pavement. Any disturbance or damage to the flexible pavement shall be made good as directed by the superintendent.

(e) A subsoil drain shall be provided at the bottom of the trench, in accordance with subsection SC6.4.6.20 Subsoil, foundation and pavement drains and details shown on the drawings.

(3) Concrete

(a) Concrete for slab anchors shall be produced, transported and placed in accordance with the requirements for hand placed concrete base.

(b) Slab anchors shall be poured separately from the concrete base slabs and to the dimensions and details shown on the drawings - up to the top surface of the sub-base.

(c) A transverse isolation joint shall be provided on the downhill side of the slab anchor.

(d) Steel reinforcement in slab anchors shall be of the type and size shown on the drawings and shall be supplied and fixed in accordance with clauses SC6.4.6.15.5(1) Material and SC6.4.6.15.5(5) Placing.

(e) Bridge approach slabs, if not in the bridge contract, shall be constructed at bridge abutments to the dimensions and details shown on the drawings and in accordance with the requirements for the concrete base.

SC6.4.6.15.10 Conformance of concrete strength, compaction and thickness

(1) Concrete cylinders

(a) Test specimens

(i) Test specimens for determining the compressive strength of concrete shall be standard cylinders complying with AS 1012.8. The contractor shall supply a sufficient number of moulds to meet these requirements for the frequency of testing specified in this clause. The contractor will also arrange for a laboratory with appropriate NATA registration to conduct the sampling of fresh concrete and the making, curing, delivery and testing of specimens. Copies of test results shall be forwarded to the superintendent.

(ii) Samples of concrete for testing shall be taken in accordance with AS 1012.1. The selection of the

batches to be sampled shall be taken randomly. The specimens shall be moulded from each sample so that they are as identical as practicable.

(iii) The method of making and curing specimens shall be in accordance with AS 1012.8 with compaction by internal vibration.

(iv) The contractor shall mark the specimens for identification purposes.

(b) Frequency of moulding of test specimens

Test specimens shall be moulded at 7 days and 28 days or as directed by the superintendent - for the determination of the compressive strength. Each test specimen shall be moulded as follows:

(i) for each lot of up to 50 cubic metres of concrete placed at the one time - One pair of specimens;

A lot is defined as a continuous pour of up to 50 cubic metres of concrete placed.

(c) Inspection, capping and crushing of specimens

(i) Specimens required by this sub-section shall be tested at the NATA registered laboratory nominated by the contractor.

(ii) Specimens shall be inspected, capped and crushed in accordance with AS 1012.9.

(iii) Before crushing, the mass per unit volume of the seven day specimens shall also be determined in accordance with AS 1012.12.2, so that the relative compaction of cores taken from the same lot of concrete base can be determined.

(2) Compressive strength of concrete

(a) General

The compressive strength of the concrete represented by a pair of specimens moulded from one sample shall be the average compressive strength of the two specimens unless the two results differ by more than 3 MPa, in which case the higher result shall be taken to represent the compressive strength of the lot of concrete.

(b) Adjustment of test compressive strength for age of specimen

Should any specimen be tested more than 28 days after moulding the equivalent 28 day compressive strength shall be the test compressive strength divided by the factor applying to the age of the specimen at the time of the test shown in Table SC6.4.6.15.5 Concrete age conversion factors. For intermediate ages the factor shall be determined by interpolation.

Age of Specimen at time of test (days)	Factor
28	1.00
35	1.02
42	1.04
49	1.06
56	1.08
70	1.10
84	1.12
112	1.14
140	1.16
168	1.18
196	1.20
224	1.22
308	1.24
365 or greater	1.25

(c) Conformance for Compressive Strength

(i) If the 28 day compressive strength of test cylinders for any lot is less than 33 MPa or greater than 45 MPa, the lot represented by the test cylinders shall be removed and replaced in accordance with clauses SC6.4.6.15.11(1) General – Removal and replacement of base, SC6.4.6.15.11(2) Removal and disposal of base and SC6.4.6.15.11(3) Replacement of base.

(ii) In case of non-conformance the contractor may elect to core the in situ concrete base for testing

of the actual compressive strength to represent the particular lot. The locations for testing shall be nominated by the superintendent. Such locations may be determined by the use of a nuclear density meter, or any alternative method approved by the Superintendent. Testing shall be carried out at the request of the contractor. Base concrete failing to reach the required in situ compressive strength shall not be re-tested for at least 72 hours after the determination of the value of the in situ compressive strength.

(iii) After testing for compressive strength of the sample concrete cores, as required, the superintendent shall consider the test results and shall, at his absolute discretion determine the compressive strength of the concrete to be either:

(A) The average of the 28 day compressive strength of the pair of specimens moulded at the time of placing; or

(B) The equivalent 28 day compressive strength of the core.

(iv) A lot is defined as a continuous pour of up to 50 cubic metres of base represented by a set of test specimens cast from a sample of the concrete used in its construction.

(v) Thickness measurements of the concrete base shall be determined and certified by a licensed surveyor. Measurements are to be taken at the edges or by coring. Audit checks using a suitable probe may be carried out whilst the concrete is being placed. The readings shall be rounded off to the nearest 5 mm.

(vi) Concrete base which is below the specified thickness shall be removed and replaced in accordance with clauses SC6.4.6.15.11(1), SC6.4.6.15.11(2) and SC6.4.6.15.11(3) .

(vii) Base which is thicker than the design thickness will be acceptable provided the finish satisfies the requirements of Clause SC6.4.6.15.7 Placing and Finishing Concrete Base and that the finished surface base level complies with clause SC6.4.6.14.7 (5) (b)

(3) Relative compaction of concrete

(a) Test specimens

(i) Test specimens for determining the relative compaction of the concrete placed in the work shall be cores cut from the work. Cores shall be cut from the full depth of the concrete base to the requirements of AS 1012.14, with the following exceptions:

(A) the requirement that the concrete shall be at least 28 days old before the core is removed shall not apply. However concrete must be not less than 3 days old in the warm season and 6 days old in the cool season, before removal; and

(B) the nominal diameter of the cores shall not be less than 75 mm.

(ii) The location of coring shall be chosen to exclude joints, steel reinforcement or tie bars from the core. The locations are not intended to be random, but are intended to ensure that the whole of the concrete base conforms to the minimum requirements of this sub section. Cores shall be marked for identification by the contractor.

(iii) Cores shall be placed immediately either in a tank of lime saturated water or in an individual plastic bag and sealed to prevent water loss. Cores stored in plastic bags shall be kept in the shade.

(iv) Cores shall not be subjected to temperatures in excess of either ambient temperature or 23 ºC whichever is the higher and they shall not be subjected to temperature less than 10 ºC, until delivered to the testing laboratory.

(b) Frequency of coring

(i) The Contractor shall take a minimum of one core specimen from each lot of concrete base represented by standard cylinders moulded in accordance with clause SC6.4.6.15.10(1) Concrete cylinders.

(ii) In the case of hand placed concrete base, two cores shall be taken to represent a section of work. A section of work shall be confined between construction joints. Hand worked or placed base that is cast with machine placed concrete and not separated from the machine placed concrete shall be deemed to be part of the machine placed concrete, and be cored and tested as part of the

machine placed concrete base.

(c) Repair of core holes

(i) The Contractor shall clean and restore all core holes taken in the base with non-shrink cementitious concrete having a compressive strength of not less than that in the base and a maximum nominal aggregate size of 10 mm.

(ii) The surface of the restored hole shall be similar to the surrounding surface in texture and colour.

(d) Testing of cores for compaction

(i) The core specimens shall be wet conditioned in accordance with AS 1012.14 for not less than 24 hours immediately prior to testing for compaction. Testing to determine mass per unit volume shall be carried out on specimens at age seven days.

(ii) The relative compaction of a core specimen shall be the ratio, expressed as a percentage, of the mass per unit volume of the core specimen to the average mass per unit volume of the standard cylinders used to determine the seven day compressive strength from the same lot of concrete base. The mass per unit volume of both standard cylinders and cores shall be determined in accordance with AS 1012.12.2.

(e) Conformance for Compaction

(i) If the relative compaction is less than 97 per cent, the lot represented by the core shall be removed and replaced in accordance with clauses SC6.4.6.15.11(1), SC6.4.6.15.11(2) and SC6.4.6.15.11(3).

(ii) Core specimens for compressive strength testing shall be wet conditioned, prepared and tested in accordance with AS 1012.14. Cores obtained for compaction shall not be re used for compressive strength testing.

(iii) The test strength shall be adjusted for age in accordance with clause SC6.4.6.15.10(2) Compressive strength and for length/diameter ratio in accordance with Table SC6.4.6.15.6 Correction factors by multiplying by the correction factor in Table SC6.4.6.15.6 Correction factors.

(iv) If the 28 day compressive strength of the core is less than 33 MPa, the lot represented by the compaction core shall be removed and replaced in accordance with clauses SC6.4.6.15.11(1), SC6.4.6.15.11(2) and SC6.4.6.15.11(3).

Table SC6.4.6.15.6 Correction factors

Length/Diameter Ratio	Correction Factor
2.00	1.00
1.75	0.98
1.50	0.96
1.25	0.93
1.00	0.89

SC6.4.6.15.11 Removal and replacement of base

(1) General – Removal and replacement of base

(a) Where directed by the superintendent, rejected base shall be removed and replaced in accordance with this clause. Rejected base, which extends more than 25 m longitudinally, shall be replaced by mechanical means unless the slabs are odd shaped or mismatched. Replacement shall be in full slab widths between longitudinal joints and/or external edges.

(b) At least 7 days before the commencement of concrete base removal, the contractor shall submit, for the approval of the superintendent, details of the proposed methods of carrying out the work which shall be such as to prevent damage to the adjoining concrete base and the underlying sub-base.

(2) Removal and disposal of base

(a) At each end of the section of concrete base to be removed, a transverse saw-cut shall be made for the full depth of the base layer. Such transverse saw-cut shall be normal to the control line and not closer

than 1.5 m to an existing contraction joint in the base. No over-sawing into the adjoining concrete base or underlying sub-base shall be permitted.

(b) Longitudinal saw-cuts shall be made along the existing longitudinal joints to define the edges of the base section to be removed. Such longitudinal saw-cuts shall not extend more than 250 mm past the transverse saw-cut at each end of the section to be removed and shall not extend into the underlying sub-base.

(c) No over-sawing shall be permitted on any internal saw-cuts made by the contractor to aid in the removal of the concrete base.

(d) The contractor shall dispose of the removed concrete base slabs at sites acceptable to the superintendent.

(e) Any slab, adjoining the removed slabs, damaged by the contractor's operations shall also be removed and replaced in accordance with this clause.

(3) Replacement of base

(a) Before construction of the replacement base, the sub-base shall be prepared and de-bonded in accordance with sub-section SC6.4.6.14 Mass concrete sub-base.

(b) All work involved in the replacement of the concrete base shall comply with this sub-section, including the following additional requirements:

(i) The joint faces on the adjoining slab at the transverse saw-cuts shall be deeply scabbled below the top 25 mm which shall be left smooth. Tie bars shall be provided to form a transverse construction joint in accordance with clause SC6.4.6.15.8(2) Transverse construction joints.

(ii) Transverse contraction joints shall be continuous across the full width of the base containing the replaced section. The length of the joint across the full width of the base shall be sealed with the same sealant as in adjacent work and in accordance with clause SC6.4.6.15.8(3) Transverse contraction joints.

(iii) The lower two thirds of the depth of the longitudinal joint faces shall be deeply scabbled and any concrete considered to be unsound by the superintendent shall be removed. A crack inducer ribbon shall be attached to the surface of any formed longitudinal joint in the replacement concrete base and tie bars provided to form a longitudinal tied joint in accordance with clause SC6.4.6.15.8(5) Longitudinal tied joints.

(iv) Tie bars placed into hardened concrete shall be set by the use of a hydrophilic epoxy resin. The setting system used shall develop an anchorage strength at least 85 per cent of the yield strength of the bar.

(v) Neither traffic nor construction equipment other than that associated with testing, saw-cutting, groove cleaning or joint sealing shall be allowed on the section of replaced concrete base until the joints have been permanently sealed and at least 10 days have elapsed since placing the replacement concrete base or it has reached a compressive strength of at least 20 MPa.

SC6.4.6.15.12 Limits and tolerances

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.15.7 below:

Table SC6.4.6.15.7 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	**Aggregates** a. General	Mass of the total aggregates in concrete mix shall consist of at least 40% quartz sand	SC6.4.6.15.3(5)(a)
	b. Fine Aggregate (i) Grading	To be within the limits as per Table SC6.4.6.15.2 and shall not deviate from Proposed Grading by more than amounts in Table SC6.4.6.15.2	SC6.4.6.15.3(5)(b)

Item	Activity	Limits/Tolerances	Clause
	(ii) Wet Strength	Not less than 80kN for any fraction and/or constituent	SC6.4.6.15.3(5)(c)
	(iii) 10% Fines Wet/Dry Variation	Not to exceed 35% for any fraction and/or constituent	SC6.4.6.15.3(5)(c)
	(iv) Soundness	The loss in mass when tested with sodium sulphate to be less than 9% for any constituent	SC6.4.6.15.3(5)(c)
	(v) Particle Shape	The proportion of misshapen particles (2:1 ratio) to be less than 35%	SC6.4.6.15.3(5)(c)
	(vi) Fractured Faces	At least 80% by mass of the particles shall have two or more fractured faces	SC6.4.6.15.3(5)(c)
2.	**Concrete Quality** a. Cement Content	At least 270kg per yielded cubic metre of concrete	SC6.4.6.15.4(1)
	b. Flyash	Not greater than 50kg per yielded cubic metre of concrete	SC6.4.6.15.4(1)
	c.Compressive Strength	The minimum 28 day compressive strength shall be 36.0 Mpa	SC6.4.6.15.4(2)
	d. Shrinkage	Not to exceed 450 microstrain after 3 weeks of air drying	SC6.4.6.15.4(3)
	e. Consistency	Nominated slump shall be neither less than 30mm nor more than 40mm for mechanically placed concrete. It shall be neither less than 55mm nor more than 65mm for hand placed concrete.	SC6.4.6.15.4(4)
	f. Air content	Shall not be less than 4% nor more than 7% when discharged from the transport vehicle ready for placement	SC6.4.6.15.4(5)
3.	**Concrete Mixing and Transport**	After addition of cement to the aggregate, concrete shall be incorporated into the work within: (i) One and a half hours where transported by truck mixer or agitator. (ii) One hour where transported by non-agitating trucks.	SC6.4.6.15.6(2)
4.	**Concrete Placing**	Concrete shall not be placed when the air temperature in the shade is above 38ºC. The temperature of the concrete shall be neither less than 10ºC nor more than 32ºC.	SC6.4.6.15.7(1)
		Where the value of Rate of Evaporation exceeds 0.50kg per square metre per hour, the Contractor shall cease work.	SC6.4.6.15.7(2)
5.	**Alignment and Surface** a. Horizontal Alignment	The outer edges of the base shall not deviate from the plan position at any point by more than 10mm.	SC6.4.6.15.7(5)(a)

Item	Activity	Limits/Tolerances	Clause
	b. Surface Level	The level at any point on the top of the base shall not vary by more than +10mm or -0mm from that shown on the drawings or as directed by the superintendent. The top surface of the base shall not deviate from a 3m straight edge, laid in any direction, by more than 5mm.	SC6.4.6.15.7(5)(b)
6.	**Joints** a. Transverse Construction	The line of the transverse construction joints shall not deviate from a 3m straight edge placed along the joint by more than 10mm.	SC6.4.6.15.8(2)
	b. Transverse Contraction	(i) May be reduced locally to a skew of 1 in 12 to accommodate construction joints and slab anchors. (ii) No edge shall deviate from a 3m straight edge by more than 10mm. (iii) The surface of the transverse contraction joint shall not exhibit more than 5mm of vertical or horizontal edge ravelling. The length of edge ravelling shall not be more than 300mm in any 1m length of joint on each edge. (iv) Temporary sealing - the top of the sealant shall be neither higher than nor more than 10mm below the concrete surface. (v) Permanent Sealing The top of the sealant shall be neither less than 5mm nor more than 7mm below the surface of the base.	SC6.4.6.15.8(3)
	c. Transverse Isolation	The line of the transverse expansion joint shall not deviate from a 3m straight edge more than 10mm.	SC6.4.6.15.8(4)
	d. Longitudinal Tied Joints	(i) All parts of any tie bar shall be within 50mm of its designed position. (ii) The line of longitudinal tied joints shall not deviate from the designed position at any point by more than 10mm. The line shall also not deviate from a 3m straight edge by more than 10mm having made due allowance for any planned curvature. (iii) For sawn-induced joints, the maximum increase in length of the sealant after installation shall be 10% of the original length. The top of the sealant shall be neither less than 5mm nor more than 7mm below the surface of the base. (iv) For ribbon-induced joints, the inducer ribbon shall be a minimum of 0.5mm thick and when placed it shall be within 5 of the vertical plane.	SC6.4.6.15.8(5)

Item	Activity	Limits/Tolerances	Clause
	e. Longitudinal Isolation Joints	The line of the longitudinal isolation joint shall not deviate from the specified position by more than 10mm. The line of the joint shall not deviate from a 3m straight edge by more than 10mm.	SC6.4.6.15.8(7)
7.	**Slab Anchors**	Not placed closer than 2.0m to transverse joints (other than associated transverse expansion joints).	SC6.4.6.15.9(1)

SC6.4.6.16 Sprayed bitumen surfacing

SC6.4.6.16.1 Introduction

(1) Scope

This policy sub-section provides standards, advice and guidelines for the supply of all materials and the application of any or all of the following types of sprayed bituminous surfacing:

(a) prime
The application of a primer of field or refinery prepared cutback bitumen without aggregate to provide penetration of the surface (preferably from 5 to 10 mm) and waterproofing;

(b) primerseal
The application of a primerbinder of field or refinery prepared cutback bitumen to provide surface penetration (preferably from 2mm to 5mm) and incorporation of a light cover of aggregate to provide a temporary wearing surface; and

(c) seal or reseal
The application of a bituminous binder into which aggregate is incorporated to provide a durable wearing surface (including bitumen emulsion of polymer modified seals).

The locations and required types of sprayed bituminous surfacings, including types of binders and aggregate sizes, shall be as shown on the construction drawings and/or as detailed in SC6.4.6.16 Attachment A Details of work.

For multiple application treatments, the binder and aggregate may be required to be laid in one or more separate applications indicated in SC6.4.6.16 Attachment B.

Requirements for adhesion agent in the bitumen and tolerances for binder application rates are set out in SC6.4.6.16 Attachment B Binder details.

Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

Editor's note - A reference to drawings is a reference to construction drawings.

(2) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-section
SC6.4.6.30 - Control of traffic

(b) Australian Standards
AS 1160 - *Bituminous emulsions for the construction and maintenance of pavements*
AS 2008 - *Residual bitumen for pavements*
AS 2157 - *Cutback bitumen*
AS 2758.2 - *Aggregate for sprayed bituminous surfacing*
AS 3568 - *Oils for reducing the viscosity of residual bitumen for pavements*

(c) Queensland Department of Transport and Main Roads Technical Standards
MRTS11 10/10 - *Sprayed Bituminous Surfacing (excluding Emulsion)*
MRTS12 06/09 - *Sprayed Bituminous Emulsion Surfacing*
MRTS17 11/11 - *Bitumen*
MRTS18 11/11 - *Polymer Modified Binder*
MRTS19 11/11 - *Cutter and Flux Oils*
MRTS20 11/11 - *Cutback Bitumen*
MRTS21 06/09 - *Bituminous Emulsion*
MRTS22 10/10 - *Supply of Cover Aggregate*

(d) Queensland state legislation

Fire and Rescue Service Act 1990

(e) Other
Austroads, *Guide to Pavement Technology Part 4K: Seals*
Austroads, *Bituminous Materials Sealing Safety Guide*

(3) Control of traffic
The Contractor shall provide for the control of traffic in accordance with the requirements of policy sub-section SC6.4.6.30 Control of traffic while undertaking the work and shall take all necessary precautions to protect the work from damage until such time as the new seal coat has developed sufficient strength to carry normal traffic without disturbance of the aggregate.

Where early use of the new seal is required to facilitate the movement of traffic, vehicles may be allowed to run on the work after initial rolling has taken place provided that vehicles are controlled to such slow speeds that no lateral displacement of aggregate occurs. Where necessary, the Contractor shall use patrol vehicles to ensure that traffic travels at an acceptable speed.

The Contractor shall take all necessary steps to avoid or minimise delays and inconvenience to road users during the course of the work. Where adequate detours or side tracks are included in the Contract or are otherwise available, traffic shall be temporarily diverted while the work is in progress.

If facilities for the diversion of traffic are not available, the Contractor may spray part width of the pavement in the one operation and make available to traffic the adjacent strip of roadway, except during the actual spraying operation when all traffic movement through the work shall cease. Traffic shall not be permitted to encroach upon the edge of the sprayed bituminous material until such time as it is covered with aggregate.

SC6.4.6.16.2 Materials

(1) Sampling and testing of materials
Sampling and testing of materials shall be arranged by the Contractor and carried out by a laboratory with appropriate NATA registration in accordance with the requirements of the relevant Queensland Department of Transport and Main Roads (DTMR) Specification.

(2) Bituminous materials and additives
Bituminous materials shall be in accordance with the relevant DTMR Specifications.

(3) Aggregate precoating agent and bitumen adhesion agent

(a) Aggregate pre-coating agents shall be as listed.

Acceptable Pre-coating Agents
The following products listed in Table SC6.4.6.16.1 may be used subject to testing on each type of cover aggregate and verification of suitability of the product and application rate.

Table SC6.4.6.16.1 Preferred pre-coating agents

Product	Manufacturer	Approximate Application Rate (L/m^3)
1st Preference – Shell Mexkote A	Shell Company of Aust Ltd	8
2nd Preference – Boral ATP2	Boral Resources (Qld) Pty Ltd	8
3rd Preference – Premol E2	Emoleum (Australia) Ltd	8
4th Preference – Emulcoat C	Pioneer Road Services Pty Ltd	12
4th Preference – Precoat 245	BP Australia Ltd	8
4th Preference – Emulsion Precoat	Emoleum (Australia) Ltd	17

Time period between pre-coating and spreading of pre-watered aggregate shall be in accordance with Table 7.1.4 of MRS22.

(b) Bitumen adhesion agents.
Adhesion agents shall conform to the following requirements:

(i) adhesion agent is to be added to bitumen at the rate of 5 kg for every 1,000 Litres of bitumen CL170 and 10 kg for every 1,000 litres of polymer modified bitumen; and

(ii) adhesion agents approved for use are Diamintol, or Bitumite EXP3995 if Diamintol is unavailable.

(4) Oils for reducing viscosity of bitumen
Cutter Oil shall conform to MRTS 19.

Delivery and storage procedures for cutter oil delivered in drums or in bulk shall ensure that all containers are free from any deleterious material prior to filling with cutter oil, and all drums are stored so as to ensure that entry of water through seals or welds in the drums is prevented.

(5) Aggregate
Aggregate shall conform to MRS22.

The Contractor shall obtain test results for each lot/stockpile of aggregate and certification of compliance from a laboratory with appropriate NATA accreditation, before aggregate from the lot is incorporated in the works.

SC6.4.6.16.3 Design of bituminous surfacing

(1) Before commencing sprayed bituminous surfacing work, the Superintendent will confirm the approved details of the proposed bituminous surfacing design for the work. Additional details are required to be submitted to the Superintendent prior to carrying out the work for check with the proposed bituminous surfacing design. These additional details include:

(a) test results for all nominated materials;

(b) aggregates source, geological type, nominated grading, average least dimension (ALD);

(c) pre-coating agent and bitumen adhesion agent types, proportions and manufacturer (if applicable);

(d) bitumen refinery source and certification of compliance;

(e) cutback bitumen refinery source of bitumen, type of cutter, source of cutter, cutter oil fraction, certification of compliance;

(f) polymer modified bitumen – refinery source of bitumen and manufacturer, class of polymer and fraction, certificate of compliance; and

(g) bitumen emulsion – refinery source of bitumen and manufacturer, grade of emulsion, certificate of compliance.

Design rates of application of binder and aggregate for bituminous surfacing shall be in accordance with *Guide to Pavement Technology Part 4K: Seals*. Design application rates shall be known as “nominated application rates” and materials as “nominated materials”.

SC6.4.6.16.4 Pre-coating of aggregate general

The aggregate pre-coating agent shall be applied to the aggregate in a manner and at a rate and time which will provide a complete, light, uniform, effective cover of all aggregate particles at the time of spreading.

Pre-coating of aggregate shall not be carried out when rain is imminent. If aggregate has been pre-coated and rain appears imminent, the aggregate shall be adequately covered to prevent the pre-coating material being washed from the aggregate particles.

The Contractor shall take precautions, such as covering stockpiles, to prevent settlement of dust, penetration of moisture or drying out of the pre-coating agent on the stockpiled aggregate.

Stockpiles pre-coated more than 14 days in advance of use shall be retreated unless otherwise approved by the

Superintendent and shall not be used if less than 3 days old.

SC6.4.6.16.5 Application of sprayed bituminous surfacing

(1) General

The Contractor shall carry out sprayed bituminous surfacing so as to:

(a) provide a uniform application of binder with adequate adhesion to the underlying surface;

(b) provide a complete cover of interlocking aggregate particles, and

(c) achieve effective bond between binder and aggregate.

Details of equipment and methods to be used for sprayed bituminous surfacing shall be submitted to the Superintendent for approval prior to their use on the works.

(2) Plant

A mechanical sprayer shall be used to apply primer, primerbinder and binder. The sprayer shall have a current Sprayer Certificate issued by the Queensland Department of Transport and Main Roads.

The spray nozzles shall be of the make and type endorsed on the Sprayer Certificate. Any nozzles which may be damaged or become unduly worn or defective shall be replaced by satisfactory nozzles of similar type. A sufficient number of nozzles for this purpose shall be available at all times.

Mechanical spreading equipment shall be used to spread aggregate and shall be capable of achieving a uniform and accurate spreading rate.

Rollers shall be utilised in accordance with Clause SC6.4.6.16.4(9) Application and rolling of aggregate.

The Contractor shall remove from the site any plant or equipment considered by the Superintendent to be not fully operational or not in a satisfactory condition for carrying out work in accordance with this sub-section.

(3) Preparation of pavement surface

Before the application of primer, primerbinder or binder, the pavement surface shall be swept by the use of a mechanically operated rotary road broom or suction broom to provide a uniformly clean surface. If necessary, additional sweeping shall be done by hand, using stiff brooms. Sweeping shall, where possible, extend at least 300 mm beyond each edge of the area to be sprayed.

Adherent patches of foreign material shall be removed from the surface of the pavement.

For the spraying of primer or primerbinder, the pavement surface shall be slightly damp so as to impede dust interfering with initial adhesion except where explicit instructions are provided with the seal design.

(4) Review of nominated application rates

The Contractor shall select the locations where each lot of aggregate is to be incorporated in the works.

The Superintendent shall review the bituminous surfacing design at each location based on the actual average least dimension (ALD) test result for the lot of aggregate instead of the nominated ALD value of the aggregate adopted at design. The revised application rates shall be known as "target application rates".

The Contractor shall give the Superintendent notice of the Contractor's intention to commence sprayed bituminous surfacing. This notice shall confirm spray rates, aggregate size and ALD.

(5) Bitumen temperature requirements

Bitumen temperature requirements are as per MRTS 17, 18, 19, 20 and 21.

Table SC6.4.6.16.2 Cutback bitumen spraying temperatures

Grade	Temperature Range (ºC)
AMC 00	10 - 35
AMC 0	35 - 55
AMC 1	60 - 80
AMC 2	75 - 100
AMC 3	95 - 115
AMC 4	110 - 135
AMC 5	120 - 150
AMC 6	135 - 160
AMC 7	150 - 175

(6) Pavement temperature and weather conditions

The Contractor shall measure and record pavement temperatures at regular intervals during the course of the work. For this purpose, a spirit or mercury in glass thermometer or other suitable type of thermometer shall be placed in direct contact with the pavement and allowed to remain in position until the reading becomes steady. When a spirit or mercury in glass thermometer is used to measure pavement temperature, the bulb of the thermometer shall be covered from direct sunlight with a small heap of grit or similar material. Suitably calibrated infra-red thermometers may be used.

If the pavement is partly in sun and partly in shade, the temperatures for both conditions shall be taken and recorded.

Spraying primers, primerbinders and binders shall be undertaken only if the pavement temperature has been at or above 20 ºC, 25 ºC for PMB, 10 ºC for emulsion for spraying for at least one hour before commencement of spraying and does not fall below 20 ºC, 25 ºC for PMB, 10 ºC for emulsion for spraying during the period of spraying.

Spraying shall not be carried out on a wet pavement, while rain appears imminent or during high winds or dust storms.

(7) Incorporation of cutter oil, flux oil and adhesion agent

(a) Cutting back bitumen

The Contractor shall determine and record the proportion of cutter oil added to each sprayer load, using MRTS.11 and based on the measured pavement temperatures.

The cutter oil, without being previously heated, shall be pumped into the sprayer, followed by the hot bitumen. The full sprayer load of cutback bitumen shall be circulated at a rate of at least 700 litres per minute for 20 minutes to ensure that the mixture is homogeneous.

If a part sprayer load of field cutback bitumen is unused on the date of mixing, and needs to be returned to the heater tanks, it shall be placed in an empty tank reserved for that purpose. No bitumen or cutter shall be added to the returned cutback bitumen unless the tank is fitted with an effective mechanical mixing system. When the returned cutback bitumen is subsequently used as part of a sprayer load, allowance shall be made for the cutter oil contained in the returned cutback bitumen.

(b) Fluxing bitumen

Where flux oil is to be included, it shall be added to the bitumen in the sprayer and the mixture circulated at a rate of at least 700 litres per minute for at least 20 minutes before spraying.

(c) Bitumen adhesion agent

Where bitumen adhesion agent is to be included, it shall be added to the bitumen in the sprayer and the mixture circulated twice at a rate of at least 1,000 litres per minute for at least twenty minutes before spraying. Spraying shall occur within 4 hours.

(8) Application of primer, primerbinder and binder

(a) General

The area to be sprayed with primerbinder or binder shall be limited to the area which can be covered with aggregate at the target application rate within ten minutes of spraying bitumen or cutback bitumen.

(b) Primer and primerbinder

Nominated and target application rates and quantities of primer and primerbinder shall apply to the whole material, including cutter oil, measured at 15oC. Primer, Primerbinder and Binder application rates outside the tolerances indicated in SC6.4.6.16 Attachment B Binder details constitute a non-conformance.

After application of a primer, a period of at least forty eight hours, or such longer period as determined to be necessary for the primer to become completely dry, shall elapse before the binder for a seal is applied. All traffic shall be kept off the primed surface.

After application of a primerbinder, a period of at least fourteen days shall elapse before the binder for a seal is applied.

(c) Binder

The class of bitumen or grade of cutback bitumen shall be as specified in SC6.4.6.16 Attachment A Details of work.

Nominated and target application rates and quantities of binder shall be based on the volumes of bitumen measured at a temperature of 15 ºC and shall not include any bitumen adhesion agent and/or cutter oil. If flux oil has been added to the bitumen, the quantity of flux oil shall be included as part of the binder. Binder application rates outside the tolerances provided in SC6.4.6.16 Attachment B Binder details shall constitute a non conformance.

Where bitumen adhesion agent and/or cutter oil have been added to the binder, the application rate of the total binder at 15 ºC shall be adjusted to allow for the quantities of bitumen adhesion agent and/or cutter oil in the mixture.

The Contractor shall determine the hot application rate of total binder, including bitumen adhesion agent and/or cutter oil, using MRTS 11.

Where refinery cutback bitumen is used as the binder, the target application rate of binder shall be increased by the Contractor to allow for the cutter oil in the mixture.

(d) Operation of the sprayer

Where the longitudinal edges of spray runs are not required to overlap, special type end nozzles must be used. Where an overlap is required, the overlap of spray between adjacent longitudinal runs shall be in the range 50-100 mm for special type end nozzles. If intermediate nozzles are to be used to overlap adjacent longitudinal sprays the nozzles shall be set in the normal manner for intermediate nozzles and the overlap shall be in the range 250-350 mm.

The spraying of primer, primerbinder or binder for each run of the sprayer shall commence on a protective strip of heavy paper weighing not less than 120 grams per square metre laid across and held securely to the pavement surface beforehand by addition of cover aggregate. The sprayer shall commence moving at a sufficient distance in advance of the protective strip to ensure that the road speed for correct application and correct alignment is attained at the commencement of spraying.

The sprayer shall maintain a uniform rate of application throughout the length of each sprayer run.

The spraying for each run shall terminate on a protective strip of paper laid across and held securely to the pavement surface beforehand. The width of paper at the commencement and/or termination of each run shall not be less than that endorsed on the Sprayer Certificate.

Spraying shall cease immediately if any defect develops in the spraying equipment and spraying shall not recommence until the fault has been rectified.

Where any blockage or partial blockage of nozzles occurs, spraying shall cease immediately. If the blockage is due to the condition of the binder being sprayed and is likely to re-occur, that load together with any binder from the same bulk tanker or supply unit shall not be used in the works.

Where a mechanical sprayer is not able to satisfactorily spray small areas or areas of irregular shape, such areas shall be sprayed by means of the hand spray equipment attached to the sprayer. The work shall be planned so as to minimise the area sprayed by hand spray equipment.

After each sprayer run, the quantity of binder sprayed shall be checked against the area covered and any necessary adjustments shall be made to ensure that the target application rate is achieved in subsequent runs. If the actual application rate of binder after three runs differs by more than 5 per cent from the target application rate, the sprayer shall not be used until a new Sprayer Certificate has been obtained.

Areas not within 5 per cent of the target application rate of primer, primerbinder or binder shall constitute a “non-conformance”.

(9) Application and rolling of aggregate

The application of aggregate shall proceed immediately after spraying is commenced and shall be completed within ten minutes of spraying bitumen or cutback bitumen. For polymer modified binder spreading and rolling shall start immediately after spraying and continue until adhesion is complete.
Wet aggregate shall not be used.

The Contractor shall apply the aggregate of the specified nominal size and at the target aggregate application rate. Sufficient loaded and measured trucks of dry aggregate shall be at the site to provide full cover for the area sprayed.
The aggregate shall be spread uniformly over the sprayed surface by means of suitable mechanical spreading equipment.

Any bare or insufficiently covered areas shall be re run by the mechanical spreader or covered by hand as necessary to give a uniform and complete coverage. Any aggregate spread in excess of the target aggregate application rate shall be removed before rolling is commenced if it is localised and can be efficiently removed by hand brooming.
After the aggregate has been applied to each section of the work, initial rolling shall be carried out with two or more dual axle smooth pneumatic tyred multi wheel rollers of minimum load of 1 tonne per tyre and minimum tyre pressure of 550 kPa. A roller with a rubber surface drum providing equivalent compactive effort may be used in lieu of a multi-wheeled roller. Initial rolling shall continue until the aggregate is firmly embedded in the primerbinder or binder. Roller speed shall be 15-25 km/h subject to safe working conditions.

If the aggregate is not evenly distributed over the surface of the pavement, the surface shall be traversed with a light drag broom after the initial rolling. If the broom has any tendency to dislodge aggregate particles bedded in the primerbinder or binder, the Contractor shall defer or eliminate the drag brooming. Where drag brooming is eliminated, the Contractor shall substitute light hand brooming.

Backrolling shall then be carried out for a minimum period of 1 hour per 1000 square metres sprayed for roads having a traffic volume of less than 500 vehicles per lane per day and 1 hour per 1500 square metres sprayed for other roads, up to a maximum of 24 hours after the aggregate has been applied.

Where a bituminous surfacing is specified with separate applications of coarse and fine aggregate on a single application of binder, the coarse aggregate shall be applied first, rolled and any necessary brooming carried out as described above, before application of the fine aggregate and its subsequent rolling and brooming. In this case, the time limits for incorporation of aggregate shall apply only to the application of the coarse aggregate.

After final sweeping, and prior to removal of speed restriction and warning signs, the number of loose aggregate particles remaining on the surface of seals constructed with 10 mm, or larger, aggregates not to exceed the values specified in Table SC6.4.6.16.3.

Table SC6.4.6.16.3 Table heading needed

Road type	Loose stones (particles/m²) max
Urban areas	20
Other medium to high traffic (> 250 v/l/d)	30
Low traffic (< 250 v/l/d)	40

Any remaining loose particles of aggregate shall be removed by light sweeping and/or vacuumed from the pavement and disposed of responsibly by the Contractor as per Table SC6.4.6.16.4 below or as directed to by the Superintendent.

Table SC6.4.6.16.4 Table heading needed

Traffic volume (vehicles/lane/day)	Maximum time limits
> 2000	Within 8 hours of sealing
1000 to 2000	Within 24 hours of sealing
250 to 1000	Within 48 hours of sealing
< 250	Within 5 days of sealing

Prior to leaving the work site, ensure that all services are uncovered and cleaned, if necessary. Remove from site all waste paper and rubbish arising from the sprayed sealing operations. Clean the stockpile site and store any excess material in a tidy heap or remove, depending on the requirements of the Superintendent.

(10) Work records

Particulars of the work performed shall be recorded by the Contractor on a spray record sheet. Details of primer, primerbinder, binder and aggregate applied shall be recorded immediately after every sprayer run. Each form shall be signed by the Contractor's representative as a true record of the work performed. The Contractor shall supply to the Superintendent a copy of each completed form.

(11) Protection

(a) New work

Protect the new work by providing warning signs as follows:

(i) provide signs to warn public of loose stones and absence of line marking including provision of temporary raised pavement markers;

(ii) maintain signs until loose aggregate has been removed and linemarking reinstated; and

(iii) if linemarking is to be undertaken by others, erect warning signs indicating the absence of linemarking to be maintained by the organisation responsible for linemarking.

(b) Services and road fixtures

The Contractor shall take all necessary precautions to prevent primer, primerbinder, binder, aggregate or other material used on the work from entering or adhering to gratings, hydrants or valve boxes, access chamber covers, bridge or culvert decks and other road fixtures.

Immediately after aggregate has been spread over the binder, the Contractor shall clean off or remove any sprayed surfacing material and leave the services and road fixtures in a condition equivalent to that existing when the Contractor commenced the sprayed surfacing work.

SC6.4.6.16.6 Nonconformance of materials and work

If any materials supplied or any section of sprayed bituminous surfacing work fail to conform to the requirements whether failure of the work is due to bad workmanship, defective materials supplied by the Contractor or materials made defective by the method of operation adopted, or any other cause then such failure or failures shall constitute a “non-conformance”.

The nonconforming section of sprayed bituminous surfacing work shall be either replaced or corrected as proposed by the Contractor, subject to the approval being obtained.

The rectifying nonconformances, including any restoration work to any underlying or adjacent surface or structure,

which becomes necessary as a result of such replacement or correction, shall be the responsibility of the Contractor. Materials removed from the site by the Contractor shall be replaced with materials which conform to this sub-section.

SC6.4.6.16.7 Limits and tolerances

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.16.5 below.

Table SC6.4.6.16.5 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	**Design of Bituminous Surfacing**	Contractor to provide details of design to Superintendent before proposed commencement of work	SC6.4.6.16.3
2.	**Commencement of Work**	Contractor to give notice to the Superintendent of intention to commence work	SC6.4.6.16.5(1)
3.	**Sweeping of Pavement Surface**	Sweeping shall extend at least 300mm beyond each edge of the area to be sprayed	SC6.4.6.16.5(3)
4.	**Bitumen Heating** (a) Bitumen Temperature	When incorporated with cutter oil, bitumen shall be in temperature ranges as per MRTS.17 and 18 (06/09)	SC6.4.6.16.5(5)
	(b) Refinery Cutback Bitumen Temperature	At the time of spraying shall be in temperature range as per MRTS 20 (06/09)	SC6.4.6.16.5(5)
	(c) Retention of Temperature	Bituminous materials shall not be held at temperatures within the ranges of MRTS 17,18 and 20 for periods in excess of 10 hours.	SC6.4.6.16.5(5)
5.	**Spraying Temperature** (a) Pavement Temperature	Bituminous surfacing shall not be undertaken if the pavement temperature has not been at or above 20°C, 25°C for PMB, 10°C for emulsion for at least one hour before commencement of spraying or if the pavement temperature falls below 20 °C, 25°C for PMB, 10°C for emulsion during the period of spraying.	SC6.4.6.16.5(6)
6.	Cutting Back Bitumen	Circulation of hot bitumen and cutter oil mixture in the sprayer shall be at the rate of at least 700 litres per minute for 20 minutes.	SC6.4.6.16.5(7)
7.	Fluxing Bitumen or adding Bituminous Adhesion Agent	Circulation of fluxing oil or bituminous adhesion agent with hot bitumen shall be at the rate of at least 1,000 litres per minute for 20 minutes. Spraying to occur within 4 hours.	SC6.4.6.16.5(7)
8.	**Application of Bituminous Material** (a) Spray Area	Area to be sprayed shall be limited to area which can be covered by aggregate at target application rate within 10 minutes of spraying.	SC6.4.6.16.5(8)
	(b) Application Rates	Application rates and quantities shall apply to a temperature of 15C and have T1 tolerances of ±5% as set out in clause SC6.4.6.16.6 and T2 tolerances as set out in SC6.4.6.16 Attachment B.	SC6.4.6.16.5(8)
	(c) Primer	At least a 48 hour period shall elapse after spraying of primer before binder for a seal is applied.	SC6.4.6.16.5(8)
	(d) Primerbinder	At least a 14 day period shall elapse after spraying of primerbinder before application of binder.	SC6.4.6.16.5(8)

Item	Activity	Limits/Tolerances	Clause
9.	**Application of Aggregate** (a) Spreading Time	Application of aggregate shall be completed within 10 minutes of spraying bitumen or cutback bitumen on each section.	SC6.4.6.16.5(9)
10.	**Rolling** (a) Roller Numbers and Type	Initial rolling shall be carried out with two or more dual axle smooth pneumatic tyred multi-wheeled rollers. Minimum load of one tonne per tyre and minimum tyre pressure 550KPa.	SC6.4.6.16.5(9)
	(b) Backrolling	(i) For traffic volume of <500 vehicles per lane per day, backrolling for minimum of one hour per 1000 square metres sprayed.	SC6.4.6.16.5(9)
		(ii) For traffic volume >500 vehicles per lane per day, backrolling for minimum of one hour per 1500 square metres sprayed.	SC6.4.6.16.5(9)

SC6.4.6.16 Attachment A: Details of work

Section		Prime	Primer Seal		Seal or Reseal	
Road Name		Binder Type	Binder Type	Aggregate Nom. Size	Binder Type	Aggregate Nom. Size
From	To					

Note —prime and primer seal binder type shall be indicated in this Attachment using the descriptive terms as follows:

Very Light Prime or Primer - equivalent cut back bitumen to grade AMCOO.

Light/Medium Prime or Primer - equivalent cutback bitumen to grade AMCO or AMC1.

Heavy Prime or Primer - equivalent cut back bitumen to grade AMC1 or AMC2.

Click here to obtain a copy of the following form.

SC6.4.6.16 Attachment B: Binder details

BINDER TYPE	**ADHESION AGENT** (At 0.5% of binder) **(YES/NO)**

Primer, Primerbinder and Binder Application Tolerance Thresholds T2

(Refer to clause SC6.4.6.16.6)

Nominal Aggregate Size (mm)	**Tolerance Thresholds T2 expressed as ± percentages**

SC6.4.6.17 Bituminous micro-surfacing

SC6.4.6.17.1 Introduction

(1) Scope

The work to be executed under this sub-section consists of the design, supply, mixing and placement of bituminous microsurfacing for surface correction and wearing surface applications on road pavements, carparks, cycleways and footpaths.

Bituminous microsurfacing shall consist of a mixture of emulsified polymer modified bitumen binder, mineral aggregate, mineral filler, additives and water proportioned and mixed to form a slurry which is placed and spread evenly on the road surface. It shall be capable of being spread in variably thick layers for surface correction and for wearing surface applications.

The size, nominal thickness, and extent of bituminous microsurfacing shall be as shown on the drawings or as directed by the Superintendent.

For all new works on road and carpark pavements, this sub-section should be read in conjunction with sub-section SC6.4.6.16 Sprayed bitumen surfacing. For new works on road and carpark pavements, bituminous mircrosurfacing shall be preceded by the application of a sprayed bituminous seal a minimum of 2 weeks prior to the application of the bituminous microsurfacing wearing course.

Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

(2) Terminology

Users of this specification should be aware that where terms are not specifically defined in the following section, AS 1348 should be the default standard.

Bituminous microsurfacing	Is one of two types of bituminous slurry surfacing. It is distinguished from the other type, slurry seals, by the incorporation of polymer and other additives to the bituminous binder to improve the performance of the slurry surfacing. Bituminous microsurfacing is also commonly known under various proprietary names such as “cold overlay”,“microsealing”, “paveseal”, “microasphalt”, etc. The size of the bituminous microsurfacing is based on the nominal largest stone size in the mix. For the purpose of this sub-section, the size shall be either Size 5 or Size 7.

(3) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-section to be read and applied in conjunction with this sub-section are as follows:

SC6.4.6.16 Sprayed bitumen surfacing

SC6.4.5 Construction management

(b) Australian Standards

AS 1141.11.1	*Particle size distribution – Sieving method*
AS 1141.12	*Material finer than 75 micrometre in aggregates (by washing)*
AS 1141.22	*Wet/dry strength variation*
AS 1141.23	*Los Angeles value*
AS 1141.25.1	*Methods for sampling and testing aggregates - Degradation factor - Source rock*
AS 1141.25.2	*Methods for sampling and testing aggregates - Degradation factor - Coarse aggregate*
AS 1141.25.3	*Methods for sampling and testing aggregates - Degradation factor - Fine aggregate*
AS 1141.42	*Pendulum friction test*

AS 1160	*Bitumen emulsions for the construction and maintenance of pavements*
AS 1289.3.7.1	*Determination of the sand equivalent of a soil using a power-operated shaker*
AS 1348	*Glossary of terms - Roads and traffic engineering*
AS 2008	*Residual bitumen for pavements*
AS 2350	*Methods of testing Portland and blended cements*
AS 2891.3.1	*Binder content and aggregate grading - Reflux method*

(c) International Slurry Surfacing Association Tests

ISSA TB 100 - *Test method for wet track abrasion of slurry surfaces*

ISSA TB 109 - *Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester*

ISSA TB 114 - *Wet stripping test for cured slurry seal mixes*

ISSA TB 139 - *Method of classified emulsified asphalt/aggregate mixtures by modified cohesion test measurement of set and cure characteristics*

ISSA TB 144 - *Classification compatibility by Schulze-Breuer and ruck procedure*

SC6.4.6.17.2 Materials

(1) Sampling and testing of materials

Sampling and testing of materials shall be arranged by the Contractor and carried out by a NATA registered laboratory for the nominated test methods.

(2) Binder

The binder supplied and used in the works shall be an emulsified polymer modified bitumen, formulated to meet the performance requirements of the mix specified in clauses SC6.4.6.17.3(1) Mix properties and SC6.4.6.17.4(6) Surface texture.

Prior to emulsification, incorporation of polymer and additives, the bitumen shall comply with AS 2008.

The Contractor shall provide the Superintendent with sufficient information to verify that the binder supplied is the same as that nominated in the mix design.

(3) Mineral aggregates

Mineral aggregates shall consist of crushed rock or crushed gravel, or a mixture of crushed rock or crushed gravel and natural sand. It shall consist of clean, hard, angular, durable particles, and free form clay, dirt, organic material or other deleterious matter.

The aggregate from each source shall comply with the requirements given in Table SC6.4.6.17.1 Aggregate properties.

Table SC6.4.6.17.1 Aggregate properties

Property	Test Method	Requirement
Degradation Factor	AS 1141. 25.1	50 minimum
Los Angeles Value	AS 1141.23	30 maximum
Aggregate Wet Strength	AS 1141.22	150 kN minimum
Wet/Dry Strength Variation	AS 1141.22	30% maximum
Polished Aggregate Friction Value	AS 1141.42	45 minimum
Sand Equivalent	AS 1289.3.7.1	60 minimum

When tested in accordance with AS 1141.11 and AS 1141.12, the aggregate (including mineral filler) shall conform with the grading limits given in Table SC6.4.6.17.2 Grading limits for combined aggregate/filler.

Table SC6.4.6.17.2 Grading limits for combined aggregate/filler

Sieve Size	Percent Passing by Mass	
	Size 5	Size 7
13.2 mm	100	100
9.50 mm	100	100
6.70 mm	100	85-100
4.75 mm	90-100	70-90
2.36 mm	50-70	45-70
1.18 mm	30-50	28-50
600 µm	20-35	19-34
300 µm	12-25	12-25
150 µm	7-18	7-18
75 µm	4-10	5-15

The Contractor shall nominate the source/s of aggregates to the Superintendent, and shall submit NATA certified test reports on the quality and grading of the combined aggregate proposed to be used.

The Contractor shall submit test results to the Superintendent for each lot/stockpile of aggregate a minimum of seven days prior to incorporation in the works.

(4) Mineral filler

Mineral filler shall consist of hydrated lime, flyash, portland cement, or other material approved by the Superintendent.

The mineral filler shall be dry, free from lumps and any deleterious material, with a minimum of 85 per cent passing a 75 µm sieve. In all other respects, the mineral filler shall comply with the requirements of AS 2350.

The quantity of filler added to the bituminous microsurfacing during placement shall not vary by more than 1 per cent of the total aggregate (by mass) from the filler content nominated in the mix design.

(5) Water

Water added to the bituminous microsurfacing shall be potable and shall be compatible with the component materials.

(6) Additives

Details of the type, source and nominal proportions of additives shall be submitted to the Superintendent with the mix design.

SC6.4.6.17.3 Mix design

(1) Mix properties

The nominated mix design shall satisfy the properties given in Table SC6.4.6.17.3 Mix properties.

Table SC6.4.6.17.3 Mix properties

Mix Property	Test Method	Requirement
Wear Loss	ISSA TB 100 6 day	800 g/m^2 maximum
Traffic Time	ISSA TB 139 30 minutes 60 minutes	12 kg.cm minimum 20 kg.cm minimum
Adhesion	ISSA TB 114 or ISSA TB 144	≥90% or 11 grade points minimum (AAA, BAA)

(2) Nominated mix

At least 7 days before commencing bituminous microsurfacing work, the Contractor shall submit to the Superintendent for approval, details of the nominated bituminous mircrosurfacing mix design for the work including the target application rate (m^3 of mix/m^2 of road surface) and the corresponding nominal layer thickness, together with NATA certification and test results demonstrating that the nominated mix and its constituents meet the requirements of the specification.

The details of the nominated mix design shall include the following:

(a) bitumen emulsion content of the mix, and the residual binder content of the emulsion;

(b) target combined aggregate/filler grading;

(c) proportions of constituent materials used;

(d) type and sources of aggregates, filler and binder; and

(e) all relevant compliance certificates.

(3) Approved mix

When a nominated mix has been approved by the Superintendent, it shall be known as the “approved mix”. Work shall not commence until a bituminous microsurfacing mix has been approved.

The combined aggregate/filler grading and the binder content of the approved mix will be termed the "approved grading" and the "approved binder content" respectively.

Any changes to the approved mix, its method of production or source of supply of constituents require written approval 21 days prior to proposed implementation.

SC6.4.6.17.4 Production and paving

(1) Requirements of production mix

Bituminous microsurfacing produced in the paving unit at the site shall be known as the "production mix".

The production mix shall comply with the requirements given in Table SC6.4.6.17.4 Maximum permitted variations from approved mix and shall be confirmed by the Contractor as required in SC6.4.6.17.4(2) Sampling and testing of production mix.

The Contractor is responsible for taking samples for testing at a NATA registered laboratory to confirm compliance with Table SC6.4.6.17.4.

Table SC6.4.6.17.4 Maximum permitted variations from approved mix

Production Mix Properties	Maximum Permitted Variations from Approved Mix (by mass)	
	Size 5	Size 7
Grading*	Nil	Nil
Passing 9.50mm AS sieve and larger	Nil	± 7%
Passing 6.70mm	± 6%	± 6%
Passing 4.75mm	± 5%	± 5%
Passing 2.36mm and 1.18mm	± 4%	± 4%
Passing 0.600mm	± 3%	± 3%
Passing 0.300mm	± 2%	± 2%
Passing 0.150mm	± 1.5%	± 1.5%
Passing 0.075mm		
Residual Binder Content	- 0.5% + 1.0%	- 0.5% + 1.0%

Note—*these allowable variations shall not fall outside the limits for design of nominated mix as given in Table SC6.4.6.17.2 Grading limits for combined aggregate/filler.

(2) Sampling and testing of production mix

(a) Lot definition

Compliance sampling and testing of bituminous microsurfacing shall be undertaken on a lot by lot basis. For this purpose, 50m^3 or one day's production (whichever is the lesser), or such smaller quantity which is considered as representative of consistent production of the paving unit, shall be considered as representative of consistent production of the paving unit.

(b) Responsibility of sampling

The Contractor shall be responsible for taking samples and shall supply all facilities, equipment and labour for that purpose.

(c) Frequency of Sampling

For the testing of production mix, two 1.5kg representative samples of bituminous microsurfacing shall be taken from each lot at random intervals. The samples shall be taken from the discharge of the paving unit and the sample containers immediately sealed.

For the testing of the binder, two 2L samples of bitumen emulsion shall be taken from each bulk delivery in accordance with AS 1160.

(d) Testing

The samples of bituminous microsurfacing shall be treated and tested at a NATA registered laboratory to confirm compliance with Table SC6.4.6.17.4 Maximum permitted variations from approved mix. Prior to testing for Residual Binder Content and Aggregate Gradation, as determined by AS 2891.3.1, the samples shall be dried to constant weight in an oven at 60ºC for a minimum of 15 hours.

Each delivery of emulsion shall be tested for residual binder content in accordance with AS 1160 Appendix D and accompanied by a certification of specification compliance traceable to the relevant batch at the supplier's storage tank.

The paving unit to be used shall be calibrated for the component materials of the approved mix prior to the commencement of paving. Previous calibration documentation covering the same materials and approved mix shall be acceptable provided that calibration has been carried out within the previous 12 months.

The documentation shall include an individual calibration for each component material at various settings which can be related to the paving unit's metering devices.

No paving unit shall be allowed on the work until the calibration has been verified and approved by the Superintendent.

(3) Preparation of pavement

The existing surface shall be clean and free from any loose stones, dirt, dust and foreign matter. The surface shall be swept beyond the edge of the area to be surfaced by at least 300mm. Any foreign matter adhering to the pavement and not swept off shall be removed by other means. Any areas significantly affected by oil contamination shall be cleaned to the satisfaction of the Superintendent.

The Contractor shall take all necessary precautions to prevent the bituminous microsurfacing or other materials used on the work from entering or adhering to kerbs, gutters, driveways, gratings, hydrants, valve boxes, access chamber covers, bridge or culvert decks or other road fixtures. After the bituminous microsurfacing has been spread the Contractor shall clean off any such material and leave such gratings, access chamber covers and other road fixtures, in a clean and satisfactory condition.

(4) Weather limitations

Bituminous microsurfacing shall not commence if either the pavement or air temperature is below 10ºC and falling.

Bituminous slurry may be applied when both pavement and air temperatures are above 7ºC and rising, or above 10ºC.

Spreading shall not proceed during rain or when rain appears imminent.

The Superintendent will require cease of works, if weather conditions are not appropriate.

(5) Spreading

The surface may be pre-dampened if necessary by fogging ahead of the spreader box. Water used for pre-wetting the surface shall be applied so that the entire surface is damp with no apparent flowing water ahead of the spreader box. The application rate of the fog spray shall be adjusted to suit temperature, surface texture, humidity and dryness of the surface being covered.

Bituminous microsurfacing shall be mixed and applied using a purpose built paver. The mix shall be of the desired consistency when deposited in the spreader box, and nothing more shall be added other than minor amounts of water for the purpose of overcoming temporary build-up of microsurfacing in the corners of the spreader box.

The mixing time shall be sufficient to produce a complete and uniform coating of the aggregate and the resulting mixture shall be conveyed into the moving spreader box at a sufficient rate to always maintain an ample supply across the full width of the strike-off.

The strike-off shall be adjusted to provide an application rate which will completely fill the surface voids and provide the nominal application rate of bituminous microsurfacing as scheduled.

After the bituminous microsurfacing has been spread, the Contractor shall ensure that all kerbs, gutters, driveways, gratings, hydrants, valve boxes, access chamber covers, etc. are uncovered and left in a clean and satisfactory condition.

After the emulsion has broken and the mix is sufficiently stable, rolling shall be carried out using pneumatic tyred rollers to produce a dense, even, homogeneous compacted surface where there is insufficient local traffic to achieve satisfactory compaction across the mat.

Bituminous microsurfacing shall be capable of carrying slow moving traffic (<40 km/h) within 1 hour of application without permanent damage occurring, such as rutting or ravelling. When the time before the microsurfacing is capable of carrying traffic exceeds 1 hour, work shall cease unless specifically approved by the Superintendent.

(6) Surface texture

The resulting surface after spreading shall be uniform in appearance, and free of areas exhibiting segregation or

excessive or insufficient binder.

The surface texture shall be demonstrated on a short test run for approval by the Superintendent. If the surface texture is acceptable to the Superintendent, then all subsequent work shall be finished to an equivalent surface texture.

Where increased surface texture is required, a fabric skirt may be trailed behind the spreader box.

(7) Joints

Longitudinal joints in the wearing course shall be straight and placed at either the edge or the centre of a traffic lane. If necessary, the edges and joints shall be lightly screeded with a hand squeegee to achieve a smooth uniform appearance and to remove excess build-up of material.

(8) Shape and levels

Where a correction and wearing course have been placed, the finished surface level shall not vary from the design level at any point by more than ±10mm. Additionally immediately adjacent to any kerb and/or gutter the finished surface level shall not be below nor more than 10mm above the level of the lip of the adjacent gutter.

Notwithstanding the above, the deviation from a 3m long straight edge placed anywhere on the top of the finished surface shall not exceed 10mm when assessed within 24 hours of work completion.

(9) Non-conformance of materials and finished surfacing

If any materials supplied fail to conform to the requirements in this sub-section or if any section of bituminous microsurfacing fails to conform to the requirements of this sub-section - whether failure of the work is due to bad workmanship, defective materials supplied by the Contractor or materials made defective by the method of operation adopted - then such failure or failures shall constitute a “Notice of Non Conformance”. Such non-conforming sections of bituminous microsurfacing work shall be either replaced or corrected.

The rectification of nonconformances, including any restoration work to any underlying or adjacent surface or structure, which becomes necessary as a result of such replacement or correction, shall be the Contractor’s responsibility. Materials removed from the site by the Contractor shall be replaced with materials which conform to this sub-section.

(10) Control of traffic

The Contractor shall provide for traffic in accordance with the requirements of sub-section SC6.4.6.30 Control of traffic while undertaking the work and shall take all necessary precautions to protect the work from damage until such time as the new work has developed sufficient strength to carry normal traffic without damage.

The Contractor shall take all necessary steps to avoid or minimise delays and inconvenience to road users during the course of the work. Where adequate detours or side tracks are included in the Contract or are otherwise available, traffic shall be temporarily diverted while the work is in progress.

SC6.4.6.17.5 Limits and tolerances

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.17.5 below.

Table SC6.4.6.17.5 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Spec Clause
1.	**Mineral Aggregate**	As per Table SC6.4.6.17.1	SC6.4.6.17.2(3)
2.	**Combined Aggregate/filler**	As per Table SC6.4.6.17.2	SC6.4.6.17.2(3)
3.	**Mineral Filler**	> 85% passing a 75 µm Sieve	SC6.4.6.17.2(4)
4.	**Mix Properties**		
	(a) Design properties	As per Table SC6.4.6.17.3	SC6.4.6.17.3(1)
	(b) Permitted variations	As per Table SC6.4.6.17.4	SC6.4.6.17.4(1)
5.	**Surface Preparation**	Sweeping shall extend at least 300mm beyond edge of area to be surfaced	SC6.4.6.17.4(3)
6.	**Weather Limitations**	Microsurfacing shall not commence if either air or pavement temperature is below 10°C and falling, and shall only commence if both air and surface temperature is above 7°C and rising or above 10°C	SC6.4.6.17.4)4)
7.	**Shape and Levels**		
	(a) Finished Levels	Shall not vary at any point by more than ± 10mm from design levels. Immediately adjacent to kerb and/or gutters, levels shall not be below nor more than 10mm above design level	SC6.4.6.17.4(8)
	(b) Finished Shape	Deviation from the bottom of a 3m straight edge shall not vary by more than 10mm	SC6.4.6.17.4(8)

SC6.4.6.18 Segmental paving

SC6.4.6.18.1 Introduction

(1) Scope

(a) This sub-section covers the construction of both clay and concrete segmental paving for road pavements, medians, traffic islands, driveways, cycleways, footpaths and other pedestrian areas.

(b) The work covered under this sub-section consists of the supply, placement and compaction of segmental pavers including the provision of a sand or crusher dust bedding course and joint filling sand, over bound or unbound base and/or subbase layer/s.

(c) This sub-section should be read in conjunction with the appropriate specifications for the construction of the base and subbase layers beneath the segmental paving, ie. SC6.4.6.12 Flexible pavements, SC6.4.6.14 Mass concrete subbase.

(d) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

Editor's note - A reference to drawings is a reference to construction drawings

(2) Choice of paver type, shape, class and laying pattern

(a) The choice of concrete or clay segmental pavers, the paver class (for clay pavers), shape type (for concrete pavers), shape name, colour, thickness and laying pattern shall be as per decision requirement for each area of application.

(b) Unless otherwise specified, concrete pavers for road pavements shall be placed in herringbone laying pattern and shall be in accordance with the requirements for the appropriate road application shown in Table SC6.4.6.18.1.

(c) Unless otherwise specified, clay pavers for road pavements shall be Class 4, minimum 65 mm nominal thickness, and placed in a herringbone laying pattern.

(3) Terminology

Concrete segmental pavers are units of not more than 0.10 square metres in gross plan area, manufactured from concrete, with plain or dentated sides, with top and bottom faces parallel and with or without chamfered edges. Concrete pavers are identified by shape as being one of the following types:

(a) **Shape Type A** - Dentated chamfered units which key into each other on four sides, are capable of being laid in herringbone bond, and by their plan geometry, when interlocked, resist the spread of joints parallel to both the longitudinal and transverse axes of the units; or

(b) **Shape Type B** - Dentated units which key into each other on two sides, are not (usually) laid in herringbone bond, and by their plan geometry, when keyed together, resist the spread of joints parallel to the longitudinal axes of the units and rely on their dimensional accuracy and accuracy of laying to interlock on the other faces; or

(c) **Shape Type C** - Units which do not key together and which rely on their dimensional accuracy and accuracy of laying to develop interlock.

Clay pavers are manufactured from clay, shale or argillaceous materials which may be mixed with additives. Clay pavers may have square, bevelled (chamfered), rounded or rumbled edges. They are generally rectangular in shape, with the length twice the width, plus 2 mm.

Laying patterns of pavers are identified as being either Herringbone, Basket-weave, or Stretcher as shown in SC6.4.6.18 Attachment A Laying patterns. Each of these may be laid at either 90º or 45º to the line of edge restraints. A variation of Stretcher is the Zig Zag Running Bond, also shown in SC6.4.6.18 Attachment A.

(4) Reference and source documents
Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this policy sub-section are as follows:
SC6.4.6.9 - Open drains kerb and channel
SC6.4.6.10 – Earthworks (construction)
SC6.4.6.12 - Flexible pavements
SC6.4.6.14 - Mass concrete subbase
SC6.4.6.19 - Stabilisation
SC6.4.6.28 - Minor concrete works.

(b) Australian Standards
AS 1141.11.1 - *Particle size distribution - Sieving method*
AS/NZS 4455 - *Masonry units, pavers, flags and segmental retaining wall units*
AS/NZS 4456.0 - *Methods of test - General introduction and list of methods*
AS/NZS 4456.3 – *Methods of test - Determining dimensions*
AS/NZS 4456.5 – *Methods of test - Determining the breaking load of segmental pavers and flags*
AS/NZS 4456.9 – *Methods of test - Determining abrasion resistance*
AS/NZS 4586 - *Slip resistance classification of new pedestrian surface materials.*

(c) Concrete Masonry Association of Australia specifications
CMAA MA56-2010 - *Guide to permeable interlocking concrete pavements*
CMAA MA57-2010 - *Concrete segmental and flag pavements - guide to specifying*
CMAA T45-1997 - *Concrete segmental pavements - Design guide for residential access ways and roads*
CMAA T46-1997 - *Concrete segmental pavements - Detailing guide.*

(d) Clay Brick and Paver Institute specification
CBPI Manual 1: 2003 - *Clay Paving Design and Construction.*

SC6.4.6.18.2 Materials

(1) General

(a) The Contractor shall submit details of all proposed segmental paving materials, including bedding sand or crusher dust and joint filling sand. These details shall be submitted to the Superintendent for approval supported with test results from a nominated NATA registered laboratory, confirming that the constituents comply with the requirements of this sub-section.

(b) No pavers shall be delivered until the Superintendent has approved the type and quality of the pavers and noted the source of supply as compliant to the requirements of this sub-section.

(c) All pavers shall have suitable “slip resistance” for pedestrian traffic and vehicular traffic with a classification “W” according to AS/NZS 4586 for the Wet Pendulum Test. Where specific localities or levels of usage require a higher slip resistance classification, this classification shall be indicated on the drawings. Such approval shall not relieve the Contractor of any responsibility for supplying materials that comply with this sub-section.

(2) Concrete segmental pavers

(a) Concrete segmental pavers shall comply with the requirements of relevant Concrete Masonry Association of Australia Specifications and AS/NZS 4455 for each area of application.

(b) The material requirements for concrete pavers for each application, derived from CMAA MA57-2010 *Concrete segmental and flag pavements - guide to specifying*, are shown in Table SC6.4.6.18.1.

Table SC6.4.6.18.1 Material requirements for concrete segmental pavers

Pavement application		Minimum characteristic breaking load *kN	Work size minimum thickness mm	Dimensional deviation category (See Table SC6.4.6.18.3)	Maximum abrasion resistance (mean abrasion index) †		
Relevant Australian Standard		AS/NZS 4455.2 AS/NZS 4456.5	AS/NZS 4455.2	AS/NZS 4455.2 AS/NZS 4456.3	AS/NZS 4455.2 AS/NZS 4456.9		
Residential	Pedestrians only (eg paths, patios and outdoor areas)	2	40	DP0	§		
	Pedestrian and light vehicles only (eg driveways, parking spaces and the like)	3	40	DPB1	§		
	Pedestrian and commercial vehicles	5	60	DPB1	§		
					Pedestrian traffic volume		
					Low	Medium	High
Public space	Pedestrian only**	2	40	DPB1	7‡	5.5	3.5
	Pedestrian and light vehicles only	3	50	DPB2	7‡	5.5	3.5
	Pedestrian and commercial vehicles	5	60	DPB2	7‡	5.5	3.5
Trafficked segmental pavers	Minor and residential	6	60	DPB2	NA		
	Local access	6	60	DPB2	NA		
	Collector M	6	76	DPB2	NA		
Industrial	M	10	80	DPB2 or DPB3	7		

(Source: CMAA MA57-2010 *Concrete segmental and flag pavements - guide to specifying* - Table 1: Minimum Requirements for Dimensions, Breaking Load and Abrasion Resistance)

Note—

* At 28 days

† At 90 days

** where cleaning of pavers and flags is undertaken by mechanical means or where prevention of vehicle entry cannot be guaranteed, the minimum recommended pavers and flags are the 'Pedestrian and light vehicles only' for such pavement applications.

§ No abrasion criteria are specified for residential pavers. Abrasion resistance requirements for aesthetic or other purposes shall be specified to the supplier/manufacturer.

NA Not applicable.

* Shape Type A pavers – dentated pavers that key into each other and by their plan generally interlock and resist relative movement of joints parallel to both the longitudinal and transverse axes of the pavers.
Examples of Type A shapes

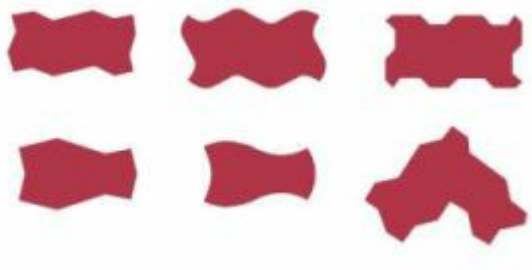


Table SC6.4.6.18.2 Maximum dimensional deviations determined by individual measurement

Category	Work Size dimensions, mm			
	Plan		Height	
	Standard deviation	Mean	Standard deviation	Mean
DP0	No requirement			
DPB1	2.0	± 3.0	3.0	± 2.5
DPB2	2.0	± 2.5	3.0	± 2.0
DPB3	Values declared by the supplier or by agreement between supplier and purchaser			
DPB4	1.5	± 2.0	2.0	± 2.0

Source: CMAA MA57-2010 Concrete segmental and flag pavements - guide to specifying - Table 2: Maximum Dimensional Deviations Determined for Pavers and Flags by Individual Measurement)

Note—all paving units will be categorised in accordance with AS/NZS 4455.3 Method for Determining Dimensions.

(3) Clay segmental pavers
Clay segmental pavers shall comply with the requirements of CBPI Manual 1:, *Clay paving design and construction* (chapter 3, Specifying clay pavers), and with the requirements of AS/NZS 4455.

(4) Bedding sand or crusher dust

(a) The bedding material shall be well-graded, consisting of clean, hard, uncoated grains uniform in quality, generally passing a 4.75 mm sieve. The bedding material shall be from a single source or blended to achieve, when tested in accordance with AS 1141.11, the following grading:

AS Sieve	**% Passing**
9.52mm	**100**
4.75	**95 - 100**
2.36	**80 - 100**
1.18	**50 - 85**
600µm	**25 - 60**

300	**10 - 30**
150	**5 - 15**
75	**0 - 10**

(b) The material shall be of uniform moisture content when spread. It shall be covered when stored on site to protect it from rain penetration.

(c) The bedding material shall be free of deleterious soluble salts or other contaminants which may cause, or contribute to, efflorescence.

(5) Joint filling sand

(a) The joint filling sand shall be well graded passing a 2.36 mm sieve, and when tested in accordance with AS 1141.11, having the following grading:

AS Sieve	**% Passing**
2.36mm	**100**
1.18	**90 - 100**
600µm	**60 - 90**
300	**30 - 60**
150	**15 - 30**
75	**5 - 10**

(b) The sand shall be dry when spread. It shall be covered when stored on site to protect it from rain penetration.

(c) The sand shall be free of deleterious soluble salts or other contaminants.

(d) Material used for bedding is not suitable for joint filling.

(6) Concrete for edge restraints

(a) Concrete supplied and placed for the construction of edge strips shall comply with sub-section SC6.4.6.28 Minor concrete works.

(b) Unless otherwise indicated on the drawings, or where the edge restraint is provided by kerb and/or gutter, the concrete used for edge restraints shall have a minimum 28 day characteristic compressive strength of 32 MPa for edge restraints to pavers on road pavements and 25 MPa for edge restraints to pavers on footpaths, cycleways, medians and driveways.

SC6.4.6.18.3 Construction

(1) Subgrade preparation

(a) The subgrade shall be formed to the required depth below finished surface level as shown on the drawings in accordance with SC6.4.6.10 Earthworks (construction).

(b) The finished subgrade foundation for the provision of subbase and/or base shall be subject to the approval of the Superintendent.

(2) Subbase

(a) As shown on the drawings, a subbase or working platform shall be constructed in accordance with SC6.4.6.14.10 Subgrade Beams.

(b) The subbase shall be constructed to the specified thickness, compaction and depth below finished surface level and to the design grade and crossfalls of the finished surface.

(c) The finished subbase shall be subject to the approval of the Superintendent.

(3) Base

(a) The base shall be constructed to the specified thickness and depth below finished surface level, and to the design grade and crossfalls of the finished surface, as shown on the drawings in accordance with sub-section SC6.4.6.12 Flexible pavements.

(b) The base course shall extend in width to at least the rear face of all new edge restraints.

(c) Notwithstanding the finished level tolerances contained within sub-section SC6.4.6.12 Flexible pavements for base of ± 10 mm of design levels, the level on the finished surface of the base course for road pavements to be overlain with segmental paving shall be trimmed to within + 10 mm or – 0 mm of design levels. The deviation from a 3 m long straight edge placed anywhere and laid in any direction on the top surface of the base course for all segmental paving shall not exceed 10 mm. Bedding material shall not be used as a levelling material to compensate for base finishing outside the above tolerances.

(d) The finished surface of the base shall drain freely without ponding.

(e) The finished base shall be subject to the approval of the Superintendent.

(4) Edge restraints

(a) Edge restraints in the form of kerb and/or gutter or edge strips shall be constructed along the perimeter of all segmental paving as shown on the drawings. Concrete kerb and/or gutter and edge strips shall be constructed in accordance with sub-section SC6.4.6.9 Open drains and SC6.4.6.28 Minor concrete works.

(b) Faces of edge restraints abutting pavers shall be vertical.

(c) Edge restraints shall be supported on compacted base and/or subbase of the thickness as shown on the drawings. Where not otherwise specified or indicated, the minimum thickness of compacted base beneath the edge restraints shall be 100 mm adjacent to road pavements and medians, and 50 mm adjacent to footpaths, cycleways and driveways.

(d) Unless otherwise shown on the drawings, contraction joints, 20 mm depth shall be formed every 5 m of edge restraint length.

(e) After the concrete has hardened and not earlier than 3 days after placing, unless otherwise directed by the Superintendent the spaces at the back of the edge restraint shall be backfilled with earth, compacted in layers not greater than 150 mm thick, then topsoiled to meet surrounding design levels.

(5) Bedding

(a) The bedding course shall be spread in a single uniform layer and screeded in a loose condition to the nominated design profile and level. The bedding course shall be laid such that a uniformly thick nominal 20-25 mm layer is achieved following final compaction of the segmental paving.

(b) Any depressions in the screeding material exceeding 5 mm shall be loosened, raked and rescreeded before laying pavers.

(c) For the manual placing of paving units, the bedding material shall be maintained at a uniform loose density. For mechanised laying, the bedding material shall be uniformly and firmly, but not fully, compacted.

(d) Screeded material left overnight of subject to rain shall be checked for level and rescreeded where necessary before pavers are placed. The material shall not be screeded more than 2 m in advance of the laying face at the completion of work on any day.

(6) Laying pavers

(a) Pavers shall be uniformly placed on the screeded bedding to the nominated laying pattern. Pavers shall be placed so that they are not in direct contact with each other and shall have uniform 3 mm nominal joint widths. The pavers shall be mixed between various pallets to ensure that any colour variation from one pallet of pavers to the next is evenly distributed over the entire paved area.

(b) The first row shall be located next to an edge restraint or an established straight line, and laid at a suitable angle to achieve the required orientation of pavers in the completed pavement.

(c) In each row, full units shall be laid first. Edge or closer units shall be neatly cut using a paver scour, or mechanical or hydraulic guillotine, and fitted subsequently. Cut pieces of pavers which are smaller in

size than one quarter of a full block shall not be used.

(d) Access chambers, drainage gullies and similar penetrations through the pavement shall be finished against the paving with a concrete surround or apron designed to suit and fit the laying pattern, otherwise complying with the requirements for edge restraints.

(e) Where pavers are placed over an isolation, contraction or expansion joint in an underlying concrete pavement, a joint is to be provided in the pavers. The joint shall consist of 10 mm thick preformed jointing material of bituminous fibreboard.

(f) Any foot or barrow traffic shall use boards overlaying paving to prevent disturbance of units prior to compaction. No other construction traffic shall be allowed on the pavement prior to compaction and provision of joint filling sand.

(g) On completion of subsequent bedding compaction and joint filling operations, all joints shall have widths within the range 2-4 mm.

(7) Bedding compaction

(a) After laying the pavers the bedding shall be fully compacted and the surface brought to design levels and surface profiles by not less than two passes of a high frequency low amplitude plate compactor which covers at least 12 units. Compaction shall continue until all pavers form a smooth surface with adjacent paver edges matching. The level difference between adjoining edges of any two pavers shall be a maximum of 2 mm, to avoid trip hazards, unless approved otherwise by the Superintendent for rough textured pavers.

(b) Any units which are structurally damaged during bedding compaction shall be removed and replaced. The pavement shall then be recompacted for at least 1 metre surrounding each replacement unit.

(c) The paving operations shall be arranged so that the use of the plate compactor proceeds progressively behind the laying face without undue delay, and such that compaction is completed prior to cessation of construction activity on any day. Compaction shall not be attempted within 1 metre of the laying face except on completion of the pavement against an edge restraint.

(d) The finished surface level shall not vary from the design level at any point laid in any direction, by more than 6 mm for all areas with Class 4 segmental pavements and 8 mm for all other areas of segmental paving. Notwithstanding this, the finished surface of the segmental paving, including where the paving abuts an edge restraint other than a drainage inlet, shall not deviate from the bottom of a 3 m straight edge laid in any direction, except at grade changes, by more than 6mm for road pavements and 8 mm for all other areas of segmental paving.

(e) The channels formed between abutting chamfered units shall finish with their inverts not less than 5 mm nor more than 10 mm above adjacent drainage inlets.

(f) All compaction shall be complete and the pavement shall be brought to design profiles before spreading or placing sand filling in the joints.

(8) Filling joints

(a) As soon as practicable after bedding compaction, and in any case prior to termination of work on any day, dry sand for joint filling shall be spread over the pavement and the joints filled by brooming.

(b) To ensure complete filling of the joints, both the filling sand and pavers shall be as dry as practicable when sand is spread and broomed into the joints.

(c) The pavement shall then receive one or more passes of a plate compactor and the joints then refilled with sand, with the process then repeated sufficiently to ensure that the joints are completely filled.

(9) Protection of work

Other than wheeled trolleys, forklifts and cluster-clamp vehicles, construction and other traffic shall not use the pavement until bedding compaction and joint filling operations have been completed.

(10) Opening to traffic

(a) As soon as practicable after the filling of joints, construction vehicles may use the pavement, and should

be encouraged to traverse the greatest possible area of pavement to assist in the development of “lock-up”.

(b) Excess joint filling sand shall be removed prior to opening to traffic.

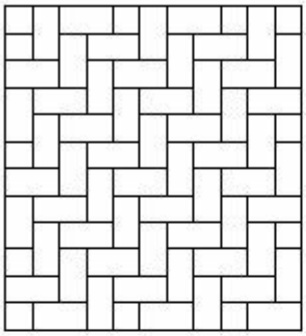
(c) The pavement shall then be inspected by the Contractor at regular intervals up until the expiration of the defects liability period to ensure that all joints remain completely filled.

SC6.4.6.18.4 Limits and tolerances

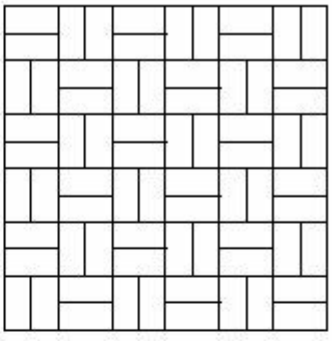
The limits and tolerances applicable to the various clauses in this Specification are summarised in Table SC6.4.6.18.3 below:

Table SC6.4.6.18.3 Summary of limits and tolerances

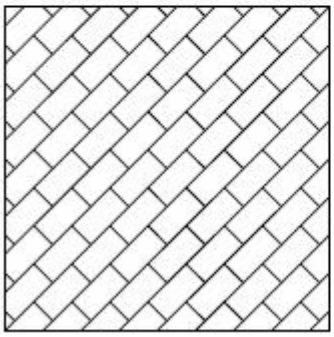
Item	Activity	Limits/Tolerances	Clause
1.	**Base**		
	(a) Surface Level	Finished level of base for road pavements to be within +10mm or -0mm of design levels.	SC6.4.6.18.3(3)
		Finished level of base other than for road pavements, to be within ±10mm of design levels.	SC6.4.6.18.3(3)
		The top surface of the base for all segmental paving shall not deviate from a 3m straight edge, laid in any direction, by more than 10mm.	SC6.4.6.18.3(3)
2.	**Laying Paving Units**		
	(a) Joint widths	Within the range 2 -4mm.	SC6.4.6.18.3(6)
3.	**Completed Segmental Paving**		
	(a) Surface level	Finished surface level of pavers shall not vary from design levels by more than ±6mm for road pavements and ±8mm for other than road pavements.	SC6.4.6.18.3(7)
		Finished surface of pavers shall not deviate from a 3m straight edge, laid in any direction, by more than 6mm for road pavements and 8mm for other than road pavements.	SC6.4.6.18.3(7)
	(b) Level adjacent to drainage inlets	Invert level of channels between abutting chamfered units shall be not less than 5mm and not more than 10mm above the level of adjacent drainage inlets.	SC6.4.6.18.3(7)
	(c) Difference in level of adjacent pavers	≤2mm	SC6.4.6.18.3(7)



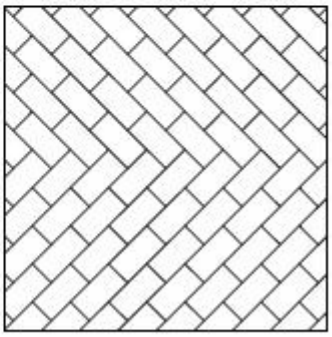
Herringbone



Basketweave



Stretcher



Zig Zag Running Bond

SC6.4.6.19 Stabilisation

SC6.4.6.19.1 Introduction

(1) Scope

This sub-section identifies the materials requirements for stabilised materials provided by stationary plant production as well as materials and process requirements for in-situ stabilisation.

The work to be executed under this sub-section consists of the supply and incorporation of stabilising binders with material in a nominated pavement course or subgrade layer (including materials for the selected material zone, and selected backfill), at specified locations in the work and the spreading, compaction, trimming and curing of such materials.

This sub-section provides the requirements for stabilisation of the types of pavement courses and subgrade zones or layers as shown in Table SC6.4.6.19.1.

Table SC6.4.6.19.1 Types of pavement courses, subgrade zones or layers and stabilising binder

Pavement Course Or Subgrade Zone Or Layer	Stabilising Binder
PAVEMENT COURSE	
Base and Subbase	Cement Blended Stabilising Agent Hydrated Lime (pugmill) Quicklime (in-situ)
SUBGRADE ZONE OR LAYER	
Selected Material Zone	Cement Blended Stabilising Agent Quicklime (in-situ) Hydrated Lime (pugmill)
Other Subgrade Layers	Cement Blended Stabilising Agent Quicklime (in-situ) Hydrated Lime (pugmill)
Selected Backfill Zone	Cement Hydrated Lime (pugmill)

The pavement course or subgrade zone or layer to be stabilised shall be as specified in sub section SC6.4.6.12 Flexible pavements, or as indicated on the drawings.
Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

(2) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) The Development manual planning scheme policy sub-sections to be read and applied in conjunction with this sub-section one as follows:
SC6.4.6.4 Stormwater drainage
SC6.4.6.10 – Earthworks (construction)
SC6.4.6.12 - Flexible pavements
SC6.4.6.30 - Control of traffic

(b) Australian Standards

AS 1141.11.1	*Particle size distribution – Sieving method*
AS 1289	*Methods of testing soils for engineering purposes*
AS 1289.5.7.1	*Compaction control test – Hilf density ratio and Hilf moisture variation (rapid method)*
AS 1289.5.8.1	*Determination of field density and field moisture content of a soil using a nuclear surface moisture-density gauge - Direct transmission mode*

AS 1289.4.2.1	*Determination of the sulphate content of a natural soil and the sulphate content of the ground water - Normal method*
AS 1289.6.1.1	*Determination of the California bearing ratio of a soil - Standard laboratory method for a remoulded specimen*
AS 2350.4	*Methods of testing portland, blended and masonry cements -Setting time*
AS 2350.9	*Methods of testing portland, blended and masonry cements - Determination of residue on the 45 micrometre sieve*
AS 3582.1	*Fly ash*
AS 3582.2	*Slag - Ground granulated iron blast-furnace*
AS 3583.3	*Determination of loss on ignition*
AS 3583.6	*Determination of relative water requirement and relative strength*
AS 3583.12	*Determination of available alkali*
AS 3583.13	*Determination of chloride ion content*
AS 3583.14	*Determination of insoluble residue content*
AS 3972	*General purpose and blended cements*
AS 4489.6.1	*Test methods for limes and limestones – Lime index - Available lime*
AS 5101.4	*Methods for preparation and testing of stabilized materials – Unconfined compressive strength of compacted materials*

(c) Other publications

Austroads

Guide to pavement technology Part 4D - Stabilised materials, AGPT04D-06.

The Glossary of Austroads Terms, AP-C87-10

NSW Roads and Maritime Services Test Methods

Test method T432: Rate of slaking of quicklime, 2012

SC6.4.6.19.2 Inspection, sampling and testing

(1) Pre-construction compliance

The Contractor shall provide a certificate from a laboratory with appropriate NATA registration stating that the stabilisation mix(es) submitted and the mix constituents comply with the mix nominated in approved stabilisation mix design approved as part of the pavement design and that the stabilised material meets the requirements of sub section SC6.4.6.12 Flexible pavements if incorporated into the works as a pavement layer or alternatively SC6.4.6.10 Earthworks (construction) or SC6.4.6.4 Stormwater drainage.

(2) Construction compliance

Regular inspection, sampling and testing of pavement and subgrade materials shall be undertaken by the Contractor while stabilisation is in progress in accordance with this sub section.

SC6.4.6.19.3 Materials

(1) Unsuitable materials and shape correction

These shall be with unbound gravel of Type 1, Type 2, Type 3 or Type 4 in accordance with SC6.4.6.10 and SC6.4.6.12 New material shall not have a water soluble sulphate content exceeding 1.9 grams of sulphate per litre.

(2) Cement and stablising agent

The type of cement used as the stabilising agent or a constituent in a blended stabilising agent shall comply with AS 3972.

Cement shall be from a source approved under the Queensland Government's State Purchasing Policy at time of production.

Documentary evidence of the quality and source of the cement shall be furnished by the Contractor to the Superintendent upon request at any time.

If the Contractor proposes to use cement which has been stored for a period in excess of 3 months from the time of manufacture, the Contractor shall arrange a re-test, to ensure the cement still complies with AS3972, before the cement is used in the work. Test results shall be forwarded to the Superintendent for approval at least 2 days in advance of usage of the material.

The Contractor shall order gravel material with the cement content required to achieve the designed unconfined compressive strength (UCS) of the pavement. It is the Contractor's responsibility to ensure the material being used achieves the required UCS.

(3) Quicklime stabilising agent
Quicklime, consisting essentially of calcium oxide in a highly reactive form, shall have the following properties at the point of spread:

(a) available lime - the content of calcium oxide, determined by AS 4489.6.1, shall not be less than 85 per cent. Unless otherwise specified, the spread rate for quick lime shall be 20 kg/m^3; and

(b) slaking rate - the active slaking time shall not be greater than 20 minutes and the temperature rise on slaking, determined from the average of four samples tested in accordance with Test Method T432, shall not be less than 40°C in 6 minutes.

The particle size distribution of the quick lime determined by AS 1141.11 shall comply with the following requirements in Table SC6.4.6.19.2.

Table SC6.4.6.19.2 Particle size distribution of quicklime

AS Sieve	Per Cent Passing
13.2mm	100
9.5mm	96 - 100
4.75mm	70 - 100
2.36mm	0 - 90

(4) Hydrated lime stabilising agent

(a) Hydrated lime, consisting essentially of calcium hydroxide, whether used as the sole stabilising agent or blended with other additives, shall have the following properties:

(i) available lime - the content of calcium hydroxide, determined by AS 3583.12, shall not be less than 80 per cent;

(ii) form - the material shall be in a dry powder form; and

(iii) residue on sieving - the residue on a 300 micron sieve, determined by (Particle Size) AS 3583.14, shall not exceed 2 per cent.

(b) The properties which characterise the particular hydrated lime to be used in the stabilising agent submitted as part of the mix design are:

(i) percentage of calcium hydroxide;

(ii) fineness percentage by mass passing the 45 micron sieve (AS 2350.9); and

(iii) source.

(5) Ground granulated blast furnace slag stabilising agent
The ground granulated blast furnace slag shall conform to AS3582.2.
The properties which characterise the particular ground blast furnace slag to be used in the stabilising agent submitted as part of the mix design are:

(a) fineness percentage by mass passing the 45 micron sieve (AS 2350.9);

(b) relative strength (28 days) (AS 3583.6); and

(c) source.

(6) Flyash stabilising agent
Flyash shall conform to AS 3582.1.

The properties which characterise the particular flyash to be used in the stabilising agent submitted as part of the mix design are:

(a) fineness - percentage by mass passing the 45 micron sieve (AS 2350.9);

(b) loss on ignition (AS 3583.3); and

(c) source.

(7) Blended stabilising agents

The Contractor may utilise a blended stabilising agent. The Contractor shall obtain mill and batch information which will make the blended stabilising agent traceable to the supplier's test results.

Handling and storage requirements of the Supplier shall be complied with by the Contractor who shall also arrange for sampling of the agent as required by the Superintendent.

The mass of components of the nominated blended stabilising agent shall not vary by more than ± 3 per cent from the blend percentages nominated in the mix design described in approved stabilisation mix design.

When a blended stabilising agent is produced from a combined grinding of components the following properties will characterise the particular stabilising agent blend:

(a) source of each component;

(b) fineness percentage by mass passing the 45 micron sieve (AS 2350.9); and

(c) setting time (AS2350.4).

(8) Water (for curing)

Water shall be free from harmful amounts of materials such as oils, salts, acids, alkalis and vegetable substances. The water shall not contain more than:

(a) 600 parts per million of chloride ion, determined by AS 3583.13;

(b) 400 parts per million of sulphate ion, determined by AS 1289.4.2.1; and

(c) 1 per cent by mass of undissolved solids.

Water accepted as potable and fit for human consumption will not require testing to confirm suitability.

SC6.4.6.19.4 Stabilisation processes

(1) General

The Contractor shall submit details of the proposed equipment (including the mixing plant) and stabilisation procedures to be used in the work 14 days prior to commencement of the work. This submission, hereafter called the work plan, is to include the following:

(a) the sequence of operations;

(b) widths of stabilisation passes;

(c) provision for traffic if appropriate;

(d) comply with statutory requirements for WHS;

(e) testing methods and frequency;

(f) comply with this specification;

(g) survey control methods; and

(h) curing methods.

Notwithstanding submission to the Superintendent of the Contractor's equipment and stabilisation procedures, the work shall meet all the sub-section requirements, and statutory requirements for work health and safety, and the Contractor shall perform such tests as specified as the work proceeds, to ensure compliance.

Stabilisation of pavement materials shall not proceed during wet weather or if rain is imminent and likely to occur during any stage of the stabilisation process so as to significantly influence the resultant moisture content and uniformity of moisture content in the mix.

(2) Application of stabilising agent

(a) Stationary mixing plant

Application rate of stabilising agent shall be monitored at the pug mill or equivalent plant utilised as approved by the Superintendent.

Application rate measured in kilograms per tonne of product shall be monitored and recorded for every 100 tonnes of production.

The achieved accuracy of application rate shall be ±10 per cent of the nominated rate nominated in approved pavement design's stabilisation mix design.

The application rate shall not be allowed to exceed the nominated rate by more than 10 per cent.

(b) In-situ

For environmental reasons in urban areas the incorporation of stabilising agent is to be a closed system process where stabilising agent is added and mixed into the pavement within the bowl of the specialist mixing equipment.

Where approved in rural areas spreading shall be carried out using the mechanical spreader nominated in the work plan and subsequently approved by the Superintendent. The approved pavement design's stabilisation mix design nominates the spread rate.

The actual spread rate shall be within ±10 per cent of the nominated rate. The Contractor shall verify this by testing the spread rate for each lot or 500m^2 of pavement treated (whichever is less) in each application of binder. Spread rate testing shall be performed by weighing the contents of a suitable four sided tray placed on the pavement and between the wheels of the closed system stabiliser. The rate of stabilising agent spread shall be calculated by dividing the mass collected (kg) by the area of the tray (m^2).

Where spreading/stabilising vehicles are fitted with load cells, the Contractor shall ascertain the average spreading rate of the stabilising agent by dividing the mass of the stabilising agent spread per run by the area of the run. The Contractor shall record this data for each run and make it available to the Superintendent promptly. Such action will not cancel the Contractor's obligation to undertake prescribed testing of spread rate if required by the Superintendent.

Spreading shall not proceed during windy conditions which may cause loss of stabilising agent or cause nuisance or danger to people or property. Where open spreading is approved.

Traffic or equipment not involved in spreading or mixing of the stabilising agent shall not pass over the spread material until it has been mixed into the layer to be stabilised. Where open spreading is approved.

Any spillage of the stabilising agent on site or at any loading location related to the site shall be removed as soon as possible and within the same work shift of such spillage.

(3) Mixing

(a) Stationary mixing plant

The stationary mixing plant shall be purpose built for the process of mixing road making materials. All equipment shall be maintained and calibrated so as to provide a uniformly mixed product without segregation of the aggregate material.

The plant shall provide for the controlled and metered inclusion of water into the mix.

The stationary mixing equipment shall incorporate a delivery system for mix materials capable of producing a uniform mixture to design requirements. This performance shall be confirmed by monitoring of unconfined compressive strength of production, in accordance with AS 1289.6.1.1, with a pair of test specimens tested for each 100 tonnes of production.

(b) In-situ

Mixing equipment shall be purpose built for the process of in-situ mixing of road making materials. It shall be capable of mixing to the depth specified for the layer to be stabilised and of distributing the stabilising agent uniformly through the full depth and over the whole area of the layer to be stabilised. Where directed a minimum of two passes of the mixing equipment is required. As mixing blades or tynes wear they shall be replaced so as to maintain mixing efficiency consistent with that demonstrated during the trial section. The mixing equipment will be capable of supplying a calibrated amount of water to the mixing bowl in such a manner as to provide a uniformly moist mix to a target moisture content.

The resultant mix shall be uniform over the full depth so that there are no lenses, pockets, lumps or granules of stabilising agent present in the layer or adjacent to it.

The procedure nominated in the Work Plan shall minimise disturbance of the distribution of stabilising agent spread in advance of the mixing process.

The Contractor shall carry out visual inspections during mixing to ensure uniform mixing is being achieved in the layer. Inspection results shall be recorded as cited in SC6.4.5 Construction management.

The Superintendent may require that additional passes by the mixing equipment be carried out to improve the visual uniformity of the mix and/or the moisture content.

(c) Paving equipment
For plant-mixed stabilising pavements, the mixture shall be placed by self-propelled paving machine purpose built for this work and with the capacity to place and spread the mixture in one pass at the required uncompacted thickness, width and shape. Other methods of paving may be considered by council where the use of a self-propelled paving machine is impractical.

(4) Field working period (allowable working time)
The time period from addition of water during the mixing process until the completion of compaction is nominated as the field working period.

The nominated field working period shall be provided in Stabilisation Mix Design for the stabilising agent approved as part of the pavement design. The Nominated field working period shall be based on laboratory tests determining the time from mixing until such time as the calculated Wet Density for standard compaction procedures decreases by more than 2 percentage points. This testing shall be undertaken utilising AS 1289.5.1.1 and samples of the materials representative of those to be utilised in the works. If the field working period is not specified as part of the pavement design, the maximum period between the commencement of mixing and the completion of compaction and trimming shall be 3 hours.

The Contractor will complete the compaction process within the Nominated field working period unless specific approval is provided by the Superintendent to an adjustment for site and seasonal conditions.

(5) Trimming and compaction
After mixing the layer shall be trimmed and compacted in accordance with sub-section SC6.4.6.12 Flexible pavements to produce a tight dense surface parallel with the finished wearing surface so that the levels do not vary from the design levels beyond the tolerance for primary trimming specified in clause SC6.4.6.19.4(7)(a) Levels and surface trim.

Subsequent secondary trimming may be undertaken on one or more occasions in preparation for primer seal and with the objective of meeting shape and level requirements. Secondary trimming shall involve cutting to waste. Work methods that lead to the development of laminations in the pavement will not be allowed and surface slurrying will not be accepted. The Contractor's survey control methods as stated in the work plan will be adequate to ensure that the pavement layer thickness is not reduced during secondary trimming to an extent such that it fails to comply with the requirement for layer thickness in accordance with the tolerance specified in clause SC6.4.6.19.4(7)(b) Layer thickness. When required by the Superintendent survey results shall be provided to confirm that the pavement layer thickness remains within tolerance after secondary trimming.

Measurements with a 3 m straight edge shall be taken at a minimum of ten randomly selected stations so as to represent each 200 m lane length or part thereof. Deviation of the surface from the bottom of a 3 m straight edge placed in any direction will meet the tolerance shown in clause SC6.4.6.19.4(7)(a). This testing will be undertaken immediately prior to sealing or prior to agreed practical completion for any work component.

The stabilised layer shall be compacted over the entire area and depth so that the relative compaction determined by AS 1289.5.1.1 is not less than as detailed in sub-sections SC6.4.6.12 Flexible pavements, SC6.4.6.10 Earthworks (construction) or SC6.4.6.4 Stormwater drainage as appropriate.

To provide true relative compaction assessments the lots shall be sampled and tested within the nominated field working period in accordance with AS 1289.5.1.1.

The maximum wet density (standard compaction) will be determined by sampling immediately after the determination of field density and testing will be undertaken within 2 hours of sampling. A determination of maximum wet density (standard compaction) representing the full layer depth is required for each sampling location when calculation of relative compaction is undertaken.

The field density may be determined by in situ sand replacement testing or by single probe Nuclear Density Meter in direct transmission mode in accordance with AS 1289.5.8.1.

(6) Joints

Joints are defined in this sub-section to comprise interfaces between work episodes that are separated in time by more than the nominal field working period for the nominated stabilisation mix design. A longitudinal joint shall be considered to be a joint generally parallel to the road centreline. A transverse joint occurs when a length of work is terminated and extended at a later time after a period which exceeds the nominated field working period.

All longitudinal and transverse joints shall be formed by cutting back into the previously stabilised and fully compacted sections. A minimum longitudinal overlap of mixing runs shall be 75 mm. Transverse joints shall be overlapped by a minimum of 2 m. The material disturbed during cutting back shall be remixed at full depth and incorporated into the new work. No longitudinal joints shall be allowed within 500 mm of the centreline of a typical wheelpath.

The level and shape of the joints shall be within the limits specified in clause SC6.4.6.19.4(7) Tolerances.

(7) Tolerances

(a) Levels and surface trim

The surface level after primary trimming shall be within a tolerance of +30 mm and +10 mm of the levels shown on the drawings.

The surface level after secondary trimming shall be within a tolerance of +15 mm and -15 mm of the levels shown on the drawings.

The pavement surface after secondary trimming and immediately prior to sealing shall be of a quality such that deviation under a 3 metre straight edge does not exceed 12 mm.

Ensure the final surface level is within ± 15 mm of the design levels in the event only a single trim is carried out.

(b) Layer thickness

The final thickness of the stabilised layer at any point shall be within a tolerance of +20 mm and 10 mm of the nominated layer thickness.

The average thickness of the layer in a lot shall be determined from measurements of six randomly selected locations over any 200 m length of a lot. The average thickness shall not be less than that required to meet the specified final thickness tolerances after trimming.

The layer thickness shall be measured at the edges of the stabilising run before compaction commences. The layer thickness shall be measured relative to the finished design level.

(c) Width

The width measured at any point of the stabilised layer shall be not less than the specified width as shown in the drawings by more than 50 mm.

The average width of the layer shall be determined from measurements at three sites selected at random by the Superintendent over any 200 m length of a lot and shall be not less than the specified width.

(8) Curing

The Contractor shall submit to the Superintendent details of the proposed method of curing as part of the Work Plan.

The stabilised work shall be protected against rapid drying out by keeping it continuously wet or damp during the period prior to the provision of a subsequent layer or the application of a prime or primer-seal.

Water curing shall consist of frequent light uniform spraying that will not produce significant run off or flooding on sections of the area. Slurrying of the surface or leaching of the stabilising agent shall be avoided.

Under this sub-section provision for curing up to the period indicated in the approved Stabilisation Mix Design shall be the responsibility of the Contractor.

(9) Trial section of stabilised earthworks

Prior to the commencement of works submit a trial section of stabilised earthworks to demonstrate the methods proposed to conform with this sub-section.

This trial section is constructed so that it may be incorporated in the finished work with a length of approximately 50 m.

Construct the trial stabilisation using the materials, equipment and methods for placing and finishing the same as would be used for the entire base works. Demonstrate the methods proposed to be used for the construction of joints.

In the event of deficiencies in the stabilisation the trial section may not be approved. The method, equipment, materials and personnel will require to be reviewed and an explanation submitted. A further length of stabilisation may be requested. Non-conforming trial section of stabilised earthworks must be removed to ensure to preventing damage to the remaining stabilised earthworks and underlying materials. Dispose of the removed materials at an approved location.

SC6.4.6.19.5 Limits and tolerances

The limits and tolerances applicable to the various clauses of this sub-section are summarised in Table SC6.4.6.19.3 Summary of limits and tolerances below.

Table SC6.4.6.19.3 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	Quicklime		
	a) Available Lime	>85% Calcium Oxide content	SC6.4.6.19.3(3) Quicklime
	b) Slaking Rate	Active Slaking time < 20 minutes, and temperature rise on slaking not less than 40ºC in 6 minutes (for an average of four samples).	SC6.4.6.19.3(3) Quicklime
	c) Particle Distribution	Fraction passing AS Sieve: 100% for 13.2mm Sieve 96-100% for 9.5mm Sieve 70-100% for 4.75mm Sieve 0-90% for 2.36mm Sieve	SC6.4.6.19.3(3) Quicklime
2.	Hydrated Lime		
	a) Available Lime	>80% Calcium Hydroxide	SC6.4.6.19.3(4) Hydrated Lime

Item	Activity	Limits/Tolerances	Clause
	b) Particle Size	<2% residue on a 300 micron Sieve	SC6.4.6.19.3(4) Hydrated Lime
3.	Blended Stabilising Agents	Blend percentages shall not vary by more than ± 3% from those nominated in SC6.4.6.19 Attachment A (Stabilisation mix design)	SC6.4.6.19.3(7) Blended Stabilising Agents
4.	Water		
	a) Chloride ion content	<600 PPM Chloride ion	SC6.4.6.19.3(8) Water
	b) Sulphate ion content	<400 PPM Sulphate ion	SC6.4.6.19.3(8) Water
	c) Undissolved solids	<1 per cent by mass of undissolved solids	SC6.4.6.19.3(8) Water
5.	Application of Stabilising Agent		
	a) Spread Rate or Incorporation Rate for in-situ plant.	Actual spread rate shall be within ± 10% of the nominated rate	SC6.4.6.19.4(2) Application of Stabilising Agent
6.	Trimming and Compaction		
	a) Surface Level	After primary trimming be within +30mm and +10mm of levels shown on drawings After secondary trimming be within ±15mm of levels shown on drawings	SC6.4.6.19.4(7)(a) Tolerances
	b) Layer Thickness	Final thickness of layers shall not vary more than +20mm and -10mm of required thickness	SC6.4.6.19.4(7)(b) Tolerances
	c) Shape	Shall not deviate more than 12mm under a 3m straight edge immediately prior to first sealing	SC6.4.6.19.4(7)(a) Tolerances
7.	Joints		
	a) Longitudinal Overlap	> 75mm overlap of mixing runs	SC6.4.6.19.4(6) Joints
	b) Transverse Overlap	> 2m overlap of transverse joints	SC6.4.6.19.4(6) Joints
	c) Longitudinal Joints	Shall not be allowed within 0.5m of the centreline of a typical wheelpath	SC6.4.6.19.4(6) Joints
8.	Width		
	a) Width of Stabilised Layer	At any point, the width shall be not less than 50mm short of the width shown on the drawings with an average width always greater than that shown on the drawings.	SC6.4.6.19.4(7)(c) Tolerances

SC6.4.6.19 Attachment A: Stabilisation mix design

Click here to obtain a copy of the following form.

SC6.4.6.20 Subsoil, foundation and pavement drains

SC6.4.6.20 Introduction

(1) Scope

(a) The work to be executed under this sub-section covers the excavation, bedding, installation and backfilling of subsoil, sub-pavement, intra pavement, edge and foundation drains.

(b) Subsoil and foundation drains shall be constructed where and as shown on the drawings or as directed by the Superintendent.

(c) This sub-section should be read in conjunction with SC6.4.6.21 Subsurface drainage.

(d) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

(2) Order of construction

(a) Subsoil and sub-pavement drains
Subsoil drains shall be constructed as soon as possible after necessary earthworks are completed in the area of the drain. Where stabilisation of the subgrade is required, subsoil drains shall be constructed after completion of stabilisation, except where excessive ground water is encountered, they may be constructed prior to stabilisation of the subgrade.

Where a selected material zone is specified and excessive ground water is encountered, subsoil drains may be installed in two stages as follows:

(i) Stage 1: standard subsoil drains installed below the base of the cutting prior to placement of select material in the selected material zone; and

(ii) Stage 2: extension of subsoil drain to top of the selected material zone after placement of selected material.

(b) Intra-pavement drains
Intra-pavement drains shall be constructed after the completion of the layer below the pervious pavement material or 40mm open graded asphaltic concrete subbase and preceding the construction of the subsequent layers.

(c) Edge drains
Edge drains shall be constructed after the construction of the rigid pavement and before the placement and compaction of verge material.

(d) Foundation drains
Foundation drains shall be constructed after completion of clearing and stripping operations, and preceding the commencement of embankment construction.

(3) Terminology

Subsoil drains	are intended for the drainage of ground water and/or the pavement in cuttings.
Sub-Pavement Drains	are intended for the drainage of the pavement layers unless the subbase is open graded or pervious in nature in which case intra-pavement drains shall be provided.
Intra-Pavement Drains	are intended for the drainage of the pavement layers of a flexible pavement where the subbase comprises an open graded or pervious pavement material or open graded asphaltic concrete.
Edge Drains	are intended for the drainage of rigid pavements.
Foundation drains	are required for the drainage of seepage, springs and wet areas within and adjacent to the foundations.

(4) Reference and source documents
Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with

this sub-section are as follows:
SC6.4.6.10 Earthworks (construction)
SC6.4.6.12 Flexible pavements
SC6.4.6.13 Asphaltic concrete
SC6.4.6.21 Subsurface drainage

(b) Australian Standards

AS 1289.3.3.1	*Calculation of the plasticity index of a soil*
AS 1289.5.4.1	*Compaction control test - Dry density ratio, moisture variation and moisture ratio*
AS 1477	*PVC pipes and fittings for pressure applications*

SC6.4.6.20.2 Construction

(1) Subsoil and sub-pavement drains

(a) Excavation

(i) Excavation shall be undertaken in accordance with the requirement of SC6.4.6.21 Subsurface drainage.

(ii) Trenches shall be trimmed to the required line and depth in accordance with the approved drain design specific to site conditions and as directed by the Superintendent.

(iii) The bottom of the trench shall be excavated to the same grade as the design pavement surface in the direction of the trench except where the grade of the design pavement surface in the direction of the trench is less than 0.25 per cent. In this case, the trench depth shall be increased to provide a minimum grade of fall in the trench of 0.25 per cent.

(iv) The bottom of the trench shall be excavated so that no localised ponding of water occurs. The bottom of the trench must not be more than 50 mm below the specified level of the invert of the pipe and ensure that the bottom and sides of the excavation are smooth with no protrusion that will damage the geotextile where required.

(v) If at any location the trench is excavated below the specified floor level, the trench shall be backfilled with non-porous subgrade material so that when the subgrade material is compacted to a relative compaction, determined by AS 1289.5.4.1, of at least 95 per cent (standard compaction), the bottom of the trench shall be at the specified floor level.

(vi) Where the drain is constructed in two stages, the excavation for Stage 2 shall be carried out after placement and compaction of the selected material zone or the stabilised subgrade layer. The Stage 2 trench shall be excavated to the same line and width as the Stage 1 trench and to a depth to provide a clean, full contact with the filter material placed in Stage 1. All excavated material shall be disposed to waste or incorporated into fills.

(vii) After the completion of excavation, the Contractor must present to the Superintendent the trench for inspection to ensure conformance with shape, grade line, filling and compaction and removal of any protrusions.

(b) Laying of pipe

(i) The 100mm diameter corrugated slotted plastic piping, complying with SC6.4.6.21 Subsurface drainage, shall be laid on a bed of filter material 50mm in thickness and shall be laid to the specified line and grade. The pipe shall not deviate from the specified line by more than 100mm at any point

(ii) The type of filter material shall be shown on the drawings as per the requirements of SC6.4.6.21 Subsurface drainage and shall be confirmed by the Superintendent prior to placement of material.

(iii) Joints in the pipeline shall be kept to the minimum number and, where required, shall be made using a suitable external joint coupling. The inlet end of the pipe shall be fitted with a cap.

(c) Backfilling

(i) The trench shall be backfilled with filter material to the level specified. The type of filter material shall be shown on the drawings as per the requirements of SC6.4.6.21 Subsurface drainage and shall be confirmed by the Superintendent prior to placement. The filter material shall be placed and compacted in layers with a maximum compacted thickness of 300 mm. Tamping around and over the pipe shall be done in such a manner as to avoid damage or disturbance to the pipe.

(ii) The filter material shall be compacted for its full depth to a Density Index of not less than 70 per cent as determined by AS 1289.5.6.1.

(iii) The upper section of the trench, above the level specified for filter material backfill, shall be backfilled with selected free draining backfill material, conforming to the requirements of SC6.4.6.10 Earthworks (construction), compacted for its full depth to a relative compaction of not less than 97 per cent (standard compaction) as determined by AS 1289.5.4.1.

(iv) Where shown on the drawings or as directed by the Superintendent, a geotextile conforming with the requirements of SC6.4.6.21 Subsurface drainage, shall be provided at the interface between the filter material and adjoining materials. Cover the bottom and sides of the trench with sufficient free fabric to wrap around the completed drain. Conform to the shape of the trench with minimal wrinkles, folds or air voids between fabric and trench, but not stretched on the soil. Laps of 500mm shall be provided at joints in the fabric. The Contractor must take all reasonable care to ensure that the geotextile is not damaged during installation and backfilling operations. Ensure the period between initial laying out and final cover of the geotextile with drainage backfill layer does not exceed 14 days. Where possible place geotextiles just ahead of construction works and cover with materials within 48 hours. Any geotextile fabric exposed for longer than 14 days must be removed and replaced by the Contractor as directed by the Superintendent.

(v) Where the outlet section of pipes discharging through the fill batters, the trench shall be backfilled with the nominated filter material to a depth of 50mm above the pipe. The balance of trench shall be backfilled with earth backfill material of maximum particle size of 50mm and shall be compacted for the full depth to a relative compaction of 95 per cent (standard compaction) as determined by AS 1289.5.4.1.

(d) Outlets

(i) Outlets are to be provided at maximum intervals of 150m. Where possible, subsoil drains shall discharge into gully pits and other stormwater drainage structures. Where not possible, an outlet shall be constructed of unslotted plastic pipe of the same diameter as the main run to discharge below the edge of the road shoulder. An outlet structure in accordance with the drawings shall be constructed at the discharge end with appropriate treatment to address erosion of adjacent areas.

(ii) The outlet shall be made rodent proof in accordance with the requirements of SC6.4.6.21 Subsurface drainage.

(iii) The outlet shall be located so that erosion of the adjacent area does not occur, or shall be protected by the placement of selected stone in the splash zone of the outlet.

(e) Cleanouts

(i) Cleanouts are to be provided at the commencement of each run of subsoil drain line and at intervals of approximately 60m or as shown on the drawings.

(ii) Details of the required cleanout construction are shown on the drawings. The standard CI caps as shown on the drawings shall be supplied by the Contractor.

(iii) Upon completion of backfilling, pump clean water into the cleanout at the commencement of each run until only clean water discharges at the outlet. The minimum rate of flow of flushing water at the inlet must be 100L/min.

(2) Intra-pavement drains

(a) Excavation

(i) A "V" shaped trench approximately 75mm deep shall be cut to the required line in the pavement layer immediately below the permeable pavement layer. No excavation is required below a 40mm open graded asphaltic concrete subbase layer.

(ii) The bottom of the trench is to be to the same grade as the roadway. The bottom of the trench shall be constructed so that localised ponding of water does not occur.

(iii) Where the pipe is to discharge through the fill batter a trench shall be constructed on a grade suitable for the pipe to discharge its contents without scour. After laying the pipe the trench shall be backfilled with fill material and compacted for the full depth to a relative compaction of not less than 95 per cent (standard compaction) as determined by AS 1289.5.4.1.

(b) Laying of pipe

(i) Thick walled unplasticised PVC pressure pipe, complying with AS 1477, and having a nominal diameter of 58mm, and a minimum pipe wall thickness of 6.5mm, shall be used with crushed rock subbases having not more than 10 per cent of material passing the 9.5mm AS sieve and having layer thicknesses neither less than 150mm nor more than 200mm or open graded asphalt subbases having layer thicknesses neither less than 80mm nor greater than 100mm.

(ii) Where crushed rock subbases require pavement drains and have a depth exceeding 200mm, the type of pavement drain will need to be certified to have adequate crushing strength and a written approval from the Superintendent to the proposed pavement drain type will be required. Similar proposals shall require Superintendent and council approval for pavement drain in asphalt subbases greater than 100mm in depth.

(iii) All pipe shall be slotted except where otherwise shown on the drawings. Details of slot sizes and spacings shall be in accordance with SC6.4.6.21 Attachment A for thick walled unplasticised PVC pressure pipe.

(iv) Thick walled unplasticised PVC pressure pipe shall have square ends and shall be butt jointed.

(v) Where spigot and socket type pipes are used, the pipes shall be joined with the socket ends facing upstream.

(vi) The pipe shall be laid to the specified line and level. The pipe shall not deviate from the specified line by more than 100mm at any point.

(vii) The inlet ends of all pipes shall be fitted with caps.

(viii) All pipes shall be securely held to the layer under the free-draining subbase to prevent movement of the pipes during placement and compaction of the free draining subbase. At least 7 days before commencement of pipe laying, the Contractor shall submit details of the proposed method of securing the pipes to the layer under the free-draining subbase for the approval of the Superintendent.

(ix) Notwithstanding the Superintendent's approval to the use of a method of securing the pipes to the layer under the free draining subbase, if such securing method allows movement of the pipes, the method shall be discontinued and the Contractor shall propose an alternative securing method for approval by the Superintendent.

(x) Any additional costs resulting from the use of the alternative method of securing the pipes shall be borne by the Contractor.

(xi) The outlet length of pipe from the outside edge of the free-draining subbase to an outlet structure in the embankment batter shall be unslotted and the pipe joints in this length of pipe shall be sealed with suitable couplings or mastic.

(c) Backfilling

(i) Subbase material shall be spread, compacted and trimmed, where appropriate, as follows:

(A) for crushed rock subbase, in accordance with sub-section SC6.4.6.12 Flexible pavements; and

(B) for open graded asphalt subbase, in accordance with sub-section SC6.4.6.13 Asphaltic concrete.

(ii) Tipping, spreading and compaction of the subbase shall be undertaken in such a manner as not to damage the intra-pavement drain pipes. If any pipes are damaged as a result of the tipping, spreading and compaction of the subbase, the Contractor shall remove and replace the damaged pipes.

(iii) The cost of the removal and replacement of such damaged pipes shall be borne by the Contractor.

(iv) The thickness of the layer of subbase material enclosing the pipe shall be within the limits specified in clause SC6.4.6.20.2(b) Laying of pipe for the type of pipe used in the intra-pavement drain.

(d) Outlets

(i) Outlets are to be provided as shown on the drawings or at maximum intervals of 150m. Where possible intra-pavement drains shall discharge into gully pits and other stormwater drainage

structures. Where not possible, each pipe shall be extended using a 60 degree bend and unslotted pipe to discharge through the fill batter and an outlet structure constructed on the discharge end in accordance with the drawings.

(ii) The outlet shall be made rodent proof in accordance with the requirements of SC6.4.6.21 Subsurface drainage.

(iii) The outlet shall be located so that erosion of the adjacent area does not occur, or shall be protected by the placement of selected stone in the splash zone of the outlet.

(iv) Joints in the pipeline shall be kept to the minimum number and, where required, shall be made using a suitable external joint coupling. The inlet end of the pipe shall be fitted with a PVC cap.

(3) Edge drains

(a) Excavation

(i) The verge material shall be trimmed to subgrade level and to the minimum width shown on the drawings. The bottom of the trench is to be constructed at the same grade as the roadway and in such a manner that localised ponding of water does not occur.

(ii) Where the grade of the roadway is less than 0.25 per cent the trench shall be excavated to provide a minimum grade of 0.25 per cent.

(iii) When the pipe is to discharge through the fill batter a suitable trench shall be excavated to provide the required grade.

(b) Laying of pipe

(i) Generally, 65mm diameter slotted corrugated plastic pipe enclosed in seamless tubular filter fabric, complying with SC6.4.6.21 Subsurface drainage, shall be used for edge drains.

(ii) Where any part of a shoulder consists of material other than concrete, slotted thick walled unplasticised PVC pressure pipe, complying with AS 1477, shall be used. Spigot and socket type pipes shall be joined with the socket ends facing upstream and the ends of each pipe shall be securely held against the vertical face of the rigid pavement. At least seven days before commencement of pipe laying, the Contractor shall submit details of the proposed method of securing the pipes against the rigid pavement for the approval of the council.

(iii) The pipe shall be laid on a prepared bed to the specified line and level. The pipe shall not deviate from the specified line by more than 100mm at any point.

(iv) Joints in the pipe shall be kept to a minimum number and shall be made using an external joint coupling approved by the Superintendent.

(v) The inlet end of the pipe shall be fitted with a cap.

(vi) The outlet section of a pipe from the vertical face of the rigid pavement to an outlet in the embankment batter shall be unslotted and the pipe joints in this length of pipe shall be sealed with mastic.

(c) Backfilling

(i) The pipe shall be covered with Type B filter material to the dimensions shown on the drawings.

(ii) Mechanical compaction of this filter material is not required, however after placement of the filter material it shall be soaked with water. Where necessary additional filter material shall be added and soaked to provide the final dimensions shown on the drawings.

(iii) Backfilling over the edge drain shall be done in such a manner as to avoid damage or disturbance of the pipe. Backfill material shall be selected material as required for verges and in accordance with the requirements of sub-section SC6.4.6.10 Earthworks (construction). Backfilling shall be compacted to a relative compaction of not less than 100 per cent (standard compaction) as determined by AS 1289.5.4.1.

(iv) Upon completion of backfilling, pump clean water into the cleanout at the commencement of each run until only clean water discharges at the outlet. The minimum rate of flow of flushing water at the inlet must be 100L/min.

(d) Cleanouts

(i) Cleanouts are to be provided at the commencement of each run of edge drain line and at intervals of approximately 60m or as shown on the drawings.

(ii) Details of the required cleanout construction are shown on the drawings. The standard CI caps as shown on the drawings shall be supplied by the Contractor.

(e) Outlets

(i) Unless otherwise shown on the drawings outlets are to be provided at maximum intervals of 150 m. Where possible edge drains shall discharge into gully pits and other stormwater drainage structures. Where not possible, an outlet shall be constructed of unslotted plastic pipe of the same diameter as the main run to discharge below the edge of the road shoulder. An outlet structure in accordance with the drawings shall be constructed at the discharge end.

(ii) The outlet shall be made rodent proof in accordance with the requirements of SC6.4.6.21 Subsurface drainage.

(iii) The outlet shall be located so that erosion of the adjacent area does not occur, or shall be protected by the placement of selected stone in the splash zone of the outlet.

(4) Foundation drains

(a) Excavation

Excavation shall be undertaken in accordance with the requirements of SC6.4.6.21 Subsurface drainage and clause SC6.4.6.20.2(1) Subsoil and sub-pavement drains of this sub-section.

(b) Laying of pipe

(i) The 100mm diameter corrugated slotted plastic piping, complying with SC6.4.6.21 Subsurface drainage, shall be laid on a bed of filter material 50mm in thickness and shall be laid to the required line and grade.

(ii) The type of filter material shall be shown on the drawings as per the requirements of sub-section SC6.4.6.21 Subsurface drainage or as directed by the Superintendent.

(iii) Joints in the pipeline shall be kept to the minimum number and, where required, shall be made using a suitable external joint coupling. The inlet end of the pipe shall be fitted with a PVC cap.

(c) Backfilling

(i) The trench shall be backfilled with filter material in accordance with the provisions of clause SC6.4.6.20.2(3)(c) Backfilling.

(ii) The upper section of the trench, above the level specified for filter material backfill, shall be backfilled with suitable earth backfill material, compacted for its full depth to a relative compaction of not less than 97 per cent (standard compaction) as determined by AS 1289.5.4.1.

(iii) Where shown on the drawings or as directed by the Superintendent, a geotextile, conforming with the requirements of SC6.4.6.21 Subsurface drainage, shall be provided at the interface between the filter material and adjoining materials. Laps of 500mm shall be provided at joints in the fabric.

(d) Outlets

An outlet structure in accordance with the detail shown on the drawings and SC6.4.6.21 Subsurface drainage shall be constructed at the discharge end.

The outlet shall be located so that erosion of the adjacent area does not occur or shall be protected by the placement of selected stone in the splash zone of the outlet.

SC6.4.6.20.3 Limits and tolerances

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.20.1 Summary of limits and tolerances below.

Table SC6.4.6.20.1 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	**Excavation**		SC6.4.6.20.2(3)(a)
	Trench Grade	0.25%	
2.	**Laying of Pipe**		
	• Alignment	Deviation <100mm from specified line at any point	SC6.4.6.20.2(3)(b)
3.	**Subsoil and Sub-Pavement Drain Backfill**		
	(a) Layer thickness	300mm max	SC6.4.6.20.2(3)(c)
	(b) Compaction (Relative)	70% Density Index	SC6.4.6.20.2(3)(c)
	Filter material	97% (Standard)	
	Backfill material		
4.	**Outlet Spacing**	150m max	SC6.4.6.20.2(3)(d)
5.	**Cleanout Spacing**	60m approx	SC6.4.6.20.2(3)(d)
6.	**Intra-Pavement Drain**		
7.	(a) Alignment	Deviation <100mm from specified line at any point.	SC6.4.6.20.3(b)
	Edge Drains		
	(a) Alignment	Deviation <100mm from specified line at any point	SC6.4.6.20.3(b)
	(b) Compaction (Relative) Backfill material	97% Standard	SC6.4.6.20.3(c)

SC6.4.6.21 Sub-surface drainage

SC6.4.6.21.1 Introduction

(1) Introduction

This is the general specification common and applicable to all types of subsurface drainage and shall be read in conjunction with subsurface drainage sub-sections:

(a) SC6.4.6.20 Subsoil, foundations and pavement drains; and

(b) SC6.4.6.8 Drainage mats

(2) Scope

(a) The work to be executed under this sub-section consists of:

(i) preparation for subsurface drainage construction;

(ii) siting of subsurface drainage facilities;

(iii) the supply of all materials associated with the provision of the subsurface drainage system;

(iv) all activities and quality requirements associated with the supply, placement and compaction of filter material;

(v) the provision of a detailed record of all subsurface drain installations; and

(vi) the marking on the ground of the location of all subsurface drains.

(b) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Supervision and construction guidelines.

(3) Extent of work

Details of the work are to be shown on the approved drawings

(4) Temporary drainage during construction

(a) All drainage works carried out by the Contractor shall provide measures of erosion and sedimentation in accordance with the requirements of the accepted project erosion and sediment control plan and/or *Best Practice Erosion and Sediment Control* and make adequate provision for runoff flows at drainage works under construction or at surrounding areas/structure

(b) The Contractor shall make adequate provision for runoff flows at subsurface drainage works under construction, to avoid damage or nuisance due to scour, sedimentation, soil erosion, flooding, diversion of flow, damming, undermining, seepage, slumping or other adverse effects to the Works or surrounding areas and structures as a result of the Contractor's activities.

(c) The Contractor's material and equipment shall be located clear of watercourses or secured so that they will not cause danger or damage in the event of large runoff flows.

(5) Siting of work

(a) Before commencing construction of any subsurface drainage activity, the Contractor shall set out on site the position of the work to the location and levels shown on the drawings, and shall present this set-out for inspection by the Superintendent.

(b) The Superintendent may amend the locations or designed levels or the lengths to suit actual site conditions. Should the Superintendent require a change to the conditions of installation an appropriate variation shall be ordered.

(c) Should the Contractor propose changes to the location, length, designed levels, conditions of installation or cover to suit the Contractor’s construction procedures, the Contractor shall present the proposed set-out in addition to the designed set-out for consideration by the Superintendent. No changes shall be made unless the prior written approval of the Superintendent is obtained.

(6) Excavation

(a) In undertaking trench excavation the Contractor shall provide any shoring, sheet piling or other stabilisation of the sides necessary to comply with statutory requirements.

(b) Where public utilities exist in the vicinity of drainage works the Contractor shall obtain the approval of the relevant authority/corporation to the method of excavation before commencing excavation.

(c) Excavation by blasting, if permitted, shall be carried out to ensure that the peak particle velocity measured on the ground adjacent to any previously installed structure does not exceed 25 millimetres per second. The Contractor shall comply with other requirements concerning blasting operations in SC6.4.6.10 Earthworks (construction).

(d) Trenches shall be excavated to the line, grade, width and depth shown on the drawings or as directed by the Superintendent. The bottom of the trench shall be constructed so that no localised ponding can occur. All loose material shall be removed by the Contractor.

(e) Any material at the bottom of the trench or at foundation level which the Superintendent deems to be unsuitable, shall be removed and disposed in accordance with SC6.4.6.10 Earthworks (construction) by the Contractor and replaced with backfill material in accordance with the requirements of this sub-section. The bottom of the excavated trench or foundation, after any unsuitable material has been removed and replaced, shall be parallel with the specified level or grade of the pipe.

(f) The excavated material shall be used in the construction of embankments backfilling or spoiled in accordance with SC6.4.6.10 Earthworks (construction).

(7) Backfilling

Backfilling shall be carried out in accordance with the requirements of the relevant subsurface drainage structures sub-sections.

(8) Outlet structures for subsurface drainage

(a) Subsurface drainage pipes shall be connected to discharge into gully pits or to outlet structures as shown on the drawings or as directed by the Superintendent.

(b) Outlets shall be spaced at a maximum interval of 150m.

(c) Outlets, including those discharging into gully pits, shall be made rodent proof using galvanised wire netting unless otherwise indicated on the approved drawings.

(d) The outlet shall be located so that erosion of the adjacent areas does not occur or shall be protected by the placement of selected stone or similar treatment together with a marker post to indicate location and assist maintenance.

(e) Outlet pipes from curtain drains shall be unslotted. At no point shall an outlet pipe be higher than the pipe at the end of the curtain drain.

(f) All concrete used in the construction of outlet structures shall conform to the requirements of sub-section SC6.4.6.28 Minor concrete works.

(9) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections
SC6.4.6.10 – Earthworks (construction)
SC6.4.6.28 - Minor concrete works

(b) Australian Standards

AS 1141.11.1	*Particle size distribution - Sieving method*
AS 1141.22	*Wet/dry strength variation*
AS 1289.5.5.1	*Determination of the minimum and maximum dry density of a cohesionless material – Standard method*
AS 1477	*PVC pipes and fittings for pressure applications*
AS 2439.1	*Perforated drainage pipe and associated fittings*
AS 2758.1	*Aggregates and rock for engineering purposes – Part 1: Concrete aggregates*
AS 3705	*Geotextiles - Identification, marking and general data*

AS 3706	*Geotextiles - Methods of test*
AS 3706.9	*Determination of permittivity, permeability and flow rate*
AS 3706.11	*Determination of durability - Resistance to degradation by light, heat and moisture*

(c) Other

Austroads, *Guide to Pavement Technology - Part 4G Geotextiles.*

ASTM International, ASTM-D2434-68 – *Standard test method for permeability of granular soils (Constant Head)*

International Erosion Control Association (IECA), *Best Practice Erosion and Sediment Control*

SC6.4.6.21.2 Materials

(1) Corrugated plastic pipe

(a) Corrugated plastic pipe shall be Class 1000 complying with AS2439.1 of 65mm or 100mm diameter as indicated on the drawings. All pipe shall be slotted except where shown on the approved drawings.

(b) Joints, couplings, elbows, tees and caps shall also comply with AS2439.1 and only the manufacturer's recommended fittings shall be used.

(c) The Contractor shall obtain from the Manufacturer a Test Certificate demonstrating compliance with AS2439.1.

(2) Other types of subsurface drainage

Where a Contractor wishes to use a subsurface drainage pipe other than corrugated plastic pipe, the Contractor shall submit full details of the type of pipe, certification from the manufacturer of its suitability and quality and written acceptance by the council for its use in each particular application. Certification of the suitability of any pipe will address the crushing strength, flexural strength, jointing system and slotting details.

(3) Filter material

(a) General

The types of filter material covered by this sub-section shall include:

(i) Type A filter material for use in trench drains and Type B drainage mats;

(ii) Type B filter material for use in trench drains and Type B drainage mats;

(iii) Type C filter material comprising crushed rock for use in Type A drainage mats; and

(iv) Type D filter material comprising uncrushed river gravel for use in Type A drainage mats.

All filter material shall consist of clean, hard, tough, durable particles. A sample of the proposed filter material is to be submitted to the Superintendent for approval.

(b) Type A filter material

Type A filter material shall be crushed rock complying with the following requirements in Table SC6.4.6.21.1.

Table SC6.4.6.21.1 Type A filter material

Test Method	Property	Requirement
AS 1141.11	Material passing AS sieve	Per cent by mass
	6.7mm	100
	4.75mm	85 to 100
	2.36mm	0 to 40
	1.18mm	0 to 5
	425µm	0 to 2

(c) Type B Filter Material

Type B filter material shall be granular material complying with the following grading requirements in Table SC6.4.6.21.2.

Table SC6.4.6.21.2 Type B filter material

Test Method	Property	Requirement
AS 1141.11	Material passing AS sieve	Per cent by mass
	4.75mm	100
	2.36mm	95 to 100
	425µm	20 to 80
	300µm	0 to 30
	150µm	0 to 2
	75µm	0 to 0.1

In addition to the above grading requirements, Type B filter material shall have a coefficient of saturated permeability, when compacted to its maximum dry density as determined by AS 1289.5.5.1 and then tested in accordance with Test Method ASTM D2434 68, of at least 8m per day after 3 hours of flow.

Type B filter material shall not vary from its original grading as a result of compaction processes by more than the following amounts listed in Table SC6.4.6.21.3.

Table SC6.4.6.21.3 Type B filter material variation

AS Sieve	Variation From Grading Before Treatment (per cent of mass)
2.36mm	± 3
1.18mm	± 1
425µm	± 1
300µm	± 1
150µm	± 0.5
75µm	± 0.1

(d) Type C Filter Material

Type C filter material shall be crushed rock complying with the following requirements in Table SC6.4.6.21.4.

Table SC6.4.6.21.4 Type C Filter Material

Test Method	Property	Requirement
AS 1141.11	Maximum particle size	37.5mm
	Maximum passing the 9.5mm AS Sieve	5% by mass
	Maximum (D90:D10)*	3
AS 1141.22	Minimum wet strength	100kN
	Maximum 10% fines wet/dry variation	30%

Note—the D90 value shall be determined by sieving the material using 75mm, 53mm, 37.5mm, 26.5mm, 19mm, 13.2mm and 9.5mm AS sieves, as appropriate, and then plotting the results on a graph of AS sieve size v percentage passing. The plotted points shall be joined by straight lines and the D90 value shall be determined as the theoretical sieve size corresponding to 90 per cent passing.

D10 denotes the theoretical size of a sieve through which 10 per cent of the material would pass and shall be determined from the same graph used to determine the D90 value.

(e) Type D Filter Material

Type D filter material shall be uncrushed river gravel complying with the description of rounded aggregate in Table B1, Appendix B of AS2758.1 and the following requirements in Table SC6.4.6.21.5.

Table SC6.4.6.21.5 Type D Filter Material

Test Method	Property	Requirement
AS 1141.11	Maximum particle size	75mm
	Maximum passing the 9.5mm AS sieve	5% by mass
	Maximum (D90 : D10)	3
AS 1141.22	Minimum wet strength	100kN
	Maximum 10% fines wet/dry variation	30%

(4) Geotextile

Prior to placing geotextiles, documentary evidence that the geotextile and installation process conform to the requirements of this sub-section must be produced and submitted to the Superintendent.

(a) General

The geotextile, other than seamless tubular filter fabric, shall consist of either a woven or a non-woven type which shall be manufactured from synthetic materials other than polyamide. Rolls of geotextile shall be marked with product identification and supplied with data sheets and information in accordance with the requirements of AS 3705.

The geotextile shall be bio stable and resistant to attack by alkalis, acids, dry heat, steam, moisture, brine, mineral oil, petrol, diesel and detergents when tested in accordance with the appropriate parts of AS 3706.

The geotextile shall be resistant to ultra violet light. No geotextile shall be left exposed to sunlight during storage and construction for a period longer than a total of 21 days. If exposure in excess of 21 days does occur, the geotextile shall be tested in accordance with AS 3706.11 and if its characteristics have deteriorated to or below 90 per cent of the characteristics claimed by the manufacturer or the characteristics determined on unexposed geotextile, whichever is the better, it shall be removed and replaced with a geotextile complying with this specification.

The geotextile material type, strength rating “G”, and minimum mass requirements shall be as shown on the drawings.

The type, properties, functions, design and construction requirements for a particular application of geotextile installation shall be compatible with recommendations provided by the Guide to Pavement Technology – Part 4G, as well as requirements indicated on the drawings.

In addition to the above mentioned requirements, geotextiles for curtain drains shall consist of either polyester, polypropylene or polyethylene. The required rates of water flow are shown on Table 4.1 of Guide to Pavement Technology – Part 4G, under 100mm constant head determined using the perpendicular flow test to conform with AS 3706.9.

(b) Seamless tubular filter fabric

Seamless knitted tubular filter fabric shall be used to enclose all slotted pipes and shall be manufactured from either polypropylene or polyester. The fabric shall be free of imperfections in weave or yarn and have abrasion resistant and weave stability qualities such that it shall not form holes, ladder, deweave, tear or unravel more than 5mm from a cut end.

Fitting of the seamless tubular filter fabric shall be in accordance with the requirements of SC6.4.6.21 Attachment A. Filter fabric that is excessively stretched, torn or otherwise damaged during fitting of the fabric, storage, transportation or pipe laying will be removed and replaced so as to eliminate any damaged lengths.

SC6.4.6.21.3 Recording of subsurface drainage information

(1) The Contractor shall keep a detailed record of all subsurface drainage pipes and the completed subsurface drainage systems shall be shown on the work as executed plans to be returned to the Superintendent upon completion of work.

In addition, the Contractor shall prepare a subsurface drainage information sheet or sheets at the completion of construction of each drain or drainage system and shall submit the subsurface drainage sheet or sheets to the Superintendent within 5 working days of the completion of the drain or drainage system.

SC6.4.6.21.4 Limits and tolerances

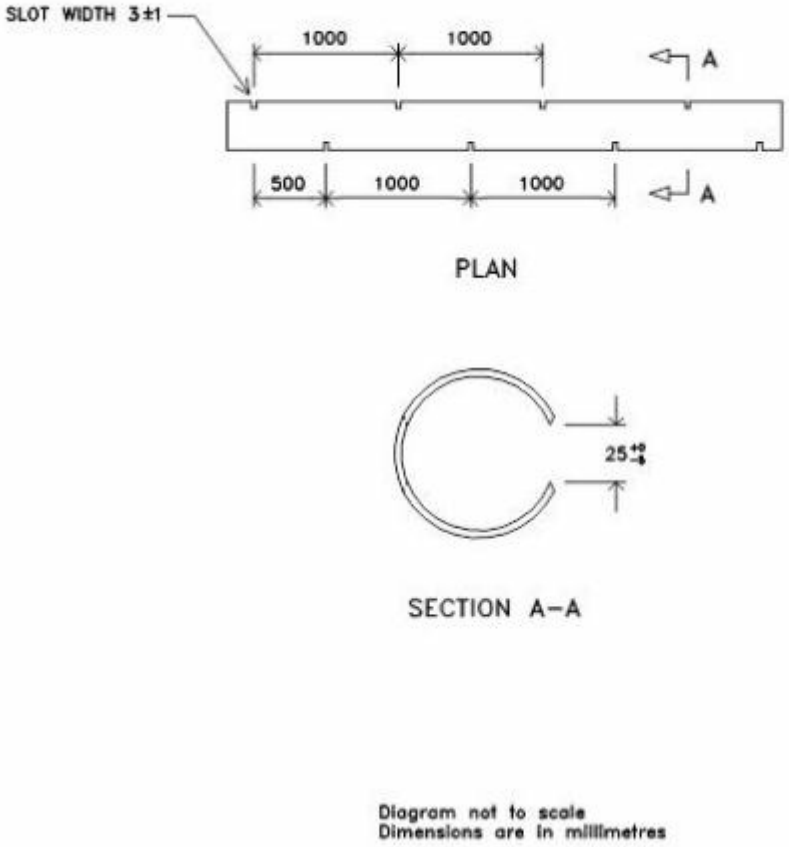
The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.21.6 Summary of limits and tolerances below.

Table SC6.4.6.4.21.6 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	**Excavation by Blasting** Peak particle velocity	25mm/sec	SC6.4.6.21.1(6)
2.	**Outlets** Spacing	Max 150m	SC6.4.6.21.1(8)
3.	**Filter Material**		
	(a) Type A	Table SC6.4.6.21.1	SC6.4.6.21.2(3)
	(b) Type B	Tables SC6.4.6.21.2 and SC6.4.6.21.3	SC6.4.6.21.2(3)
	(c) Type C	Table SC6.4.6.21.4	SC6.4.6.21.2(3)
	(d) Type D	Table SC6.4.6.21.5	SC6.4.6.21.2(3)
4.	**Geotextile**		
	(a) Exposure to sunlight	<21 days If >21 days deterioration not to exceed 10% of claimed characteristics	SC6.4.6.21.2(4)

Attachment A

Figure SC6.4.6.21.1 Slotting details for thick walled PVC plastic pipe



1. Slotted pipes fitted with seamless tubular filter fabric

   (a) Procedure for fitting seamless tubular filter fabric to slotted pipe

      (i) Seamless tubular filter fabric shall be fitted to slotted pipe immediately before the slotted pipe is to be laid in its final position in the work.

      (ii) The filter fabric shall be initially pulled over and onto a short length of smooth pipe of internal diameter between 20mm and 30mm greater than the external diameter of the slotted pipe to be enclosed by filter fabric. The short, larger diameter pipe shall be referred to as the "mandrel".

      (iii) The pipe to be enclosed by the filter fabric shall be passed through the mandrel. The filter fabric shall be slipped on to the pipe as the pipe emerges from the mandrel leaving enough overhang of the filter fabric to make a suitable joint with the filter fabric on the adjacent pipe. The filter fabric shall be firmly held to the forward end of the pipe so that it cannot slip back along the pipe.

      (iv) The pipe shall be pulled right through the mandrel allowing the filter fabric to progressively slip over the pipe. The filter fabric shall be restrained from easily slipping off the mandrel thus ensuring the filter fabric is stretch fitted onto the pipe.

      (v) When the end of the pipe emerges from the mandrel, the filter fabric shall be clamped to that end of the pipe so that the filter fabric cannot slip down the pipe. The filter fabric shall remain clamped to each end of the pipe to ensure the filter fabric remains stretch fitted onto the pipe when the pipe is placed in its final position in the drain. The filter fabric shall be cut cleanly leaving enough overhang off the end of the pipe to make a fully covered join with the filter fabric on the adjacent pipe when the pipes are installed in the drain.

   (b) Precautions to be taken when using slotted pipe fitted with seamless tubular filter fabric

      (i) Slotted pipe fitted with seamless tubular filter fabric shall not be dragged over the ground. If carried, the pipe shall be lifted clear of the ground and the filter fabric shall be protected from damage at all times.

      (ii) Seamless tubular filter fabric which has been so damaged as to affect its filtering properties shall be removed from the pipe and replaced with undamaged filter fabric.

      (iii) If at any time during the installation of a slotted pipe it is found that the enclosed filter fabric has become loose on the pipe it shall be restretched to its correct position. If restretching causes any damage to the filter fabric, the damaged filter fabric shall be removed from the pipe and replaced with undamaged filter fabric.

SC6.4.6.22 Pavement markings

SC6.4.6.22.1 Introduction

(1) Scope

This sub-section provides standards, advice and guidelines for the removal, setting out, supply and application of pavement marking paint, thermoplastic pavement marking material, pavement marking tape and raised pavement markers. Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

(2) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-section

SC6.4.6.30 - Control of traffic

(b) Australian Standards

AS 1580.205.4	*- Paints and related materials – Methods of test – Application properties – Airless spraying*
AS 1906.3	*- Raised pavement markers (retroreflective and non-retroreflective)*
AS 2009	*- Glass beads for pavement-marking materials*
AS 2700	*- Colour Standards for general purposes*
AS 4049.1	*- Solvent-borne paint - For use with surface applied glass beads*
AS 4049.2	*- Thermoplastic pavement marking materials - For use with surface applied glass beads*
AS 4049.3	*- Waterborne paint - For use with surface applied glass beads*

(c) Queensland Department of Transport and Main Roads Publications

Manual of Uniform Traffic Control Devices (MUTCD)

Guide to pavement markings (GTPM)

Q513 *Wet Film Thickness of Paint (Wheel Gauge), Materials Testing Manual*

MRS45 *Road Surface Delineation*

Traffic and Road Use Management Manual (TRUM):

- TRUM 1.34 - Coloured surface treatments for bicycle lanes, Volume 1: Signing and pavement marking
- TRUM 3.23 - School zones, Volume 3: Road Safety

(d) Other

Australian Paint Approval Scheme – Specification 0041/4 - Roadmarking paint, thermoplastic

Australian Paint Approval Scheme – Specification 0041/5 - Roadmarking paint, water borne

(3) Type of markings

Details of the various types of pavement markings and devices are in accordance with the requirements of the MUTCD, TRUM and GTPM.

Colours

White paint must have a colour equivalent to or whiter than Off White, Colour Y35 in AS2700.

Where yellow is used, the colour shall be equivalent to Y12, Wattle or Y14, Golden Yellow as detailed in AS 2700 or any other colour deemed to lie between these two colours.

Where Green is used as a coloured surfacing on bicycle lanes, guidance on the application of green coloured surface treatments is contained within TRUM 1.34. The colour must be equivalent to Emerald, Colour G13; Traffic Green, Colour G16 or Shamrock, Colour G23 in AS2700. Where only one shade of each colour is specified, Traffic Green, Colour G16 is used.

(4) Types of materials to be applied

The materials shall be applied as follows:

(a) Pavement marking paint
Permanent markings on all wearing surfaces. Temporary markings, other than on the final wearing surfaces. Traffic islands and kerbs where specified;

(b) Thermoplastic pavement marking material
Permanent markings where explicitly indicated on the drawings;

(c) Pavement marking tape
Temporary markings on final wearing surfaces;
Temporary raised pavement markers (TRPMs);
Temporary markers fixed on any surface as a temporary marking.

(d) Reflective glass beads
To be applied to all painted and thermoplastic markings; and

(e) Raised pavement markers
Studs which may be retroreflective (RRPM) or non-retroreflective (NRPM) set into the roadway or attached to the road surface with adhesives, lane dividers, or pavement bars are installed as permanent as shown on the drawings.

(5) Material quality
The Contractor shall submit to the Superintendent NATA Registered Laboratory Test Reports, at least 7 days before work is scheduled to commence, on the quality of the materials, including paint, glass beads, raised pavement markers and thermoplastic material proposed for use.
Only materials conforming to the requirements of the referenced Specifications/Standards shall be used.

(6) Setting out
The Contractor shall set out the work "spotting" to ensure that all markings are placed in accordance with the drawings.
The locations of pavement markings shall not vary by more than 20 mm from the locations shown on the drawings. Spotting for longitudinal lines is generally at 10 metre intervals with 3 metre intervals on curves of less than 50 m radius.
The contractor must obtain approval from the administrator of the spotting prior to any application of pavement marking.

(7) Surface preparation
Surfaces which are to receive pavement markings shall be cleaned of all dirt, loose material and other contaminants. Pavement surfaces shall be thoroughly dry immediately prior to the application of pavement markings. Pavement marking shall not be carried out during wet weather or, if rain is likely to fall during the process.
In all cases, the reinstatement of longitudinal markings, particularly barrier lines and dividing lines, should occur as soon as possible after the new seal has been laid.
Where raised pavement markers are specified for pavements having a concrete wearing surface, the full area under each raised pavement marker shall be lightly scabbled to remove fine mortar material (laitance).
All painted markings whether installed by machine or hand are retroreflectorised by the application of drop-on glass beads (ballotini).

(8) Provision for traffic and protection of work
In accordance with MUTCD, Part 3 Works on Roads, and SC6.4.6.30 Control of traffic while undertaking the work and shall protect the pavement markings until the material has hardened sufficiently (no pick-up) so that traffic will not cause damage.

(9) Maintenance of pavement markings
The Contractor shall be responsible for the maintenance, and replacement if necessary, of raised pavement markers and all pavement marking during the contract period and the contract defects liability period.
Council requires all linemarking to be refreshed prior to to the end of the Defects Liability Period.

SC6.4.6.22.2 Pavement marking paint

(1) Materials

Paint shall comply with the requirements of AS 4049.1 or AS 4049.3. In this sub-section, the term “paint” shall mean “pavement marking paint”.

Glass beads shall comply with the requirements of AS 2009 for drop-on beads.

(2) Mixing of paint

All paint shall be thoroughly mixed in its original container before use in accordance with the manufacturer’s recommendations to produce a smooth uniform product consistent with the freshly manufactured product.

(3) Application of paint and beads

All longitudinal lines shall be sprayed by an approved self-propelled machine. Line must have uniform thickness and intensity. Two coats of paint and glass beads shall be applied on longitudinal lines to new surfaces. The first coat shall be cured to “no pick up time” prior to the application of the second coat. The two sets of lines forming a one way or two way barrier line pattern shall be sprayed concurrently.

Hand spraying with the use of templates to control the pattern and shape shall be permitted for transverse lines, symbols, legends, arrows and chevrons.

The paint shall be applied uniformly and the wet film thickness shall be neither less than 0.35 mm nor more than 0.40 mm.

Glass beads shall be applied by air propulsion to the surface of all longitudinal lines at a net application rate of 0.30 kilograms per square metre immediately after application of the paint. The actual application rate shall be set to overcome any loss of beads between the bead dispenser and the sprayed line.

Glass beads shall be similarly applied to all other paint markings at a net application rate of 0.30 kilograms per square metre immediately after application of the paint by an applied method.

Pavement markings shall be straight or with smooth, even curves where intended. All edges shall have a clean, sharp cut off. Any marking material applied beyond the defined edge of the marking shall be removed leaving a neat and smooth marking on the surface of the pavement.

The lengths and widths of longitudinal lines and transverse lines must be within the tolerance specified in MUTCD/ GTPM and MRST 45.

The dimensions of arrows, chevrons and speed markings must be within the tolerances specified in MUTCD/ GTPM as appropriate.

Arrows and speed markings shall be placed square with the centreline of the traffic lane.

Glass beads shall be uniformly incorporated in all coats of paint concurrently with the application of the paint.

Longitudinal line marking, when applied, must have a minimum retroreflectivity of 350 mcd/ lux/m2 measured between 10 and 20 days of wear.

(4) Field testing

The thickness of the wet film applied to the road pavement shall be checked by the method described in AS 1580, comb gauge or test Q513 – (07/10).

The application rate of glass beads applied to the surface of the markings shall be checked by the method described in SC6.4.6.22 Attachment A Procedure for measurement of rate of application of spherical glass beads.

(5) Application rates

The minimum application rates for the paint and glass beads shall be as specified in Table SC6.4.22.1.

Table SC6.4.6.22.1 Application rates for paint and glass beads

Work type	Coverage (minimum per coat)	Wet application rate
Longitudinal lines – first coat Type B (drop on beads)	> 300 g/m^2	0.375 lit/m^2 ± 0.25
Longitudinal lines – second coat Type B (drop on beads)	> 300 g/m^2	0.375 lit/m^2 ± 0.25
Longitudinal lines – repaint Type B (drop on beads)	> 200 g/m^2	0.300 lit/m^2 ± 0.20
Longitudinal lines – second coat or repaint applying Type D beads	> 400 g/m^2	0.500 lit/m^2 ± 0.25
Transverse lines – Type B (drop-on beads)	> 300 g/m^2	0.375 lit/m^2 ± 0.25
Transverse lines – Type D beads	> 400 g/m^2	0.500 lit/m^2 ± 0.25

Source: MRTS 45

The combination application rates for anti skid and glass beads shall not exceed the values specified above and in SC6.4.6.22.2(6) unless specified by the manufacturer.

Table SC6.4.6.22.2 Volume of glass beads (ml) required in 10 seconds of operation

Road Speed km/h	Line Widths			
	75mm	**100mm**	**125mm**	**150mm**
8	371	495	619	742
13	603	804	1006	1207
16	742	990	1238	1484

Note—

1. Tolerance of +10% shall be permissible when measuring the above volume.
2. When two or more glass bead dispensers are to be used, each dispenser shall be checked separately to make up the totals shown.
3. Glass beads weigh approximately 1.53 grams per millilitre.

(6) Anti skid

Transverse markings shall incorporate an anti skid treatment with a skid resistance greater than 45 BPN. The application of anti-skid shall comply with the manufacturer's requirements.

SC6.4.6.22.3 Thermoplastic pavement marking material

(1) Primer

A primer, of the type recommended by the manufacturer of the thermoplastic material, shall be applied to the surface immediately in advance of, but concurrent with, the application of thermoplastic material.

The primer shall be applied at the application rate recommended by the manufacturer and shall not be thinned.

(2) Application of thermoplastic material

Thermoplastic material may be applied by screeding, extrusion or profiling or as preformed material.

Thermoplastic material shall be applied to the pavement at a temperature between 180ºC and 200ºC unless a different temperature is recommended by the manufacturer.

The pavement surface to which thermoplastic material is applied shall be completely coated by the material and any voids in the pavement surface shall be filled.

(3) Application rate

Thermoplastic material shall be applied at the minimum thickness specified in Table SC6.4.6.22.3.

Location	Minimum application thickness (mm)
Longitudinal lines	2
Transverse markings	2

Editor's note - the term “thermoplastic material” shall mean “thermoplastic pavement marking material”.

Where specified, glass beads shall be applied immediately to the surface of the molten thermoplastic material at a rate of not less than 0.12 kg/m2.

(4) Materials

Thermoplastic pavement marking material shall comply with the requirements of AS 4049.2.

Glass beads shall be incorporated in thermoplastic material, in the proportion of 10 per cent of the total mass, as part of the aggregate constituent and shall comply with the requirements of AS 2009, Intermix type.

Glass beads for surface application shall comply with the requirements of AS 2009, Drop-on beads.

Tack coat material shall be to the manufacturer's specification.

(5) Preparation of thermoplastic material on site

Immediately before application, the thermoplastic material shall be uniformly heated in a suitable oil bath kettle to the temperature recommended by the manufacturer. The thermoplastic material shall not be heated above the temperature recommended by the manufacturer. The thermoplastic material shall not remain molten for more than 6 hours for hydrocarbon resins and 4 hours for wood and gum resins. Should over-heating occur and/or the time expire for molten materials, then the thermoplastic material shall be discarded.

(6) Application of thermoplastic material and beads

Where the wearing surface of the pavement is smooth or polished, a tack coat of material may be required by the Superintendent and shall be applied in accordance with the recommendations of the thermoplastic manufacturer. The tack coat shall be applied immediately before the application of the thermoplastic material in accordance with the directions of the manufacturer of the thermoplastic material and the manufacturer of the tack coat material.

All longitudinal lines shall be sprayed by a self propelled machine. The two sets of lines forming a one way or two way barrier line shall be sprayed concurrently. The thermoplastic material shall be applied uniformly and the cold film thickness shall be 2.0 mm with a tolerance of plus or minus 0.5 mm.

Glass beads shall be applied by air propulsion to the surface of all longitudinal lines at a net application rate of 0.30 kilograms per square metre immediately after application of the thermoplastic material. The actual application rate shall be set to overcome any loss of beads between the bead dispenser and the sprayed line.

All transverse lines, symbols, legends and arrows shall be screeded. The screeded thermoplastic material shall be applied using a mobile applicator, and templates to control the pattern.

Preformed thermoplastic sheeting applied in accordance with manufacturer’s specifications is an approved process.

The thermoplastic material for transverse lines, symbols, legends and arrows shall be applied uniformly and the cold film thickness shall be 3.5 mm with a tolerance of plus or minus 1.5 mm. The surface finish shall be smooth.

Glass beads for other than longitudinal lines shall be uniformly applied to screeded markings at a net application rate of 0.30 kilograms per square metre immediately after application of the thermoplastic material.

Pavement marking shall be straight or with smooth, even curves where intended. All edges shall have a clean, sharp cut off. Any marking material applied beyond the defined edge of the marking shall be removed leaving a

neat and smooth marking on the wearing surface of the pavement.

The lengths of longitudinal lines shall not vary by more than 20mm from the lengths shown in MUTCD/ GTPM. The widths of longitudinal lines shall not vary by more than 10mm from the widths shown in MUTCD/ GTPM. The lengths and widths of transverse lines shall not vary by more than 10mm from the lengths and widths shown in MUTCD/ GTPM.

The dimensions of arrows, chevrons and speed markings shall not vary by more than 50mm from the dimensions shown on the drawings or in MUTCD/ GTPM as appropriate. Arrows and speed markings shall be placed square with the centreline of the traffic lane.

(7) Field testing

The thickness of the cold film of thermoplastic material applied to the road pavement shall be checked by measurement, using a micrometer, of the thickness of thermoplastic material applied to a metal test plate. The application rate of glass beads applied to the surface of the markings shall be checked by the method described in SC6.4.6.22 Attachment A Procedure for measurement of rate of application of spherical glass beads.

SC6.4.6.22.4 Pavement marking tape

(1) Materials

Pavement marking tape shall be a strippable type of tape, such as “Staymark Detour Grade”, or equivalent tape approved by the Superintendent. Pavement marking tape must only be used on temporary works.

(2) Application of pavement marking tape

The method of application of pavement marking tape, including surface preparation, shall be in accordance with the manufacturer's recommendations.

(3) Removal of pavement marking tape

When directed by the Superintendent, the Contractor shall remove pavement marking tape in accordance with the manufacturer's recommendations.

(4) Temporary raised pavement markers (TRPMs)

Temporary raised pavement markers must comply with the requirements of AS 1906.

Temporary raised pavement markers may be used to mark the temporary travelled path at short-term work sites, or to indicate the permanent travelled path on new work prior to the application of permanent pavement markings.

The use of temporary raised pavement markers may preclude the need for spotting where existing markings are to be reinstated after a reseal, and for respotting if proposed line markings were set out before the final seal on new works is applied. In these cases, the distance between TRPMs should be the same as would apply for spotting.

Temporary raised pavement markers should not take the place of spotting, as TRPMs may be broken off by traffic before final marking can be carried out. Once the longitudinal lines have been marked, the Temporary raised pavement marker flaps can be removed by cutting them off flush with the pavement surface.

SC6.4.6.22.5 Raised pavement markers

(1) Materials

Raised pavement markers, both reflective and non reflective, shall comply with AS 1906.3 and shall have the dimensions shown on the drawings.

The adhesive used for attaching the raised pavement markers to the wearing surface of the pavement shall be a hot melt bitumen adhesive or an equivalent product approved.

(2) Installation of raised pavement markers

The use of raised retroreflective pavement markers must be in accordance with the MUTCD, GTPM and TRUM 1.25 Fire Hydrant Indication System.

Raised pavement markers shall be fixed to the wearing surface of the pavement using a hot melt bitumen adhesive or an equivalent product. The adhesive shall be freshly heated to the manufacturer's instructions and thoroughly mixed.

The adhesive shall be spread uniformly over the underside of the raised pavement marker to a depth of approximately 10mm. The raised pavement marker shall be pressed down onto the pavement surface in its correct position and shall be rotated slightly until the adhesive is squeezed out around all edges of the marker. The raised pavement marker shall not be disturbed until the adhesive has set.

On rough surfaces, such as newly laid coarse sprayed bituminous seals, an initial pad of adhesive of diameter 20 mm larger than the diameter of the base of the raised pavement marker, shall be provided. The adhesive shall be applied to fill the irregularities in the pavement surface to produce a flat, smooth surface flush with the upper stone level. The adhesive pad shall be allowed to set. Additional adhesive shall be applied to the pavement, as described above, and then the raised pavement marker shall be pressed down onto the adhesive pad on the pavement surface to ensure good adhesion.

When installed, raised pavement markers shall conform to the tolerances specified in Table SC6.4.6.22.4.

Table SC6.4.6.22.4 Tolerances - raised pavement markers

	Tolerance (mm)	**Distance**
Lateral position –	+ 25, - 50	from edge of line
• barrier/edge line	± 10	from edge of line
• broken line	± 10	from centre of line
• flush medians		
Longitudinal position –	± 10	1 m from start of line
• broken line	± 100	1 m from start of line
• new construction	± 300	1 m from start of line
• replacement		

(1) General

The Contractor shall remove pavement markings, no longer required, from the wearing surface of pavements without significant damage to the surface.

Where required, existing pavement markings must be removed by the appropriate method stated in Table SC6.4.6.22.5.

The method of removal shall be submitted to the Superintendent for approval before commencement of the work.

Table SC6.4.6.22.5 Method of removal of existing pavement marking

Method of removal	**Duration of result**
Black paint	< 1 week
Emulsion and sand	< 2 weeks
Black cold applied resin or plastic	< 6 months
Chip seal	Permanent
Line grinder (asphalt only)	Permanent
Profiler (asphalt only)	Permanent
Abrasive blasting	Permanent

SC6.4.6.22.7 Surface treatments for bicycle lanes and school zone threshold

(1) Coloured surface treatments for bicycle lanes

Refer to the Traffic and Road Use Management Manual - Coloured Surface Treatments For Bicycle Lanes.

(a) The preferred colour is G13 Emerald (AS 2700 S 1996). To accommodate different materials and varying conditions, an approximate colour match to one of the following three AS 2700 S greens is permitted - G13 Emerald, G16 Traffic green or G23 Shamrock. Approximate colour match is determined in accordance with AS/NZ1580.601.1.

(b) A consistent green colour should be provided along a route or within a given locality.

(c) Where green surface colouring is used, it should be continuous through the required area and be bounded by the bicycle lane lines. Pavement markings, such as bicycle symbols and any directional arrows, should be placed over the coloured surface.

(d) A coloured surface treatment needs to do more than just provide a colour contrast. It must be designed to function like any other road surfacing, providing a sound, durable surface layer, which maintains the required texture and skid resistance for its design life.

(e) The design and specification of a coloured surface treatment for bicycle lanes should:

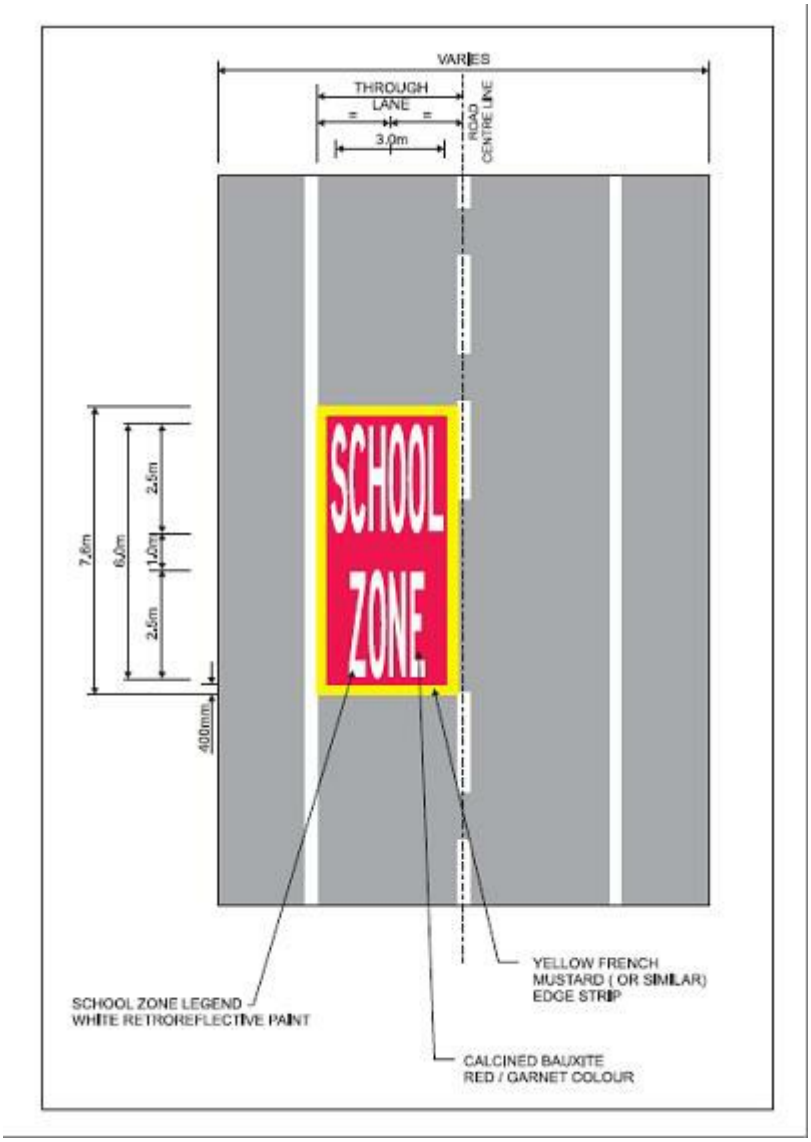
- ensure the suitability of the existing surface to support and bond with the colour treatment;
- provide a surface texture and skid resistance suitable for bicycle use, including in wet conditions; and
- limit differential skid resistance between the bicycle lane and adjacent traffic lanes.

(f) The Department of Transport and Main Roads is considering development of a formal specification for coloured surface treatments for Queensland. Until this is available it is recommended that advice on performance requirements, and the suitability of any product or service being considered for use, be sought from the Superintendent for approval before commencement of the work.

(2) Surface treatments for school zone thresholds

Refer to the Traffic and Road Use Management Manual - 3.23 Traffic and Road Use Management Manual - School Zones.

Threshold treatments may be provided at entrances to school zones to create a change in driver perception of the speed environment. A typical threshold treatment for a school zone is shown in Figure SC6.4.6.22.1.



Source:TRUM.

Figure SC6.4.6.22.1 Typical threshold treatment for a school zone

Advice on performance requirements, and the suitability of any product or service being considered for use, is to be sought from the Superintendent for approval before commencement of the work.

The pavement marking treatment (set out, type of material, preparation of surface, rate of application, method of application and maintenance) must be submitted to the Superintendent for approval before commencement of the work.

SC6.4.6.22.8 Limits and tolerances

The limits and tolerances applicable to the various clauses of this Specification are summarised in Table SC6.4.6.22.6 – Summary of limits and tolerances below:

Table SC6.4.6.22.6 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	**Location of Markings**	± 20mm from specified location	SC6.4.6.22.1(6)
2.	**Longitudinal Lines**		
	(a) Length	± 20mm from lengths shown in MUTCD/MRDGPM	SC6.4.6.22.2(3) SC6.4.6.22.3(3)

	(b) Width	± 10mm from widths shown in MUTCD/MRDGPM	SC6.4.6.22.2(3) SC6.4.6.22.3(3)
3.	**Transverse Lines**		
	(a) Length	± 10mm from lengths and widths shown in MUTCD/MRDGPM	SC6.4.6.22.2(3)
	(b) Width		SC6.4.6.22.2(3)
4.	**Arrows, Chevrons, Speed Markings etc.**	± 50mm from the dimensions shown in MUTCD/MRDGPM	SC6.4.6.22.2(3) SC6.4.6.22.3(3)
5.	**Application of Paint**		
	(a) Film Thickness	>0.35mm <0.40mm	SC6.4.6.22.2(3)
6.	**Application of Thermoplastic**		
	(a) Longitudinal Lines Cold Film Thickness	2.0mm ± 0.5mm	SC6.4.6.22.3(3)
	(b) Transverse Lines, Symbols, Arrows etc. Cold Film Thickness	3.5mm ± 1.5mm	SC6.4.6.22.3(3)
7.	**Glass Beads**		
	(a) Volume used in operation	0.30 kg/sq m + 10%	SC6.4.6.22.2(3) SC6.4.6.22.3(3)

Attachment A Procedure for measurement of rate of application of spherical glass beads

Attachment A: Procedure for measurement of rate of application of spherical glass beads

(1) **Scope**

The following procedure shall be adopted for field measurement of the rate of application of spherical glass beads on to wet paint or thermoplastic surfaces.

(2) **Spherical Glass Beads**

The glass beads shall comply with AS 2009.

(3) **Measurement**

The method of field measurement shall be as follows:

(a) Turn off the paint or thermoplastic supply valves and operate the glass bead dispenser for exactly 10 seconds allowing glass beads to run into a plastic bag or tray.

(b) Pour the glass beads from the bag or tray into a suitable measuring cylinder calibrated in millilitres to measure the volume of glass beads collected. Level but do not compact the glass beads in the cylinder.

(c) Compare the volume of glass beads collected with the correct figure given in Table SC6.4.6.22.1 - Volume of Glass Beads (ml) required in 10 seconds of operation. Table SC6.4.6.22.1 - Volume of Glass Beads (ml) required in 10 seconds of operation shows the correct volumes of glass beads required to give a net application rate on the marked line of approximately 0.30 kilograms per square metre for different line widths and road speeds. The glass bead volume figures given in Table SC6.4.6.22.1 - Volume of Glass Beads (ml) required in 10 seconds of operation are calculated for an actual application rate of 0.34 kilograms per square metre.

(d) These figures are used for calibrating the machine because there is a loss of beads between the bead

dispenser and the marked line and

(e) The volume is measured with beads not compacted.

SC6.4.6.23 Guide posts

SC6.4.6.23.1 Introduction

(1) Scope

This policy sub-section provides standards, advice and guidelines for the setting out, supply of all materials and erection of guide posts in areas where street lighting is not provided to maintain safety of movement network.

(2) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-section
SC6.4.6.30 - Control of traffic

(b) Australian Standards
AS 1906.2 - *Retroreflective devices (non-pavement application)*

(c) Queensland Department of Transport and Main Roads specifications
MRS14 *Road Furniture*

SC6.4.6.23.2 Materials

(1) General

Guide posts shall be a proprietary metallic or flexible (driveable or non-driveable) post.

The surface of all posts shall have a gloss or semi-gloss white finish. The surface shall be smooth and easily cleaned.

Proprietary posts shall be minimum 1500 mm in length and shall have one face of a minimum 80 mm width.

(2) Proprietary posts

Where a proprietary metallic or flexible guide post is proposed, the Contractor shall supply details of the proposed guide post including the manufacturer's recommended installation procedure, technical specifications and test certificates for approval by the Superintendent.

(3) Delineators

Corner-cubed delineators, conforming to AS 1906.2 shall be attached to each post.

The delineators shall conform to MRS14 *Road Furniture*.

SC6.4.6.23.3 Construction

(1) General

The Contractor shall at all times conform to the requirements of sub-section SC6.4.6.30 Control of traffic.

Where the shoulder is in embankment or at natural surface level, the guide posts shall be placed near the outer edge of the shoulder and at a uniform distance, minimum 1 m, from the pavement edge line. Where the shoulder is located in a cutting, the guide posts shall be placed on the road pavement side of the table drain, and minimum 1 m from the pavement edge line, in such a manner as not to impede the flow of water in the drain.

Guide posts shall be erected at the locations shown on the Drawings. Underground services laid in proximity to the guide posts shall be located prior to erection of posts all care shall be taken not to damage such services.

(2) Erection of guide posts

Guide posts shall be set vertically in the ground to a depth of approximately 500 mm. In order to offset shoulder irregularities this depth shall be varied so as to give uniform display of guide posts to a height of approximately 1000 mm above ground level, with the tops evenly graded. Each guide post shall be erected with the widest face at right angles to the centre line of the road.

Allowance shall be made in the height of guide posts above the ground for the effects of superelevation and other road geometry in order to keep the guide posts within the range of the beam of vehicle headlights.

Backfilling shall be compacted in layers of depth not more than 150 mm for the full depth of the guide posts up to ground level. The density of the compacted backfilling shall not be less than that of the adjacent undisturbed ground. Guide posts shall be firm in the ground to the satisfaction of the Superintendent.

Proprietary guide posts, when installed in the ground in accordance with the recommendations of the manufacturer, shall resist overturning, twisting and displacement from wind and impact forces. The Contractor shall provide the Superintendent the manufacturer's instructions for anchorage.

If the guide posts are proposed to be installed on concrete pavements, the Contractor shall provide the Superintendent details of fixing the guide posts to the concrete prior installation.

All necessary steps shall be taken to prevent people and stock from stepping into the post holes during the erection of the guide posts.

(3) Delineators

"Corner Cubed" delineators, complying with AS 1906.2, shall be attached to each guide post using one way, anti-theft screws or rivets etc. In the case of proprietary posts, the delineators shall be glued or otherwise fastened to the post in such a manner that they are not dislodged or rendered inactive under vehicular impact.

The delineators shall be mounted so that the top of the reflector is 100 mm below the top of the guide post.

The delineators shall be so arranged that drivers approaching from either direction will see only red delineators on their left side and white delineators on their right side.

SC6.4.6.24 Signposting

SC6.4.6.24.1 Introduction

(1) Scope

This sub-section provides standards advice and guidelines for:

(a) the supply and erection of the regulatory, warning, guide, information and direction signs as described in Manual of Uniform Traffic Control Devices MUTCD.

(b) the supply and erection of sign support structures to support the signs, and

(c) the adjustment of existing signs and sign support structures.

Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

(2) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this sub-section are as follows:

SC6.4.6.28 - Minor concrete works

SC6.4.6.30 - Control of traffic

(b) Australian Standards

AS 1163	*Cold-formed structural steel hollow sections*
AS 1214	*Hot-dip galvanised coatings on threaded fasteners (ISO metric coarse thread series)*
AS 1379	*Specification and supply of concrete*
AS/NZS 1554.1	*Welding of steel structures*
AS/NZS 1580.602.2	*Measurement of specular gloss of non-metallic paint films at 20 degrees, 60 degrees and 85 degrees*
AS 1580.108.2	*Dry film thickness - Paint inspection gauge*
AS/NZS 1734	*Aluminium and aluminium alloys - flat sheet, coiled sheet and plate*
AS/NZS 1866	*Aluminium and aluminium alloys - extruded rod, bar, solid and hollow shapes*
AS 2700	*Colour standards for general purposes*
AS/NZS 3678	*Structural steel - hot-rolled plates, floorplates and slabs*
AS/NZS 3679.1	*Structural steel - hot-rolled bars and sections*
AS 3990	*Mechanical equipment - Steelwork*
AS/NZS 4680	*Hot-dip galvanised (zinc) coatings on fabricated ferrous articles*

(c) Queensland Department of Transport and Main Roads Publications

Manual of Uniform Traffic Control Devices (MUTCD)

Traffic and Road Use Management Manual (TRUM)

(3) Provision for traffic

The Contractor shall provide all necessary traffic safety measures in accordance with the requirements of sub-section SC6.4.6.30 Control of traffic while undertaking the work and shall organise the work to avoid or minimise delays and inconvenience to traffic.

Where a sign is erected before its intended use by traffic and is visible to traffic, the face of the sign shall be completely and securely wrapped in porous cloth sheeting or other opaque covering material approved by the Superintendent, until the Superintendent directs that the sign shall be uncovered.

SC6.4.6.24.2 Materials

(1) General

The Contractor shall advise the names of the proposed suppliers of signs and sign support structures for the Superintendent's concurrence. Only suppliers who have previously established or can now establish their competence to carry out the work in accordance with this sub-section shall be used.

The Contractor shall supply documentary evidence, satisfactory to the Superintendent that all materials and parts proposed for use comply with the requirements of the appropriate Australian Standard(s) as stated in this policy sub-section.

Details of the signs and sign support structures to be provided under the Contract shall be as shown on the drawings.

The dimensions, legend and background for each sign shall be in accordance with this sub section and the drawings.

(2) Sign blanks

Sign blanks shall be 1.6 mm thick aluminium sheet alloy. The aluminium alloy shall be Type 5251 or Type 5052 and Temper H38 or Temper H36 in accordance with AS 1734.

Sign blanks shall be free of cracks, tears and other surface blemishes and the edges shall be true and smooth. The dimensions of the sign blank shall be within plus or minus 1.5 mm of the dimensions specified and the finished sign shall be flat within a maximum allowable bow of 0.5 per cent of the maximum dimension of the sign blank in any direction.

Sign blanks shall be one piece except where the sign is of such a size as to require more than one full sheet of aluminium in which case a multipiece sign shall be allowed.

A multipiece sign shall be made up of the minimum number of pieces practical and sheets of the multipiece sign shall be butted together with a maximum gap of 1 mm at any point along the joint.

All joints shall be covered by a backing strip. The backing strip shall be riveted to each sheet with rivets, coloured to match the background material on the face of the sign, at a spacing not exceeding 200 mm. Backing strips shall be of the same material and colour as used for the sign blank and shall have a minimum width of 50 mm over the full length of the joint.

The aluminium extrusion used for mounting may be used as the backing strip for horizontal joints where it complies with the spacing requirements.

The face of each sign blank shall be chemically cleaned and etched or mechanically abraded. Where the sign blank is to receive a paint background, the face shall be spray painted with a compatible etch primer.

The back of each sign blank shall be uncoated and the surface finish shall be rendered dull and non reflective either by mechanical or chemical means and shall be free of scratches and blemishes.

Signs shall be supplied with square holes or aluminium extrusion backing for mounting purposes, at the centre spacings as shown on the drawings.

(3) Aluminium extrusion backing

The signs shall include special aluminium extruded sections for mounting purposes. The aluminium shall be Type 6063 T5 in accordance with AS 1866.

The aluminium extrusion shall be fixed at the centre spacings as shown on the drawings and shall be riveted to the sign blank with correctly coloured rivets at a spacing not exceeding 200 mm.

(4) Retro-reflective material for background and legend

Retro reflective material shall conform in colour and class to the requirements of AS 1743 and Table 1 in Section 1.2 of DTMR’s Traffic and Road Use Management manual for Class 1, Class 2 and Class 2A materials. Unless shown otherwise on the drawings, the material shall be Class 2.

(5) Non-reflective background material

(a) Background paint

Background paint shall be an approved long life industrial quality, two compound polyurethane paint. The paint shall exhibit high standards of adhesion, abrasion resistance, resistance to weathering and colour fastness under widely varying conditions of exposure. The paint shall be compatible with the etch primer used on the sign blank.

The paint shall be applied using conventional air spray application to give a uniform cover free of blemishes. A minimum dry film thickness of 38 microns is required when tested in accordance with AS 1580.108.2.

Background paint shall be as specified from one of the following colours:

(i) White Gloss

(ii) “Dark” Green Matt Colour No G61 as specified in AS 2700.

(iii) “Tourist” Brown Matt Colour No X65, Dark Brown, as specified in AS 2700.

(iv) “Dark Grey” Matt Colour No N64, Dark Grey as specified in AS 2700.

(b) Background sheet material
Adhesive cast vinyl sheet material or other equivalent material approved by the Superintendent may be used in place of background paint.

(c) The material shall be of uniform density and compatible with the material used for the legend both in application and durability.

The colours and gloss levels shall be uniform and conform to the requirements of clause SC6.4.6.24.2(5)(a) Background paint.

(6) Non-reflective material for legend

(a) Legend screening ink
Screening ink shall be a high quality, full gloss, non fade, non bleed and scratch resistant type of ink compatible with the material to which it is applied. Screening ink shall have durability at least equal to the material to which the screening ink is applied.

(b) Legend sheet material
Adhesive cast vinyl sheet material or other equivalent material approved by the Superintendent may be used in place of screening ink. The material shall be of uniform density and compatible with the material used for the background both in application and durability.

(c) Colours and finish
The requirements of clause SC6.4.6.24.2(5)(a) Background paint shall also apply to non reflective materials for legends but additional colours complying with AS 2700 may be specified.

(7) Rivets
Each rivet shall consist of a domed head and shank made of aluminium alloy and a steel mandrel which is discarded after securing the rivet.

A paint coating shall be applied to the domed head so that when the rivet is in position it will show the same colour as the material to which it is attached. Paint may cover the shank of the rivet, providing the coating thickness does not restrict the insertion of the shank into the standard drilled hole for that rivet.

The paint shall be an alkaloid enamel, which shall be applied after an appropriate treatment of the shank of the rivet to ensure long lasting adhesion.

(8) Reference markings
All signs shall be clearly and permanently stamped or engraved with an identification coding. The coding shall appear in ciphers of height neither less than 6 mm nor more than 10 mm on the rear of the sign and shall be carried out in such a manner that the front face of the sign is not damaged.

Manufacturers shall include coding information in the following format:

(a) sign reference number;

(b) manufacturer's name;

(c) month and year of manufacture; and

(d) manufacturer and class of retro reflective material.

(9) Sign support structures

(a) General

Sign support structures shall be fabricated from steel sections which shall comply with the requirements of AS 1163, AS 3678 and AS 3679.1.

Signs support structures shall be standard round galvanised posts of 50, 65 or 80 mm nominal bore or purpose designed steel structures as shown on the drawings and manufactured in accordance with the requirements of AS 1250.

Splices in members shall be restricted to a maximum of one splice per member. Splices shall be full penetration butt welds.

All welding shall be as shown on the drawings and in accordance with the requirements of AS 1554.1, Category GP.

(b) Protective treatment

Except for standard galvanised posts, all steel components including brackets shall be protected by hot dip galvanising after all fabrication processes are completed.

The steel components shall be finished by the hot dip galvanising process in accordance with AS/NZS 4680 to provide an average minimum coating thickness of 85 microns and a bright finished surface free from white rust and stains.

Bolts, nuts and washers and brackets shall be galvanised in accordance with AS 1214.

Splices in standard galvanised posts shall be painted by using an organic zinc rich primer, or inorganic zinc silicate paint, in accordance with the repair requirements in Appendix E of AS/NZS 4680.

Scratched and slightly damaged surfaces of galvanised coatings shall be renovated by using an organic zinc rich primer, or inorganic zinc silicate paint, in accordance with the repair requirements in Appendix E of AS/NZS 4680.

This method of renovation shall be restricted to areas not exceeding 2500 square millimetres on any one structure. Any structure with totally damaged coating areas exceeding 2500 square millimetres shall be regalvanised by the Contractor.

(c) Attachment of signs

Posts and other components shall be provided with the required sign attachment holes or fittings to suit the typical attachment systems as shown on the drawings. Sign panels shall be attached to each supporting member at each extrusion section or bolt hole in the sign panel.

The Contractor shall submit details of the proposed attachment systems for the Superintendent's approval.

SC6.4.6.24.3 Erection of new signs

(1) Setting out

The location of signs shall be as shown on the drawings or as directed by the Superintendent. The Contractor shall set out the work to ensure that all signs and support structures are placed in accordance with the drawings or as directed by the Superintendent.

Signs shall be aligned approximately at right angles to the direction of the traffic they are intended to serve. On curved alignments, the angle of placement should be determined by the course of approaching traffic rather than the orientation of the road at the point where the sign is located. Parking signs will generally be aligned at

45 degrees to the kerb line if not otherwise specified on drawings.

The Contractor shall submit details of and set out, for the Superintendent's inspection and approval, the proposed location and alignment of each sign support structure.

Work on the foundations of the sign support structure shall not commence until the Superintendent has approved the location and alignment of the sign support structure.

The Contractor is responsible in locating existing underground services in proximity of the signs prior to placement of footings and erection of signs to protect services from damage

(2) Clearing

The Contractor shall advise the superintendent of any trees and undergrowth within 3 m of the sign support structure and along a driver's line of sight to the front of the sign that are required to be cleared and removed. On receipt of this advice from the superintendent, council will inspect and advise what action is to be taken by the contractor.

(3) Sign structure footings

The footings for a simple pipe support or the footings for each post of a purpose-designed sign support structure shall be constructed in accordance with the drawings or as directed by the Superintendent.

The footings shall be neatly excavated to the depth and width shown on the drawings. The material from the excavation shall be disposed of in a responsible and legal manner.
When anchor bolt assemblies are specified they shall be accurately placed and firmly supported. Anchor bolt assemblies shall be provided with levelling nuts under the sign structure baseplates to allow adjustment of the structure after installation.

Steel reinforcement shall be placed as shown on the drawings.

Concrete in the footings of sign support structures shall comply with sub-section SC6.4.6.28 Minor concrete works and have a minimum compressive strength at 28 days of 20 MPa for pipe support footings and 32 MPa for purpose-designed support footings.

If ready mixed concrete is used, the concrete shall be mixed and delivered in accordance with AS 1379.

(4) Erection

All components shall be accurately positioned and supported during erection.

The top of each pipe support post shall extend sufficiently beyond the upper extrusion section or bolt holes on the sign panels to enable attachment of the signs. The top of each post shall be below the top edge of the sign panel.

For pipe support multi post installations, the tops of the posts shall be at the same level except where sign shape or the arrangement of sign panels dictates otherwise.

During erection, sign panels shall be suitably supported and braced and the sign face protected from damage. Signs damaged during erection shall be repaired to a standard equivalent to the original sign or replaced by the Contractor.

Galvanised coatings on purpose-designed support structures which are scratched or slightly damaged during erection shall be renovated by using an organic zinc rich primer, or inorganic zinc silicate paint, in accordance with the repair requirements in Appendix E of AS/NZS 4680. This method of renovation shall be restricted to areas not exceeding 2500 square millimetres on any one structure. Any structure with totally damaged coating areas exceeding 2500 square millimetres shall be regalvanised.

SC6.4.6.24.4 Adjustment of existing signs and support structures

Where shown on the drawings and where directed by the Superintendent, the Contractor shall adjust existing sign panels and sign support structures. The work shall include minor adjustments of existing sign panels and/or sign support structures or the work may extend to the dismantling of signs and sign support structures, relocation or replacement of sign support structures including footings and re erection of signs including all fittings.

SC6.4.6.24.5 Special requirements

(1) Street name, service and tourist signs

All street name, service and tourist signs shall comply with council's adopted signage system and with the details as shown on the drawings.

Proprietary signs shall be manufactured and installed in accordance with the requirements of Parts 1 and 6 of MUTCD to the following details:

(Sample only - to be completed by compiler)

(a) Colour:

(i) Legend - Blue, Non-reflective

(ii) Background - Yellow, Class 1 Retroreflective

(b) Lettering and Numerals:

(i) Font Type - Series D

(ii) Height – 100 mm

Details of council's logo shall be supplied to the Contractor by the council.

Details of the signs and legends are to be shown on the drawings.

The Contractor shall submit details of Manufacturer, all sign materials and sign attachment system to the Superintendent for approval by the council prior to commencement of sign manufacture.

SC6.4.6.24.6 Limits and tolerances

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.24.1 Summary of limits and tolerances below:

Table SC6.4.6.24.1 Summary of limits and tolerances

Item	Activity	Limits/Tolerances	Clause
1.	**Sign Blanks**		
	(a) Dimensions	± 1.50mm	SC6.4.6.24.2(2)
	(b) Bow	< 0.5% of maximum dimension	SC6.4.6.24.2(2)
	(c) Butt gap in multipiece sign	< 1mm	SC6.4.6.24.2(2)
	(d) Rivet spacing in backing strip	< 200mm	SC6.4.6.24.2(2)
	(e) Backing strip width	> 50mm	SC6.4.6.24.2(2)
2.	**Extrusion Backing**		
	(a) Rivet Spacing	< 200mm	SC6.4.6.24.2(3)
3.	**Background Paint**		
	(a) For matt coatings, gloss level	> 12% and < 15%	SC6.4.6.24.2(5)
	(b) For gloss coatings, gloss level	> 85% and < 95%	SC6.4.6.24.2(5)

Item	Activity	Limits/Tolerances	Clause
4.	**Reference Marking**		
	(a) Height of Coding	> 6mm and < 10mm	SC6.4.6.24.2(8)
5.	**Sign Support Structures**		
	(a) Protective Treatment thickness	> 100 microns	SC6.4.6.24.2(9)(b)
	(b) Paint coating over Splices in standard galvanised posts	> 100 microns	SC6.4.6.24.2(9)(b)
	(c) Damaged Surface of galvanised surfaces		
	(i) Coating with zinc rich paint	Area < 2500 sq. mm	SC6.4.6.24.2(9)(b)
	(ii) Regalvanise	Area > 2500 sq. mm	SC6.4.6.24.2(9)(b)
6.	**Clearing**		
	(a) Trees and Undergrowth to be cleared	< 3 metres from sign support structure	SC6.4.6.24.3(2)
7.	**Concrete in Foundations of Sign Support Structures**		
	(a) Strength	> 25 MPa at 28 days	SC6.4.6.24.3(3)

SC6.4.6.25 Non-rigid road safety barrier system

SC6.4.6.25.1 Introduction

(1) Scope

The work to be executed under this sub-section consists of the setting out, supply of all materials and erection of road safety barriers and terminals, in accordance with the requirements for non-rigid road safety barrier systems in TMR Road Planning and Design Manual (Chapter 8), at the locations shown on the drawings or as directed by the Superintendent.

This sub-section details the requirements for public domain non-rigid road safety barrier systems. Where a patented non-rigid road safety barrier system is specified and shown on the drawings, all materials shall be in accordance with the manufacturer's specifications and, it shall be constructed strictly in accordance with the manufacturer's instructions.

(2) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied to this sub-section are as follows:

SC6.4.6.30 Control of traffic

SC6.4.6.28 Minor concrete works

(b) Department of Transport and Main Roads Standards

Road Planning and Design Manual (RPDM) 1st edition – (Chapter 8), Safety Barriers and Road Side Furniture – as amended.

(c) Australian Standards

AS/NZS 1906.2	*Retroreflective devices (non pavement application)*
AS/NZS 3845	*Road safety barrier systems*
AS/NZS 4680	*Hot-dip galvanised (zinc) coatings on fabricated ferrous articles*

SC6.4.6.25.2 Materials

(1) Components

All steel components for public domain non-rigid road safety barrier systems, W beam and Thriebeam, shall be designed and constructed strictly in accordance with the RPDM (Chapter 8 – as amended) using crushable energy-absorbing materials and shall be of the type as shown on the drawings.

(2) Certification

Road safety barrier components shall not be erected until the Contractor has produced documentary evidence to the Superintendent that such safety barrier components conform to the requirements of this sub-section.

For galvanized steel components provide a manufacturers certificate of compliance certifying that the zinc coating mass conforms to AS/NZS 4680 or, for components of proprietary safety barrier systems or devices, to the manufacturer's recommendations.

SC6.4.6.25.3 Construction

(1) General

The Contractor shall at all times conform to the requirements of sub-section SC6.4.6.30 Control of traffic.

Construction of non-rigid road safety barrier shall comply with RPDM, except where explicit departures are approved on the drawings.

Road safety barriers shall be erected after the construction of the base on concrete pavements and after the placing of the initial layer of asphaltic concrete or sprayed seal on a flexible pavement, unless otherwise approved by the Superintendent.

The Contractor shall set out the work to ensure that all road safety barriers and terminal sections are located,

in accordance with the drawings or as directed by the Superintendent.

Underground cables and ducts laid in the road safety barrier area shall be located prior to the erection of posts and all care must be taken not to damage such cables and ducts.

The posts should be set to the full depth as shown on the drawings. If this is not possible due to the presence of an underground obstruction, an alternative method of setting the posts, as approved by the Superintendent, shall be used.

Posts shall stand vertical and the spacing shall be such that when the safety barrier is erected no post movement is necessary in order to align holes or for any other reason.

(2) Erection of steel posts

The safety barrier posts are to be located as shown on the drawings. The top of the post shall be 750mm, 845mm or 905mm as appropriate for W beam, Thrie beam or modified blockout Thrie beam respectively, above the ground level, unless otherwise shown on the drawings. On terminal ends, the level of the posts shall be such as to conform to the extended crossfall of the main pavement unless otherwise shown on the drawings.

When erected in position the posts shall be on a smooth line both horizontally and vertically with the tops of posts within ±10 mm of the heights specified in paragraph 1 of this clause.

Steel posts shall be erected by driving, or by other means, as directed by the Superintendent, in accordance with the requirements for foundation posts in the TMR RPDM. The open section of the post shall point in the same direction as adjacent traffic. The posts are to be firm in the ground and any movement at ground level shall not exceed 3mm in any direction when force tested in accordance with TMR guidelines

The posts shall not have any obvious deformation as a result of driving. Any damage which does occur to the posts is to be repaired within 24 hours using an organic zinc-rich primer in accordance with the repair requirements of Appendix E in AS/NZS 4680.

Any post which has been excessively damaged will be rejected by the Superintendent and shall be replaced by the Contractor at their own expense.

(3) Erection of road safety barrier rails

Steel blockout pieces shall be erected with the open section pointing in the same direction as adjacent traffic.

All rail laps shall be in the same direction as adjacent traffic such that approach rail ends are not exposed to traffic.

Stiffening pieces, 300mm long, shall be used on intermediate posts.

Road safety barrier rails and blockout pieces shall be handled and erected in such a manner that no damage occurs to the galvanising. Any minor damage occasioned to the galvanising shall be repaired within 24 hours using an organic zinc-rich primer in accordance with the repair requirements of Appendix E in AS/NZS 4680.

Any road safety barrier rails or blockout pieces that have been excessively damaged will be rejected by the Superintendent and shall be replaced by the Contractor at their own expense.

Road safety barrier rail attachment bolts and splice bolts are to be tightened initially such that the barrier can be erected. Adjustments are then to be made to the rails using the slotted holes provided to produce a smooth regular line, free of any kinks or bumps. The overall line of the top of the safety barrier rails is to visually conform with the vertical alignment of the road pavement.

When the alignment both vertically and horizontally is obtained the splice bolts are to be fully tightened. The bolt head (not the shoulder) should be in full bearing with the rail.

(4) End treatment of road safety barriers

Both approach and departure ends of the road safety barrier shall be constructed with leading and trailing terminal sections at locations shown and as detailed on the drawings.

An appropriate terminal end treatment shall be constructed, as detailed on the drawings, at the approach and end locations of road safety barriers as shown on the drawings. Consideration of alternate terminal end treatments will include sufficient clearance behind the safety fence to accommodate pedestrians and cyclists, where applicable.

The approach and departure ends of double sided road safety barriers shall have terminal sections as detailed on the drawings.

Non-rigid road safety barrier connections to rigid road safety barriers or bridge parapets shall be as detailed on the drawings.

(5) Delineators

Delineators complying with AS 1906.2 shall be fixed with brackets to the road safety barrier, to the details and at the locations shown on the drawings beginning at the first post and then in accordance with Table SC6.4.6.25.1 below.

Table SC6.4.6.25.1 Spacing of reflectors on barriers

Radius of Curve	Spacing of Reflectors on Barrier
m	every
30 - 90	3rd post
90 - 180	5th post
180 - 275	8th post
275 - 365	11th post
over 365 (including straight road)	16th post

The delineators shall be so arranged that drivers approaching from either direction will see only red reflectors on their left side, and white reflectors on their right.

(6) Connection to existing safety fencing

The Contractor is to inspect and document the condition of all existing barrier fencing and its suitability to meet current specifications and standards, prior to connection or incorporation into the subject works. All documentation of existing fencing is to made available to the Superintendent for future inspection, if requested.

If any existing safety fencing is deemed not to comply with current design and safety standards, it is to be replaced.

SC6.4.6.25.4 Limits and tolerance

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.25.2 Summary of limits and tolerances below:

Table SC6.4.6.25.2 Summary of limits and tolerance

Item	Activity	Limits/Tolerances	Clause
	Vertical Alignment	± 10mm	SC6.4.6.25.3(2)
	(a) Tops of steel posts.		
	(i) Post Movement	£ 3mm	SC6.4.6.25.3(2)
	Concrete Footings	-0mm or +50mm	SC6.4.6.25.3(3)
	(a) Diameter		

SC6.4.6.26 Landscaping

SC6.4.6.26.1 Introduction

(1) Scope

This sub-section sets out the standards and provides advice and guidelines for the construction of landscape works that will become a council asset.

Landscape works includes but is not limited to, site co-ordination, turfing, gardens, grass seeding, tree plantings, pathways, paved areas, concrete works, stormwater drainage and infrastructure.
This sub-section consists of:

(a) the vegetation of cut and fill batters, median areas, pathway verges, open drains and other areas within the site. Vegetation includes the initial surface preparation, topsoiling, fertilising, sowing of seed and may include surface protection works, hydroseeding, hydromulching and straw mulching; and

(b) the supply of plants, planting at locations fertilising, mulching, staking, watering and maintenance of plants.

Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

(2) Reference and source documents

All design and documentation, materials supplied and work carried out shall be in accordance with the following standards.

(a) Development manual planning scheme policy sub-sections to ne read and applied in conjunction with this policy sub-section are as follows:
SC6.4.6.10 - Earthworks (construction).

(b) Australian Standards

AS 1160	*Bituminous emulsions for the construction and maintenance of pavements*
AS 1289	*Methods of testing soils for engineering purposes – General requirements and list of methods*
AS 1672.1	*Limes and limestones – Limes for building*
AS 2507	*The storage and handling of agricultural and veterinary chemicals*
AS 3000	*Electrical installations (known as the Australian/New Zealand Wiring Rules)*
AS 3700	*Masonry structures*
AS 3798	*Guidelines on earthworks for commercial and residential developments*
AS 3972	*General purpose and blended cements*
AS 4419	*Soils for landscaping and garden use*
AS 4454	*Composts, soil conditioners and mulches*
AS/NZS 4671	*Steel reinforcing materials*
AS 4843	*Synthetic weed blocking fabric*

(c) Other

Electricity Act 1994

International Erosion Control Association (IECA), *Best Practice Erosion and Sediment Control*

(3) Terminology

For the purposes of this document the following definitions apply:

Defects liability period	refer to Section SC6.4.7 Acceptance of completed works.
Gardens, garden beds and garden areas	means a defined area of mulched “garden” containing various shrubs, trees, plants or hedges.
Litter	means bottles, paper, cigarette packets, cigarette butts, drink cans, ice cream sticks, plastic, rubber, glass, milk and fruit juice cartons, paper plates and the like. Litter also includes fallen branches, palm fronds, waste, household rubbish, condoms, sharps/syringes, leaves where leaves are unsightly or cause damage to lawn or garden areas, or other dumped material.

Maintenance period	equivalent to the defects liability period and includes the plant establishment period.
Plant establishment period	coincides with the defects liability period.
Planter box	means a transportable or in situ container designed specifically for containing a garden of trees and /or shrubs.
Sub grade	means the level at the underside of garden or turf top soil or the level at the underside of paving gravel base course.
Superintendent	means the nominated representative for council.

SC6.4.6.26.2 Works management

(1) Qualified personnel

Personnel shall be suitably qualified and competent in all aspects of landscape works and shall be familiar with all relevant Australian Standards. All maintenance work to new and existing trees shall be carried out under the supervision of an Arborist with formal qualifications (Level 3 Australian Qualification Framework) or at least 5 years recognised experience in Arboriculture.

(2) Design approval

The design of the landscape works will be prepared by a qualified Landscape Architect.

(3) Contractor inspections

Inspections must be certified and documented by a Registered landscape Architect (the supervising landscape architect). All approved works are required to be inspected by Townsville City Council.

(4) Council inspections

(a) Council may inspect the following:

(i) sub grade prior to placing fill;

(ii) sub grade prior to placing garden soil or turf soil;

(iii) sub grade prior to placing the gravel base course;

(iv) sub grade prior to placing paving or concrete works;

(v) installation of gypsum;

(vi) condition of plants after delivery to site and prior to planting;

(vii) gardens prior to planting;

(viii) turf areas prior to laying turf;

(ix) areas to be hydro-mulched / seeded prior to treatment;

(x) concrete structures (formwork) prior to placing concrete;

(xi) block work and reinforcing prior to placing core fill concrete; and

(xii) other elements considered necessary by the Superintendent.

(b) Inspection of irrigation works shall be undertaken by the Superintendent and a council Irrigation Officer in association with the Landscape works and is detailed below:

(i) all mainline to be inspected prior to covering;

(ii) drip tube layout prior to covering;

(iii) 240v power conduit from Ergon POS to controller for correct depth prior to covering;

(iv) all envelopers (conduits) work under hard surfaces prior to covering;

(v) all envelopers (conduits) under hard surfaces must be continuous 100 mm PVC CL9, all conduit ends must be sealed with expanding foam prior to covering; and

(vi) water meter assembly installation prior to covering to ensure correct installation of thrust blocks and copper protection.

(5) Inspection results

(a) Work inspected that complies with the sub-section and/or the design plans will be accepted by council.

(b) Any work inspected that does not comply with the sub-section and/or the design plans, will not be accepted by council. Items not acceptable will be noted for rectification.

(c) The contractor is required to rectify these items prior to proceeding to the next construction phase and shall apply for a re-inspection by council on completion of the rectification work.

(6) A minimum of 24 hours notice by is required for notification of an Inspection. Failure by the Contractor to notify council of any inspections required, will result in the works being excavated at the Contractors cost to allow an inspection to be carried out.

(7) Inspection documentation.

Editor's note—this section relates to Inspection Test Plans and is currently under development.

SC6.4.6.26.3 Supply of materials

(1) Materials supply - general

(a) Substitutions

The Contractor shall notify the council immediately if an item is unavailable for inclusion in the works and shall provide alternative supply details if appropriate. Substitutions of any materials or products shall not be made unless approved by the Superintendent in writing.

(b) Material samples

In certain instances, council may request the Contractor to provide samples of materials to be installed or used for work under the development approval.

(c) Materials testing

In certain instances, council may request the Contractor to provide results of materials testing. Where applicable, testing requirements will be set out in the conditions of approval.

(d) Materials warranty

Where requested, the Contractor shall provide to council all relevant warranty details for the materials nominated in any conditions of approval.

(2) Supply of plants

(a) Plant specifications

(i) All plants supplied shall be in a healthy condition free from weeds, pests and diseases. Plants shall be well foliated, showing signs of active growth, true to type and of a form and shape considered typical for the species or variety.

(ii) Leaves shall be of normal size, shape, colour, and texture with no physical or insect damage or disease lesions.

(iii) The plant roots shall be fibrous, well developed and not root bound, with no kinking, knotting, girdling or spiralling and shall be free of any pests or diseases or any other root defects.

(iv) All plants supplied shall be hardened off and in a condition suitable for planting in the Townsville climate.

(v) Trees supplied (unless required to be multi-stemmed) shall have a single leading stem and shall be self-supporting and unstaked.

(vi) Root bound plants, deformed plants and plants showing recent signs of root pruning will not be accepted.

(vii) At time of delivery to the site, each group of plant species shall be clearly and accurately labelled according to botanical nomenclature. Labels shall be water resistant and tied securely to one plant in every 20 for each species.

(viii) Plants which are above the minimum size requirements may be accepted for inclusion within the

works.

(b) Container stock
Plants grown in containers shall have a root system firmly established with no large roots growing out of the container, shall be of such a size that the roots have penetrated to the bottom of the container and occupy 95-100% of the soil volume and/or have sufficient roots to hold the container soil together after removal of the plant from the container.

(c) Ex-ground stock plants

(i) Where plants are growing in ground prior to delivery to the site, the necessary root pruning and/or preparation procedures in accordance with accepted transplanting practice shall be commenced in sufficient time to ensure that, at the time of planting the plant is ready and will meet the specified requirements. Transplanting of ex-ground stock should be conducted under the supervision of a qualified (Level 3 Australian Qualification Framework) horticulturalist or arborist.

(ii) Refer to Table SC6.4.6.26.1 for minimum acceptable root ball sizes for ex-ground stock plants.

Table SC6.4.6.26.1 Acceptable root ball sizes

Small Trees		Large Trees	
Height of Tree (mm)	Root Ball Diameter (mm)	Approximate Tree Trunk Diameter (mm) (300 mm above ground)	Root Ball Diameter (mm)
600 - 900	300	40	500
900 - 1200	350	50	550
1200 - 1500	400	65	600
1500 - 1800	450	75	800
1800 - 2100	550	100	950
2400 - 2700	600	125	1200
2700 - 3000	650	150	1450
3000 - 3600	750	175	1600
3600 - 4200	800		
4200 - 5000	900		

(d) Substitutions
Substitutions of plants shall not be permitted unless approved in writing by council. In the event that a plant is unavailable the Contractor may request to provide a substitution. Substituted plants shall be of the same specified type, quality and size unless otherwise agreed to by council.

(3) Supply of imported soil mix

(a) Imported soil mix shall be organic soil, soil blend or top dressing in accordance with the Australian Standard AS 4419 Soils for landscaping and garden use.

(b) The Contractor shall note the requirements of AS 4419.

(4) Supply of turf

(a) Turf shall be the species nominated on the drawings and shall be supplied by a specialist grower of cultivated turf.

(b) The soil of the turf sod shall be an even thickness of 25 mm minimum.

(c) Turf shall be free from any matter toxic to plant growth and shall be free from roots, weed or weed seeds.

(5) Supply of hydro seeding/mulching
The specific mix/blend of hydro seeding/mulching required shall be nominated on the drawings and supplied by specialist supplier of hydro seeding/mulch.

(6) Supply of mulch materials

(a) All mulch materials supplied shall be in accordance with the current relevant AS 4454 Composts, soil conditioners and mulches.

(b) Organic and inorganic mulch shall be of the type and quality as noted on the drawings.

(c) Organic mulch derived from vegetation cleared on site may only be used where it is free from deleterious materials such as rock, soil and weed material.

(7) Tree stakes and ties

(a) Stakes shall be painted Heritage green, unless otherwise noted on the drawings or approved by council and shall be durable hardwood, straight, free from knots or twists and pointed at one end.

(b) For trees up to 45 litre stakes shall be – 50 mm x 50 mm x 1800 mm long.

(c) For trees over 45 litre stakes shall be – 50 mm x 50 mm x 2400 mm long.

(d) Ties shall be 50 mm wide furniture grade hessian webbing or similar.

(e) Supply of proprietary items

Timber/concrete garden edging, soil conditioners, root barrier, furniture items, play equipment and other project specific items shall be supplied to the requirements and details noted on design and/or construction drawings.

(8) Supply of gypsum

Gypsum application rates shall be supply in accordance with AS 4454 and as required by soil types specific to the site.

(9) Supply of fertiliser

Fertilisers supplied shall be:

(a) delivered to the site in sealed bags clearly marked to show the manufacturer or vendor, weight, fertiliser type, N:P:K. ratio, recommended uses and application rates; and

(b) applied at the locations and frequencies in accordance with the manufacturers' recommendations.

SC6.4.6.26.4 Earthworks

(1) General

Earthworks relates to gardens, grass areas, pathways and paved areas and includes:

(a) site clearing;

(b) stripping of existing vegetation;

(c) stripping of existing top soil;

(d) excavation to sub grade level;

(e) filling to sub grade level; and

(f) cultivation of the sub grade surface.

(2) Quality management

All materials supplied and work carried out shall be in accordance with the current, relevant Australian Standards:

(a) AS 1289 - Methods of testing soils for engineering purposes; and

(b) AS 3798 - Guidelines on earthworks for commercial and residential developments.

(3) Existing services

Per sub-section SC6.4.6.11 Clearing and grubbing, the Contractor is required to locate all existing and newly installed services prior to commencement of any earthworks. Care shall be taken in areas to be excavated, filled or cultivated not to unearth or damage services. Any damage to services caused by the Contractor shall be reinstated by the Contractor at no cost to council.

(4) Site preparation

(a) Clearing/Demolition

(i) Clearing shall mean the removal of trees, shrubs, scrub and undergrowth and other vegetation above ground level and includes the removal of artificial obstructions such as fences, concrete slabs rubbish, timber, boulders, rubble and other man made products.

(ii) Clearing shall be carried out in accordance with sub-section SC6.4.6.11 Clearing and grubbing.

(b) Grubbing

Grubbing shall mean the removal from below ground level of trees, roots, stumps, rocks and artificial obstructions as defined and specified by sub-section SC6.4.6.11 Clearing and grubbing.

(c) Stripping of existing vegetation

Areas to be excavated or filled shall be stripped of all vegetation to a depth just sufficient to include the root zone (nominal 50 mm) All stripping of vegetation is to be in accordance with sub-section SC6.4.6.11 Clearing and grubbing and must not affect trees/vegetation to be retained, as per clause SC6.4.5.2.1(18) Work adjacent to trees and protection of environmentally significant vegetation.

The striped material shall be removed from site or may be stockpiled on site for later reuse, if approved by council and in accordance with clause SC6.4.5.2.1(16) Stockpiling of materials.

(d) Existing topsoil

Existing topsoil excavated on site may be reused provided that the material conforms to the AS 4419 requirements and is approved for reuse by the Superintendent. The material may be stockpiled on site, in accordance with clause SC6.4.5.2.1(16).

(5) Excavation (down to sub grade level)

(a) General

The existing surface of areas to be excavated shall be stripped of all vegetation prior to excavating. Care shall be taken not to unnecessarily expose subsoils through the area of construction by over excavation, to prevent any potential for the development of acid sulphate conditions.

(b) Excavation in gardens

(i) Garden beds shall be excavated down to subgrade level as required to suit the finished surface levels, the depth of garden mix soil and the depth of mulch.

(ii) The subgrade shall be shaped and graded evenly to fall towards subsoil drains (if present) and the topsoil shall be shaped to fall from the centre of the bed outwards in all directions.

(iii) Excavation in gardens shall be in accordance with council's approved standard drawings.

Editor's note— standard drawings for these works are under development.

(c) Excavation in grass areas

(i) Grass areas shall be excavated down to subgrade level as required to suit finished surface levels, the depth of turf top soil and the depth of turf.

(ii) The subgrade shall be shaped and graded evenly to fall towards subsoil drains (if any) and shall be graded evenly to follow the finished surface profile.

(iii) Excavation in grass areas shall be in accordance with council's approved standard drawings.

Editor's note—standard drawings for these works are under development.

(d) Excavation for pathways and paved areas (paving)

(i) Pathways and paved areas shall be excavated down to subgrade level as required to suit finished surface levels, the depth of the gravel base course, bedding sand, pavers or concrete. The subgrade shall be shaped and graded evenly to the falls shown on the drawings and/or to fall to stormwater pits or subsoil drains.

(ii) Excavation for pathways and paved areas shall be in accordance with council's approved standard drawings.

Editor's note—standard drawings for these works are under development.

(e) Excavation near existing trees
Excavation near existing trees shall be undertaken in accordance with clause SC6.4.5.2.1(18) Work adjacent to trees and protection of environmentally significant vegetation.

(f) Spoil

(i) Spoil material resulting from excavation shall be reused on site wherever practicable, provided that the material conforms to the specified requirements for its intended use (e.g. filling or top soil) as per AS 4419.

(ii) Spoil material to be reused may be stockpiled on site as per clause SC6.4.5.2.1(16) Stockpiling of materials.

(iii) After the excavation process has been completed, the sub grade surface shall be inspected for springs, soft soil areas and other structural weaknesses. Where such weaknesses are encountered the following remedial works may be required:

(A) excavation and replacement of unsuitable material;

(B) surface drainage blankets of sand; and

(C) subsoil drains.

(6) Filling (up to sub grade level)

(a) Existing surface treatment
The existing surface of areas to be filled shall be stripped of all vegetation prior to placing any fill. The existing surface shall then be scarified to a depth of 200 mm. If required, water shall be added to bring the existing surface up to optimum moisture content prior to placing any fill.

(b) Unsuitable existing surface
After the stripping process has been completed, the existing ground surface shall be inspected for springs, soft soil areas and other structural weaknesses in the naturally occurring soil. Where such weaknesses are encountered, the following remedial works may be required:

(i) excavation and replacement of unsuitable material;

(ii) surface drainage blankets of sand; and

(iii) subsoil drains.

(c) Acceptable types of fill material for gardens and grass areas
Fill material to garden and grass areas shall be either:

(i) "general purpose soil" to AS 4419 Clause 4.1; or

(ii) "natural soil" to AS 4419 Clause 4.3; or

(iii) spoil from on site excavations if approved by the Superintendent, with a maximum particle size 25 mm.

(d) Acceptable types of fill material for pathways and paved areas
Fill material to pathways and paved areas shall be:

(i) crusher dust, free from organic matter and lumps of clay; or

(ii) crushed rock gravel uniformly graded, nominal particle size 25 mm; or

(iii) other granular material approved by the Superintendent.

All material used shall have a linear shrinkage - 0 - 8%, Soaked California Bearing Ratio – 15 minimum.

(e) Fill in gardens
Gardens shall be filled up to sub grade level as required to suit the finished surface levels, the depth of garden mix soil and the depth of mulch. The sub grade shall be shaped and graded evenly to fall towards subsoil drains (if any).

(f) Fill in grass areas
Grass areas shall be filled up to sub grade level as required to suit finished surface levels, the depth of turf top soil and the depth of turf. The sub grade shall be shaped and graded evenly to fall towards subsoil drains (if any) or gully pits and to mirror the finished surface profile.

(g) Fill to pathways and paved areas
Path ways and paved areas shall be filled up to subgrade level as required to suit the finished surface levels, the depth of the gravel base course, bedding sand, pavers or concrete. The subgrade shall be shaped and graded evenly to the falls shown on the drawings and/or to fall to stormwater pits.

(h) Fill around existing trees
Refer to Clause SC6.4.5.2.1(18) Work adjacent to trees and protection of environmentally significant vegetation.

(7) Placing and compacting fill

(a) Fill material shall be placed and compacted in successive horizontal layers to the dimensions, levels, grades, and cross sections as shown on the drawings and so that the surface is always self-draining. Refer to Table SC6.4.6.26.2 for compaction standards. Care shall be taken to ensure that fill to garden areas is not excessively compacted.

(b) Each fill layer shall be scarified, and/or harrowed and processed to a finely divided condition, uniformly watered or aerated as the case may be, to obtain moisture content within the range of 80% - 90% of the optimum moisture content. The loose depth of the material in each layer shall be not more than 150 mm.

(c) Fill shall be placed in layers simultaneously on both sides of structures, culverts and pipe work to avoid differential loading. Fill shall not be placed against concrete or masonry structures, walls and the like until the concrete or masonry work has been in place for a minimum of 14 days.

(d) Existing works and structures shall be protected from damage due to compaction operations. Compaction by mechanical means shall not be carried out within 300 mm of paths, kerbs or structures. Compaction in these locations shall be carried out by hand or the size of compaction equipment shall be limited to ensure no damage is caused. Commence compaction of each fill layer at the structure and proceed away from it.

Table SC6.4.6.26.2 Fill compaction standards

Location	Compaction standard
Gardens and Grassed Areas	85% Relative Dry Density Standard Compaction.
Pathways , Paved Areas and Structures	95% Relative Dry Density Standard Compaction.

(8) Grading

(a) Runoff from impervious surfaces such as roofs, driveways and car parks, and overland flows from turf and garden beds is to be captured and allowed to infiltrate into subsoils by reshaping existing landforms through the use of swales, contour banks, soaks, percolation pits and basins, rain gardens and bioretention filters.

(b) To reduce runoff and erosion and encourage rainwater infiltration into soil, a landscape embankment is not to exceed grades of 1 in 5.

(c) The regrading of land is not to occur within the tree protection zone of existing trees to be retained.

(9) Cultivation

(a) Applies to gardens and grass areas (if directed or if noted on the drawings).

(b) Where shown on the drawings, the sub grade of Gardens and Grass Areas shall be cultivated prior to placing garden mix soil or turf top soil.

(c) The sub grade shall be thoroughly cultivated by ripping parallel to the final contours to loosen the compacted ground and to the depths nominated in Table SC6.4.6.26.3.

Table SC6.4.6.26.3 Cultivation depths

Location	Cultivation depth
Garden Areas	200 mm
Grass Areas	100 mm

(d) In areas of heavy clay natural soil, granulated gypsum shall be spread over the entire area of all gardens at a minimum rate of 2 kg per square metre and shall be thoroughly blended and incorporated into the subgrade during cultivation.

(e) In areas of heavy clay natural soil, granulated gypsum shall be spread over the entire area of all grass areas at a minimum rate of 2 kg per square metre and shall be:

(i) thoroughly blended and incorporated into the subgrade during cultivation if cultivation is to be carried out; or

(ii) spread prior to placing turf soil.

(f) Any soil additives and/or imported materials other than gypsum, that may be required to be applied to the natural soil shall be thoroughly blended with or spread over the subgrade.

(g) Cultivation shall not be carried out when the soil is wet or plastic.

(h) The Contractor shall ensure that no damage occurs to tree roots, underground services, kerbing and the like during the cultivation process. Cultivation by mechanical means shall not be carried out within the drip line of trees to be retained or within 300mm of pathways, paved areas and/or structures. Cultivation in these locations shall be carried out by hand.

(i) After cultivation soil lumps shall have a maximum dimension of 50 mm. Stones exceeding 25 mm, clods of earth exceeding 50 mm, weeds, roots, sticks, rubbish and any other deleterious material brought to the surface during cultivation shall be removed. Any depressions caused by the removal of these materials shall be filled with top soil or on site spoil material approved by the Superintendent.

(j) After cultivation the surface shall be graded smoothly and evenly and trimmed to the required levels allowing for placing the specified depth of imported soil to achieve the finished surface levels as noted on the drawings. Care shall be taken to prevent areas of excessive compaction being caused by construction equipment.

(10) Backfilling trenches

(a) Backfill to trenches up to sub grade level under pathways and paved areas shall be clean sand or crusher dust compacted to 95% relative dry density standard compaction.

(b) Backfill to trenches up to sub grade level in gardens and grass areas shall be imported soil mix or material excavated from the trench or may be other on site material approved by the Superintendent.

(c) Trenches excavated in gardens within the imported garden mix soil shall be backfilled with imported garden mix soil mix as specified.

SC6.4.6.26.5 Vegetation of slopes and drains

(1) Execution and timing of work

(a) The work to be executed under this clause includes the vegetation of cut and fill batters, pathway verges, median areas, open drains and other areas within the site. Vegetation includes the initial surface preparation, topsoiling, fertilising and either sowing of seed or turfing as shown on the drawings.

(b) Exposed ground shall be vegetated before the area exceeds one hectare or lesser area in compliance with council requirements.

(2) Materials

(a) Topsoil
The Contractor shall use topsoil stockpiled on site under the sub-section SC6.4.6.10 Earthworks (construction). Where imported topsoil is required it shall comply with AS 4419 and shall:

(i) be of a friable, porous nature;

(ii) be free of weeds and weed seeds, bulbs, corms and vegetable propagules;

(iii) contain no refuse or materials toxic to plant growth;

(iv) contain no stumps, roots, clay lumps or stones larger than 50 mm in size;

(v) have an organic content of at least 3 per cent by mass;

(vi) have a pH neither less than 5.5 nor more than 7.5; and

(vii) have a soluble salt content not exceeding 0.06 per cent by mass.

(b) Herbicide

Herbicide used shall be a glyphosate based herbicide listed in SC6.4.6.26 Attachment A.

(c) Seed

(i) All seed used shall be of the species and varieties list in SC6.4.6.26 Attachment A and shall be sown at the application rates specified therein. The Contractor shall submit to the Superintendent the name/s of the proposed seed supplier/s within 2 weeks of the acceptance of the tender.

(ii) The Contractor's attention is drawn to the lead time that may be required to procure some native seed species. The native seed shall be delivered to the site in separate lots for each species and variety, clearly labelled to show species, variety and weight.

(iii) All seed must be accompanied by a "Certificate of Authenticity" which shall be furnished by the Contractor to the Superintendent upon request at any stage of the work. Grass and clover seed shall be pre-packed commercially with an accompanying certificate of germination.

(iv) The Contractor shall not take possession of the seed more than 7 days before sowing is to occur. The seed shall be stored in clean, air tight containers and kept away from direct sunlight. It shall not be exposed to the elements at any stage during storage.

(v) The Contractor shall replace at his own expense any exotic seed batch found not true to type.

(d) Turf

Turf shall consist of 25 mm depth of dense, well rooted, vigorous grass growth with 25 mm depth of topsoil. The type of grass turf to be used shall be selected from SC6.4.6.26 Attachment A and in accordance with the drawings. Unless specified, Kikuyu grass shall not be used. Turf shall be free of weeds, soil pests and diseases. The turf shall be supplied as rolls in long lengths of uniform width, not less than 300 mm, and shall be in sound unbroken condition.

(e) Fertiliser

Fertiliser shall be an organic type listed in SC6.4.6.26 Attachment A with Nitrogen: Phosphorus: Potassium (N:P:K) ratios of 8 : 3.6 : 2.

(f) Vegetable mulch

Vegetable mulch used in hydromulching shall consist of straw, chaff, wood fibre, paper pulp or similar material all finely shredded to a maximum dimension of 10 mm. Meadow hay or weeds shall not be used and paper pulp if used shall not exceed 50 per cent by mass of the total mulch.

(g) Water

Water used shall be potable.

(h) Binder

The binder used in hydromulching and strawmulching shall be Grade ASS, slow setting anionic bitumen emulsion, complying with AS 1160.

(i) Wetting agent

The soil wetting agent added in hydromulching or hydroseeding shall be listed in SC6.4.6.26 Attachment A and applied at the application rate specified therein.

(j) Pesticide

Pesticide used shall be a liquid or powder listed in SC6.4.6.26 Attachment A. The storage and handling of pesticides shall be in accordance with AS 2507.

(3) Vegetation of slopes 3 to 1 or flatter

(a) Preparation of surface

(i) Slopes shall be sprayed with herbicide applied at the rate specified in SC6.4.6.26 Attachment A to kill weed infestation. Sprayed areas shall remain undisturbed for two weeks.

(ii) The surface shall then be tyned to a depth of 200 mm to produce a loose surface and all large stones, rubbish and other materials that may hinder germination shall be removed before topsoiling.

(b) Topsoiling
Topsoil shall be uniformly applied to provide an average compacted thickness of 50 mm with a minimum compacted thickness of 30 mm at any location. The topsoiled area shall be cultivated to a depth of 50 mm to provide a roughened surface with soil lumps not exceeding 50 mm dimension.

(c) Mixing of seed
The Contractor shall give the Superintendent 2 days notice before each sowing operation. Seed shall be sown on the day of mixing with pesticide.

(d) Incorporation of pesticide
Immediately before sowing, all grass and native seed shall be treated with pesticide. The pesticide shall be thoroughly mixed as a dry powder with the seed at the rate specified in SC6.4.6.26 Attachment A to the equivalent mass of seed to be spread on 1 hectare of the surface in accordance with SC6.4.6.26 Attachment A.

(e) Sowing

(i) Sowing shall be carried out with an appropriate mechanical seeder. Where practicable, passes shall follow finished surface contours. Seed shall be sown at a depth of 5 mm or shall be raked or harrowed to provide 5 mm cover.

(ii) Seed and fertiliser shall be evenly distributed over the areas to be sown at the rates specified in SC6.4.6.26 Attachment A. Fertiliser shall be applied concurrently with the seeding operation.

(f) Turfing

(i) Turf shall be placed on the prepared topsoiled surface. Runs of turf shall butt hard against each other and be placed perpendicular to the direction of water flow. Turf seams shall then be topdressed with topsoil.

(ii) Four to six weeks after placement, the turf shall be lightly topdressed with topsoil to correct any undulations or unevenness in the established turf.

(g) Watering
The Contractor shall water areas to be sown to a moist condition and shall rewater areas to a moist condition without surface runoff on a daily basis for a minimum of 15 days after sowing, or as otherwise directed by the Superintendent, to promote and maintain growth.

(4) Vegetation of slopes steeper than 3 to 1

(a) General
Where required or directed by the Superintendent, slopes shall be vegetated by one of the following methods:

(i) topsoiling and hydromulching;

(ii) topsoiling, hydroseeding and straw mulching; or

(iii) hydroseeding.

(b) Preparation of surface

(i) Weeds shall be killed by spraying with herbicides as specified in SC6.4.6.26 Attachment A.

(ii) No more than 7 days before seeding all loose material shall be removed from fill batters and cut batters, which are not stepped, by dragging a heavy steel chain of minimum weight of 30 kilograms per metre of length or by other methods approved by the Superintendent.

(c) Topsoiling
Where batters have been stepped, the steps shall be loosely filled with topsoil. Elsewhere, topsoil shall be uniformly applied to provide an average thickness of 50 mm with a minimum compacted thickness of 30 mm at any location.

(d) Hydromulching or hydroseeding

(i) The hydromulch or hydroseed shall comprise the materials shown in Table SC6.4.6.26.4. The

materials shall be applied at the application rates shown in Table SC6.4.6.26.4.

(ii) Dry surfaces shall be watered by a fine spray before the application of the hydromulch.

(iii) During preparation of the hydromulch or hydroseed slurry, liquid form pesticide shall be added to the storage tank, to facilitate surface application, at a rate of 5 litres of pesticide to the equivalent volume of hydromulch or hydroseed slurry to be spread on 1 hectare of surface in accordance with Table SC6.4.6.26.4.

(iv) Storage tanks, containers and equipment to be used in hydromulching or hydroseeding of slopes shall be clean and free of contamination from previous operations.

(v) A slurry mixture shall be produced by addition of the specified materials in the tank and agitated to maintain a uniform consistency during application. It shall be applied uniformly over the whole surface.

(vi) Hydromulch or hydroseed shall not be applied under the following weather conditions at the site:

(A) when temperature is higher than 35 ºC;

(B) when winds exceed 15 km/hr;

(C) where, in the opinion of the Superintendent, the surface is too wet; or

(D) during rain periods or when rain appears imminent.

(vii) Application rates shall be in accordance with Table SC6.4.6.26.4.

Table SC6.4.6.26.4 Materials and application rates

Application Rate per Hectare		
Material	**Hydromulching**	**Hydroseeding**
i) Vegetable Mulch (kg)	2,500	Nil
ii) Water (L)	35,000	20,000
iii) Binder (L)	700	Nil
iv) Fertiliser	See SC6.4.6.26 Attachment A	
v) Seed	See SC6.4.6.26 Attachment A	
vi) Wetting Agent (L)	35	20
vii) Pesticide (L)	5	5

(e) Straw mulching

The mulch to be applied after hydroseeding shall comprise a matrix of straw and an anionic slow setting bitumen emulsion binder. Meadow hay shall not be used. The straw mulch shall be uniformly applied by a suitable blower unit at a rate of 250 bales (each of 20 kilograms) of straw per hectare of surface. The bitumen emulsion shall be incorporated as a spray into the air stream of the mulch blower at a rate of not less than 2,500 litres of bitumen emulsion per hectare of surface. The finished straw mat shall have a minimum thickness of 20 mm at any location.

(5) Vegetation of open drains

(a) Preparation of surface

The Contractor shall so execute the work that the excavation of open drains to the specified profiles is followed within 7 days by the vegetation of the surface as specified in this clause. Topsoil shall be spread to provide an average compacted thickness of 50 mm with a minimum compacted thickness of 30 mm at any location.

(b) Sowing

Before sowing, the surface shall be watered. Seed and fertiliser shall then be applied uniformly at the rates specified in SC6.4.6.26 Attachment A by one of the following procedures as directed by the Superintendent:

(i) mechanical sowing;

(ii) hydromulching or hydroseeding; and

(iii) by hand.

(c) Surface protection - general

Where shown on the drawings or directed by the Superintendent, one of the following protective treatments shall be applied immediately to all or part of the sown surface.

(d) Surface protection - spraying with bitumen emulsion
An anionic slow setting bitumen emulsion, conforming with Grade ASS of AS 1160, shall be sprayed over the surface at a rate of 1 litre of bitumen emulsion per square metre of surface.

(e) Surface protection - lining with organic fibre mat

(i) The channel surface shall be lined with an organic fibre mat listed in SC6.4.6.26 Attachment A. The runs of matting shall be laid along the direction of water flow. The matting shall be laid loosely on the soil surface and not stretched.

(ii) The upstream end of the matting shall be slotted into a trench 150 mm wide by 150 mm deep and pinned to the base of the trench at 200 mm centres. The trench shall be backfilled with soil and compacted by foot.

(iii) The pins shall be `U' shaped, 4 mm gauge wire, 50 mm wide and 150 mm long legs.

(iv) Adjacent runs of matting shall be overlapped 100 mm with the higher run lapped over the lower run. The matting shall be pinned along the sides of each run at 500 mm centres and along the middle of each run at 1 m centres. End overlaps shall be 150 mm wide with the higher run end lapped over the start of the lower run and pinned at 200 mm centres.

(f) Turfing

(i) Turf shall be as specified under clause SC6.4.6.26.5(2)(d).

(ii) Runs of turf shall butt hard against each other and be placed perpendicular to the direction of water flow in the drain, and pinned into position at 500 mm centres.

(iii) Seams of turf shall be topdressed with topsoil.

(g) Watering
The Contractor shall water treated areas in order to promote and maintain growth as specified under clause SC6.4.6.26.5(3)(g).

SC6.4.6.26.6 Garden construction

(1) Scope
The following work activities relate to the construction of garden beds, garden areas and mass planting areas:

(a) earthworks (excavation, filling and cultivation);

(b) supply and application of soil improvement additives;

(c) supply and placing garden mix soil;

(d) supply and placing mulch;

(e) supply and planting of trees, shrubs, ground cover plants and the like including stakes and other plant supports;

(f) supply and application of fertiliser;

(g) supply and installation of garden edging; and

(h) supply and installation of subsoil drains.

Refer to the standard drawings for typical garden details.

Editor's note—standard drawings for these works are under development.

All garden construction shall be in accordance with the current relevant Australian Standards:

- AS 4419 - *Soils for landscaping and garden use*; and
- AS 4454 - *Composts, soil conditioners and mulches*.

(2) Co-ordination
The sequence for placing garden mix soil, installing irrigation, placing mulch and planting will vary according to the type of plants and irrigation system. The Contractor is required to liaise with other Contractors and the Superintendent to ensure the best possible method of construction is undertaken.

(3) Earthworks

Gardens may require Excavation or Filling to achieve the finished surface levels nominated on the drawings. After excavation or filling, all gardens may require cultivation.

(4) Garden bed dimensions

Planting bed dimensions are in accordance with the following:

(a) garden beds have an average minimum width of 1.2 m, provided that the bed is no less than 0.5 m wide; and

(b) root zone depths for plants are at least that of the root ball of the plant at planting.

(5) Soil condition

(a) Priority is to be given to using existing site soil as imported soil is a limited resource.

(b) Existing topsoil is conserved by either not disturbing the soil during construction or by stockpiling it prior to construction commencing, in accordance with SC6.4.5.2 Stockpiling of materials.

(c) Subsoil is to be cultivated to a minimum depth of 200 mm for garden beds and 100 mm for turfed areas unless this will adversely affect the roots of established trees.

(d) The minimum top soil depth is:

(i) 100 mm for non-irrigated turf areas;.

(ii) 200 mm for irrigated turf areas; and

(iii) 300 mm for garden beds;

(e) If additional soil is required to meet these minimum depths, soil is to meet AS4419 Soils for landscaping and garden use.

(f) The soil quality is sufficient to allow plants to grow effectively. Soil amelioration measures to improve the infiltration of existing soils, the soil's macropore and micropore balance and ensure a stable soil ecosystem, include the following:

(i) scarification of crusted topsoil layers;

(ii) aeration of topsoil layers;

(iii) deep ripping of subsoil layers;

(iv) using hand tools only within the tree protection zone of a tree identified for retention;

(v) the application of gypsum to sodic clay topsoils and subsoils;

(vi) installing a 50 mm layer of lucerne hay between the topsoil and mulch layer;

(vii) adding worms to the topsoil;

(viii) applying soil rhizobia in solution to the topsoil;

(ix) inoculating plants with Mycorrhizal fungi; and

(x) incorporating soil wetters, crystals and wettable foams.

(6) Soil improvement additives

Any soil additives to be applied shall be as required/recommended by soil test results.

(7) Placing imported soil in gardens

(a) Garden mix soil shall be an imported "Organic Soil".

(b) Garden mix soil shall be a minimum depth of 300 mm after consolidation.

(c) Garden mix soil shall be placed, spread and graded evenly in maximum 150 mm thick layers to finish at a level which allows the surface of the mulching material after consolidation to be flush with adjacent finished levels. Care shall be taken to prevent areas of excessive compaction being caused by construction equipment.

(d) Garden mix soil shall be graded evenly to form a gentle crowned appearance at the centre of the garden

bed and/or shall conform to the finished levels detailed on the drawings.

(e) The surface of the garden mix soil shall be smooth and free from stones or lumps of soil prior to planting.

(8) Mulch material
Refer to clause SC6.4.6.26.3 Supply of materials.

(9) Placing mulch

(a) Mulch shall be placed as soon as practicable after planting and shall be placed progressively as planting proceeds along the length of the garden or planting area.

(b) Mulch shall be spread smoothly and evenly over the entire garden so that after initial consolidation the finished level of the mulch is flush with adjacent finished levels.

(c) Mulch shall be shaped around plants to slope into the plant and shall be kept a minimum of 50 mm clear of plant stems to avoid collar rot.

(d) Organic mulch
Organic mulch shall be placed to a depth not greater than 100 mm and as a minimum shall be maintained to a depth of 75 mm after consolidation.

(e) Inorganic mulch
Not less than 14 days prior to the placing of inorganic mulch, herbicide shall be applied to the entire area to be mulched and prior to placing the mulch.

(f) Inorganic mulch shall be placed to a minimum depth of 100 mm unless noted otherwise on the drawings for the type of mulch specified.

SC6.4.6.26.7 Planting

(1) General

(a) Planting shall be carried out in accordance with the best horticultural practices.

(b) Plants shall be installed at the spacings and locations detailed on the drawings to avoid existing services or to cover an area uniformly.

(c) In feature planting areas at least 25% of tree plantings are to be provided as larger advanced stock, with a minimum 25 litre pot size.

(d) The Contractor is required to locate all existing services prior to planting.

(e) Planting shall not be carried out if the soil is very wet or water logged or during periods of extreme weather conditions such as extreme heat, cold wind or rain.

(f) Plant supplies are to be healthy, attractive, and a general high standard of stock in order to ensure long-term viability of the specimen. The stock will be free from disease, pests and weeds and structural defects, as per clause SC6.4.6.26.3 Supply of materials.

(2) Planting procedure – container stock

(a) A planting hole with vertical sides shall be excavated to a width of twice the diameter of the root ball of the plant and to a minimum depth of 100 mm deeper than the height of the plant container.

(b) The depth of the planting hole shall allow for the clearance specified and shall be in relation to the finished surface level where applicable.

(c) The sub grade material at the bottom of the planting hole shall be loosened to a depth of at least 50% of the root ball depth and the compacted sides of the planting hole shall be loosened to prevent confinement of root growth to the hole. Additional excavation of the base of the planting hole may be required to ensure that the plant has sufficient sub grade drainage.

(d) Plants shall be thoroughly watered in the pot prior to planting so that when removed from the pot the root ball is moist. Plants shall be removed from their pots without damage to the root system. Plants shall not be removed from pots until the planting hole is complete and ready for planting.

(e) The plant shall be placed in the centre of the hole with the stem vertical and shall be set at a height such that the top of the potting material is level with the surrounding soil. Plants placed on a slope shall be set

in the centre of the hole with the top of the potting material level with the lowest side of the planting hole and the plant stem vertical.

(f) Fertiliser tablets or granules shall be placed in the planting hole at the time of planting in accordance with the manufacturers recommended rates of application. The fertiliser shall be placed around the plant at half the depth of the planting hole and shall be covered with backfill soil to ensure no direct contact with the plant roots.

(g) Plants other than container stock trees placed in gardens shall be backfilled with garden mix soil as specified for the entire planting hole. The garden mix soil shall be lightly tamped around the plant and thoroughly watered to eliminate air pockets.

(h) During planting care shall be taken to ensure that soil is not mixed with the mulch. Mulch that is contaminated with soil shall be replaced.

(i) Container stock trees shall be backfilled in 150 mm layers up to within 200 mm of the top of the planting hole. The backfill soil shall be tamped around the tree and thoroughly watered to eliminate air pockets. Backfill the top 200 mm with garden mix soil.

(j) In areas other than heavily planted borders, shrubs or tuft plants, each individual plant shall have a watering basin for the extent of the planting hole formed with garden mix soil around the base of the plant.

(k) Individual container stock trees located in irrigated grassed areas shall have a 150 mm high watering basin for the extent of the planting hole formed with garden mix soil around the base of the tree.

(l) Plants placed on a slope shall have a small horizontal terrace formed for the extent of the planting hole.

(m) Immediately after planting, the plants shall be watered to thoroughly water the root ball and the backfill. Watering shall be carried out progressively as planting proceeds to ensure that plants do not dry out and as a minimum, plants shall be watered within a maximum of 1 hour from planting.

(n) All identification labels, nursery ties and the like shall be removed from the plants immediately after planting

(3) Planting procedure - ex ground stock plants

Editor's note—content under development.

(4) Transplanting trees

(a) Trees to be transplanted will be noted on the construction drawings prior to the commencement of construction.

(b) Preparation of the tree prior to transplanting shall be carried out in accordance with accepted transplanting practice and any requirements provided by council to suit the particular species and project.

(c) Preparation of the tree for transplanting shall be commenced in sufficient time to ensure that at the time of planting the tree is adequately prepared and will meet the specified requirements.

(d) All transplanting work shall be carried out under the direction of a suitably qualified horticulturist or arborist.

(e) Planting of the transplanted tree shall be generally in accordance with the details shown on the drawings.

(f) The resulting excavation after the tree has been removed shall be backfilled with compacted fill material suitable for the location.

(5) Root barrier

(a) Locations and type of root barrier shall be noted on the drawings or shall be as directed by the Superintendent.

(b) Root barrier shall be installed as per the manufacturers' recommendations and with particular attention to the location of any underground services.

(c) Root barrier must be installed in all situations where it is likely that tree roots may interfere or adversely

affect infrastructure, e.g. where species such as Ficus are to be planted in reasonable proximity to pathways.

SC6.4.6.26.8 Staking, ties and guying

(1) Every container stock tree shall be staked and tied unless otherwise approved by the Superintendent. Tree stakes

(a) Stakes shall be:

(i) a minimum of 2 stakes per tree;

(ii) placed outside of the tree root ball;

(iii) driven into the ground a minimum one third of their length;

(iv) for smaller trees (trees up to 45 litre), at least 1.0 metre apart; and

(v) for columnar trees, spaced to avoid excessive root ball damage.

(b) Care shall be taken to avoid damage to the tree root system and any services when installing stakes.

(c) All stakes shall remain in place for the entire “maintenance period” unless otherwise instructed by the Superintendent.

(2) Ties

Ties shall be fixed securely with staples to the stakes in a figure eight pattern around the tree stem. As a minimum one tie at half the height of the main stem shall be provided with additional ties as necessary to stabilise the tree.

(3) Guying

(a) Trees requiring the installation of guying shall be noted on the construction drawings or shall be as directed by the Superintendent.

(b) Guying consists of a minimum of three heavy duty stakes of either steel or timber driven into solid ground, with heavy duty galvanised wire ties firmly fasten to the stakes and looped around the tree trunk with suitable wrapping to protect the trunk.

Editor’s note—underground guying is accepted where suitable for the tree in question. Specifications are to be developed in future.

SC6.4.6.26.9 Sub soil drains construction

(1) Sub soil drains in gardens may be required in areas of heavy clay soils and in roadway medians, roundabouts and the like. Sub soil drains shall be installed at the locations and to the details shown on the drawings.

(2) Pipes and fittings shall be perforated plastic Type 1 Class 200 to AS2439: Part 1. Sub soil drain filter fabrics shall be approved geo fabric material in accordance with the relevant Australian Standards.

(3) Pipe surround shall be a coarse washed river sand complying with the grading requirements given in Table SC6.4.6.26.5 and shall completely surround the perforated pipe.

(4) The subsoil drain pipe shall be laid to grade continuously to the outlets nominated on the drawings at a minimum grade of 1:100.

(5) Sub soil drains may be inspected by the Superintendent prior to placing any garden mix soil or backfill.

Table SC6.4.6.26.5 Recommended grading for sub-soil drain sand

A.S. SIEVE	% PASSING
9.5 mm	100

4.75 mm	98-100
2.36 mm	70-100
1.18 mm	30-78
600 µm	2-15
300 µm	0-4
150 µm	0-1

SC6.4.6.26.10 Garden edging

(1) Supply and installation of timber, concrete or recycled plastic proprietary garden edging shall be in accordance with the details on the drawings and the manufacturer's recommendations where applicable. Timber or recycled plastic garden edging must have a minimum thickness of 30 mm.

(2) Supply and installation of concrete kerbing shall be as specified in clause SC6.4.6.26.15.

SC6.4.6.26.11 Planter boxes

(1) Planter boxes shall be constructed at the locations and to the details shown on the construction drawings.

(2) Planter box soil shall be an imported soil mix (Potting Mix). Refer to project specific specifications where applicable.

(3) Planter boxes must have appropriate drainage (see clause SC6.4.6.26.9 Sub soil drains construction) provided that it is connected to a lawful discharge point. The drainage discharge is not permitted to cause nuisance, such as staining or sediments, to adjacent areas.

SC6.4.6.26.12 Grass area construction

(1) General

The following work activities relate to grass areas construction:

(a) earthworks (excavation, filling and cultivation);

(b) supply and application of soil improvement additives;

(c) supply and placing turf soil;

(d) supply and lay grass turf;

(e) supply and lay grass seeding;

(f) supply and installation of hydro-seeding/mulching; and

(g) supply and application of fertiliser.

All grass area construction shall be in accordance with the current relevant Australian Standards:

- AS 4419 Soils for landscaping and garden use; and
- AS 4454 Composts, soil conditioners and mulches.

(2) Co-ordination

The sequence for placing turf soil, installing irrigation and placing turf will vary according to the type of plants and irrigation system.

(3) Earthworks

Grass areas may require excavation or filling to achieve the finished surface levels detailed on the construction drawings. Refer to clause SC6.4.6.26.4 Earthworks.

(4) Placing turf soil

(a) Turf soil shall be an imported soil mix Type 2 "Soil Blend".

(b) Turf soil shall be a minimum depth of 100 mm after light compaction.

(c) Turf areas shall be graded to fall evenly between the finished surface levels detailed on the drawings and/or shall be graded to drain freely to stormwater inlets without causing ponding. As a minimum turf areas shall be graded to fall at 1:100.

(d) Turf soil shall be spread evenly and shall be lightly compacted to finish at a level which allows for the finished turf surface to be flush with adjacent surfaces such as paved areas, pathways mowing strips and the like. Care shall be taken to prevent areas of excessive compaction being caused by construction equipment.

(e) The surface of the turf soil shall be smooth and free from stones or lumps of soil prior to laying the turf.

(5) Turf material

(a) Turf shall be the species nominated on the drawings and shall be supplied by a specialist grower of cultivated turf approved by the Superintendent.

(b) Where turf areas are provided within centre medians, round-abouts and other identified areas of road reserve where edging/mowing may require traffic control, all turf is to be Empire Zoysia or approved similar turf and of a minimum width of 1.6 m to allow for clear mowing access.

(6) Laying turf

(a) Prior to laying turf, fertiliser shall be thoroughly mixed into the turf soil. Refer to Table SC6.4.6.26.5 for application rates.

(b) Areas to be turfed shall be divided into sections that can be prepared and completed (including adequate watering) in the same day.

(c) Turf shall be laid in straight lines in a stretcher bond pattern across the fall of the slope or parallel with the long side of level areas. Cross joints shall be staggered with a maximum gap of 5 mm between adjacent sections of turf.

(d) Immediately after laying the turf shall be rolled with a roller weighing not more than 90 kg/m of width.

(e) As soon as practicable after rolling turf shall be watered thoroughly with a fine spray to a depth of 150 mm. Watering shall continue as necessary to maintain moisture to this depth and to maintain the turf in a healthy condition.

(f) Where levels have deviated from the design levels after placing and watering the turf shall be lifted and the section regraded with turf soil to achieve design levels prior to replacing the turf.

(g) Turf shall be protected from pedestrian traffic until established and shall be protected from vehicle traffic at all times.

SC6.4.6.26.13 Hyrdo seeding/mulching

(1) General

(a) Excavation, filling, cultivation and placing imported soil mix for hydro seeding/mulching areas shall be as specified for turf areas.

(b) Details for hydro seeding/mulching supply and sowing shall be as noted on the drawings and/or as specified under separate cover.

(c) Organic mulches are to be applied to landscaped garden beds and trees which:

(i) meet AS 4454 Composts, soil conditioners and mulches;

(ii) are applied to a depth of 75 – 100 mm;

(iii) are of a coarse texture to allow water penetration to prevent nitrogen drawdown of the soil;

(iv) are aged prior to application;

(v) do not use plastic sheeting, typically used for weed suppression as it prevents rainwater from infiltrating soils and inhibits gaseous exchange between the soil and air; and

(vi) use a biodegradable mulch mat on any waterway embankment.

(d) Inorganic mulches, such as recycled concrete or brick cobbles, are limited to feature or themed landscapes, or in windy areas where organic mulches may be blown away.

(2) Supply of mulch materials

(a) Mulch materials supplied shall be free of deleterious and extraneous matter such as soil, weeds, seeds, rubbish, vermin, insects, pests, fungus, sticks, disease, declared plants or noxious weeds and shall be free of any matter toxic to plant growth or germination.

(b) All mulch materials supplied shall be in accordance with AS 4454 Composts, soil conditioners and mulches.

(c) Organic mulch
Organic mulch may be either:

(i) tea tree mulch from an approved supplier; or

(ii) wood chip produced by the chipping of native and other approved vegetation removed during the clearing and grubbing process on site (max 50 mm size); or

(iii) wood chip obtained from a council stockpile as directed by the Superintendent or his delegated site supervisor; or

(iv) other material as noted on the drawings.

(d) Inorganic mulch
Inorganic mulch shall be of the type and quality and noted on the construction drawings.

(3) Surface preparation

(a) Level sites
Prior to hydro seeding/mulching the area to be treated shall be graded to fall evenly between the finished surface levels detailed on the drawings and/or shall be graded to drain freely to stormwater inlets without causing ponding.

(b) Embankments and slopes (1 on 5 maximum slope)
Prior to hydro seeding/mulching the area shall be lightly cultivated across the slope to minimise surface run-off and erosion. After cultivation, soil crumb size shall not exceed 20 mm.

(c) The surface of the area to be treated shall be free from weeds, stones, roots, sticks or other deleterious material and have a general moisture content of around 10% just prior to applying the hydroseed/mulch.

(4) Irrigation
An approved temporary above ground irrigation system shall be installed to ensure establishment of the hydro seeding/mulching is achieved within the timer frame specified. Refer to SC6.4.6.27 Irrigation.

SC6.4.6.26.14 Paving construction
Refer to sub-section SC6.4.6.18 Segmental paving.

All areas of road reserve fronting a subject site must be assessed against, and treated in accordance with SC6.4.3.3 Footpath treatment policy where specified.

SC6.4.6.26.15 Concrete kerbs
This section contains specific details for construction of concrete kerb in landscape and open space situations. Concrete kerb is most commonly used for garden edge or as a restraint for softfall areas in playgrounds.

All concrete garden edge kerb or similar structure shall have minimum rectangular profile dimensions of 150 mm wide x 200 mm deep with edges rounded to a radius of 20 mm (minimum) and constructed in accordance with clause SC6.4.6.28.2(2) Kerb and channel. Where the concrete garden edge kerb abuts grass areas, the surface of the kerb must finish level with the surface level of the grass area.

SC6.4.6.26.16 Concrete works

For all concrete works associated with Landscaping activities refer to sub-section 6.4.6.28 Minor concrete works.

SC6.4.6.26.17 Masonry work

This section covers the supply of all materials, placing and finishing of all masonry blockwork including concrete core-filling and clay brickwork. Masonry Work includes walls, retaining walls, free standing piers, structures and the like. All masonry work shall conform to the requirements of AS 3700.

(1) Materials

(a) Blocks - Hollow load bearing masonry blocks shall conform to the requirements of AS 3700 - Section 2, and shall have a characteristic unconfined compressive strength of 15 MPa unless nominated otherwise agreed.

(b) Masonry blocks shall be sound, dry, clean and crack free and shall have been cured for not less than 14 days before delivery. The correct type of block shall be used to make provision for all lintels, pilasters, bond beams, openings, etc.

(c) Clean out blocks shall be used in the first course of all reinforced cores and/or where cores are to be concrete filled.

(d) Cement - for mortar shall be Portland Cement Type A and shall conform in all respects with the requirements of AS 3972.

(e) Sand - for mortar shall be clean, sharp and free from organic impurities and excess fines and efflorescing salts.

(f) Water - used in mixing concrete shall be clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances.

(g) Hydrated lime shall conform to the requirements of AS 1672.1.

(h) Admixtures - no air-entraining additives or other admixtures shall be incorporated in the mortar unless specifically approved by the Superintendent.

(i) Reinforcement - shall comply with AS/NZS 4671 as applicable.

(j) Clay bricks - and brickwork shall conform to AS 3700. Clay brick shall have a characteristic unconfined compressive strength of 40 MPa unless otherwise agreed.

(2) Mortar for blockwork

(a) All mortar for blockwork shall consist of a homogeneous mixture of the ingredients and shall be classified as M4 in AS 3700. The following proportions by volume shall be used unless the minimum compressive strength of mortar at 28 days has been nominated on the drawings. Cement 1: Lime 0 to 0.25: Sand 3.

(b) The mortar components shall be properly volume batched using calibrated volume boxes. Batching by shovel will not be permitted.

(c) Mortar shall be mixed in an approved mixing machine for not less than 3 minutes. Handmixing shall not be permitted unless specifically approved by the Superintendent. The dry ingredients shall be thoroughly mixed prior to the addition of water, which shall then be worked thoroughly through the mixture.

(d) Mortar shall be transported in a covered container such that excessive evaporation will be prevented. Retempering of mortar shall not be permitted.

(3) Core-fill concrete

(a) Core-fill concrete shall comply with the relevant requirements of AS 3600 Concrete Structures. Ready mixed concrete from an approved supplier shall be used. As a minimum and unless shown otherwise on the drawings, core-fill concrete supplied shall have the following properties in Table SC6.4.6.26.6.

Property	Design Value
Characteristic strenght F'c at 28 days	N 20
Norminal maximum size of aggregate	10 mm
Slump	230 mm +/-30 mm

(b) Testing of core-fill concrete supplied shall be carried out by the Concrete Supplier as part of the suppliers Quality Assurance System. The Contractor is required to provide the Superintendent with copies of the suppliers Test Certificates relating to the particular batch of core-fill concrete supplied.

Core-fill concrete supplied that does not meet the requirements of this specification shall be liable to rejection by the Superintendent. If directed by the Superintendent the Contractor will rectify any masonry wall which has been filled with rejected core-fill concrete.

(4) Laying blocks

(a) All work shall be carried out by experienced tradesmen to the general requirements of AS 3700 - Section 8. Blockwork shall be laid in lifts or not more than 2400 mm in height.

(b) All blocks shall be laid dry and wetting of the blocks shall not be permitted under any circumstances.

(c) Cutting of blocks shall be reduced to an absolute minimum by setting out to avoid irregular or broken bond.

(d) Blocks shall be stacked on planks or other supports free from contact with the ground and shall be covered at all times to ensure that the blocks remain dry.

(e) Blocks shall be laid in straight uniform courses of running bond unless noted otherwise on the drawings. Intersecting walls shall be bonded as shown on the drawings.

(f) The surface of the concrete footing, floor slab, beam, etc. on which the base course is to be laid shall be thoroughly cleaned prior to laying the base course to ensure all laitance is removed.

(g) The base course shall incorporate clean out blocks at every reinforced core, with the clean out opening on the inside face of the wall.

(h) Reinforcement starter bars shall be checked for alignment prior to laying the base course. Starter bars shall be vertical. Bending starter bars to allow the laying of the base course is not acceptable. Any starter bars out of position shall be rectified by the Contractor as directed by the Superintendent.

(i) For unreinforced and reinforced masonry walls, horizontal joints shall have full mortar coverage on the face shells and on the webs.

(j) For unreinforced masonry walls all vertical joints shall have full mortar coverage. For reinforced masonry walls all vertical joints shall be buttered only for the thickness of the face shells.

(k) All horizontal and vertical joints shall be 10 mm in width with a maximum mortar intrusion into the cores of 6 mm. Mortar droppings into cavities or cores shall be avoided.

(l) Tooling of the joints shall be done when the mortar is partially set but still sufficiently plastic to bond. All tooling shall be done with a V-shaped or round bar in a manner that will compact the mortar rather than drag it out. Raked joints shall not be permitted to encroach more than 5 mm in depth.

(m) If it is necessary to move a block after it has been set in place with mortar, then the block shall be removed from the wall, the mortar removed and the block shall be reset in fresh mortar.

(n) Capping blocks shall be fixed with a suitable flexible external grade adhesive as detailed on the drawings. Laying capping blocks in mortar only is not acceptable.

(o) Where new blockwork is to be laid on top of an existing masonry block wall, the existing core concrete shall be cleaned to expose all aggregate and treated using an adhesion enhancer such as bondcrete or approved equivalent before block laying is commenced.

(p) Extreme care shall be exercised to prevent mortar adhering to the face of blockwork. Acid shall not be used to clean down masonry walls.

(5) Reinforcement

(a) Steel reinforcement shall be supplied and bent in accordance with AS 3700. Rebending of reinforcement

with or without heating is not permitted unless approved by the Superintendent.

(b) Steel reinforcement shall be free from rust, oil, varnish, mud or any other coatings, cracks, scale blister and other defects and shall comply in all respects with AS/NZS 4671.

(c) All horizontal reinforcement shall be laid into the wall as the block laying progresses. Galvanised wire loops shall be cast into the horizontal joints prior to placing the reinforcement to ensure correct positioning of the reinforcement.

(d) Vertical reinforcement shall be placed after the wall has been laid and shall be placed in the core with the correct cover to the face of the blocks as detailed on the drawings. Unless noted otherwise on the drawings vertical reinforcement shall be placed in the centre of the core.

(e) Splice lengths for both horizontal and vertical reinforcement shall not be less than 45 bar diameters for plain round bars or 30 diameters for deformed bars or 450 mm, whichever is the greater.

(f) All reinforced block walls shall have vertical reinforcement in the core at the ends, corners, sides of openings, adjacent to control joints, at unbonded intersections and at the maximum centres between these points.

(6) Cast in elements

(a) The Contractor shall co-ordinate with all other trades as necessary to ensure that all conduits, fitments, penetrations and the like are incorporated in the masonry as detailed on the drawings and as specified.

(b) All bolts, anchors and other steel fittings shall be accurately set into the walls as the work progresses and positioned such that they shall be thoroughly embedded in mortar or core-filling concrete as required.

(c) Where items to be cast into the blockwork are found to be out of position and cannot be satisfactorily corrected, then the section of blockwork shall be completely demolished, and then reconstructed to allow correct positioning.

(7) Joints in blockwork

(a) Joints in blockwork shall be the type and at the locations detailed on the drawings. Joints with steel dowels shall have the dowels securely supported to ensure that the dowel remains in the correct position during the placing of core-fill concrete.

(b) Construction joints shall be located as detailed on the drawings or shall be located where agreed with the Superintendent to suit specific site requirements.

(c) Joint filling compounds shall be as detailed on the drawings and shall be installed in accordance with the manufacturers recommendations, with particular attention to the preparation of the blockwork surface to suit the application of the joint filling compound.

(8) Placing core-fill concrete

(a) Masonry walls shall cure for at least 3 days before core-fill concrete is placed.

(b) The cores to receive core-fill concrete shall be cleaned of all mortar protrusions by rodding from the top of the wall. All mortar droppings and foreign matter shall then be removed via the clean out openings at the base of the wall, the vertical reinforcement positioned and formwork fixed in place to seal the clean out block opening.

(c) Core filling shall not proceed until the reinforcement and cores have been inspected by the Superintendent. Clean out openings shall not be sealed until the inspection has been carried out.

(d) Core-fill concrete shall be thoroughly compacted into place as it is poured with the aid of small immersion vibrators or rodding. Block cores shall be topped up after settlement occurs.

(e) Core-fill concrete shall be placed for the full height of the blockwork in lifts of not more than 2400 mm in height. A minimum delay period of 1 hour and a maximum delay period of 3 hours shall be observed between lifts.

(f) Proprietary core plates shall be used to confine the core-fill concrete to the reinforced cores.

(g) Placing of core-fill concrete in bond beams shall be done in one continuous operation for the full length of the bond beam. Construction joints in bond beams other than control joints, are not acceptable.

(h) Extreme care shall be exercised to prevent slurry adhering to the face of blockwork. Acid shall not be used to clean down masonry walls

(9) Mortar for clay bricks

(a) All mortar for clay bricks shall consist of a homogeneous mixture of the ingredients and shall be classified as M3. Refer to AS 3700.

(b) The following proportions by volume shall be used unless the minimum compressive strength of mortar at 28 days has been nominated on the drawings. Cement: 1, Lime: 1, Sand: 6.

(c) Mortar for clay bricks shall be generally in accordance with clause SC6.4.6.26.17(2) Mortar for block work.

(10) Laying clay bricks

(a) Clay bricks shall be fully bedded and fully faced. Bed joints shall be 10 mm nominal height.

(b) Clay brick masonry walls shall be laid with galvanised brick ties at 600 mm maximum centres each way and at 300 mm centres adjacent to openings in accordance with manufacturer's specifications.

(c) Laying of clay bricks shall be generally in accordance with clause SC6.4.6.26.17(4) Laying blocks.

(11) Protection of walls

(a) During construction and after the wall is laid and prior to placing core-fill concrete; under no circumstances shall masonry blocks be wetted or allowed to become wet.

(b) At the completion of a day's work and during wet weather the top and sides of all walls shall be covered to prevent rain penetrating the cores and wetting the blocks.

(c) During the construction of masonry walls and prior to the core-fill concrete having gained its full strength, the Contractor shall protect the wall by suitable means such as bracing to ensure that the wall is not damaged and to ensure the safety of workers on the site.

(12) Tolerances

(a) All masonry shall be built true and plumb such that the maximum "out-of-plumb" in a 3 m height does not exceed 10 mm.

(b) The bed joint at any level shall be within ± 3 mm.

(13) Surface finishes to masonry

(a) Surface finishes, such as painting, rendering or textured finishes shall be as detailed on the drawings or as nominated in the Finishes Schedule.

(b) Prior to applying any surface finish the substrate shall be free from dirt, dust, oil, grease, mould, fungi, efflorescence, release agents, bond breakers, scaling and laitance or any other contaminants or foreign material that may affect adhesion. Remove all traces of loosely adhering material by scraping, grinding, wire brushing or air blowing as necessary.

(c) Preparation of the surfaces to be treated, application of the surface finish and curing after application if required, shall be carried out in strict accordance with the manufacturer's recommendations. Particular attention shall be made to application during suitable weather conditions.

(d) Gap fill and/or sealant material used for joints or cracks in walls shall be checked for compatibility with the proposed surface finish.

(e) Anti-vandal coatings shall be used in circumstances where walls are exposed (i.e. not screened by soft landscaping) and prone to graffiti.

(f) Dissimilar materials adjacent to surfaces to be treated shall be masked to avoid contact, (e.g. capping and flashings).

(g) The Contractor shall provide the Superintendent with all warranty details of the surface finishes.

SC6.4.6.26.18 Stormwater drainage

All stormwater drainage shall be constructed in accordance with the relevant stormwater drainage guidelines contained in SC6.4.6.4 Stormwater drainage.

SC6.4.6.26.19 Infrastructure items

Supply and installation of infrastructure items such as timber decking, timber and steel fencing, seats, picnic sets, barbeques, play equipment and signage shall be as detailed on the drawings and constructed in strict accordance with the manufacturers' specifications. The Contractor shall provide the Superintendent with all warranty details. Concrete for footings, plinths and the like for infrastructure items shall be in accordance with clause SC6.4.6.26.16 Concrete works.

SC6.4.6.26.20 Electrical

The installation of electrical components shall comply with the requirements of AS 3000. Where required under the *Electricity Act 1994*, electrical installations shall be installed by a registered Electrical Contractor as defined by that Act. Refer to the electrical engineer's drawings and specifications for all requirements.

SC6.4.6.26.21 Summary of limited and tolerance

The limits and tolerances applicable to the various clauses in this sub-section are summarised in Table SC6.4.6.26.7 below.

Item	Activity	Limits/Tolerances	Clause
1.	**Topsoil**	>3% by mass	SC6.4.6.26.5(2)(a).
	a) Organic Content		
	b) pH	>5.5 <7.5	SC6.4.6.26.5(2)(a)
	c) Soluble Salt	<0.06% by mass	SC6.4.6.26.5(2)(a)
2.	**Turf**	Widths >300mm.	SC6.4.6.26.5(2)(d)
3.	**Vegetable mulch**	maximum size <10mm	SC6.4.6.26.5(2)(f)
	a) Material	<50% by mass of total mulch	SC6.4.6.26.5(2)(f)
	b) Paper Pulp		
4.	**Topsoiling**	Minimum compacted thickness	SC6.4.6.26.5(3)(b)
		at any location of 30mm	SC6.4.6.26.5(4)(c)
			SC6.4.6.26.5(5)(a)
5.	**Straw mulching**	Finished thickness >20mm.	SC6.4.6.26.5(4)(e)
	a) Straw Mat		
6.	**Mulch**	Shall not exceed 5% by volume.	SC6.4.6.26.3(6)
	a) Fines		
	b) Woodchip	Maximum size <50mm.	SC6.4.6.26.3(6)
7.	**Plant material**	Contain >20% <25% by volume	SC6.4.6.26.3(2)
	a) Container Soil Mix	of clay.	

Attachment A Landscaping materials

SC6.4.6.26 Attachment A: Landscaping materials

MATERIAL *(sample only - to be completed by compiler)*	**TYPE**	**MINIMUM APPLICATION RATE**
1. HERBICIDE *	"Roundup"	As per manufacturers recommendations
2. SEED		
a) Grass	Rye Corn (April-August) or	60 kg/ha
Japanese Millet (September-March		60 kg/ha
Hulled Couch		5 kg/ha
Red Clover (Inoculated)		5 kg/ha
White Clover (Inoculated)		5 kg/ha
"Elka" Perennial Rye		5 kg/ha
(b) Native	Acacia dealbata	4 kg/ha
Acacia buxifolia		1 kg/ha
Acacia decurrens		1 kg/ha
Acacia pravissima		1 kg/ha
Leptospermum lanigerum		1 kg/ha
Hardenbergia violacea		500 g/ha
Kennedia prostrata		500 g/ha
Acacia implexa		200 g/ha
Banksia marginata		200 g/ha
Bursaria spinosa		200 g/ha
Callistemon pallidus		200 g/ha
Dodonaea viscoca		200 g/ha
3. TURF GRASS (a) Medians (b) Verges/Footpaths (c) Other Areas	Couch Buffalo Couch	Refer to drawings " "
4. FERTILISER * (a) Vegetation of Slopes/Drains (b) Landscape Planting	Dynamic Lifter "Nitro" "Kokei" pellets	1000 kg/ha
5. WETTING AGENT *	"Aquasoil"	1 litre/1000 litres of mix water
6. PESTICIDE * (a) Liquid (b) Powder	"Lorsban 500 EC" "Lorsban 250 W"	5 litres 10 kg
7. ORGANIC FIBRE MAT *	"Sta-firma" (light grade)	-
8. MULCH	Composted/Pasteurized	100mm thick
* Material shall be as listed or equivalent as approved by council.		

SC6.4.6.27 Irrigation

SC6.4.6.27.1 Introduction

(1) Scope

(a) This sub-section sets out the standards for design, installation and construction of irrigation systems that will become a Townsville City Council asset.

(b) Irrigation systems that will be connected to an alternative water supply have additional requirements to this sub-section.

(2) Reference and source documents

All design and documentation, materials supplied and work carried out shall be in accordance with the following:-

(a) Australian Standards

AS 1432	*Copper tubes for plumbing, gas fitting and drainage applications*
AS/NZS 1477	*PVC pipes and fittings for pressure applications*
AS 2032	*Installation of PVC pipe systems*
AS 2033	*Installation of polyethylene pipe systems*
AS 2053	*Conduits and fittings for electrical installations (all Parts)*
AS 2129	*Flanges for pipes and valves and fittings*
AS 2698.2	*Plastics pipes and fittings for irrigation and rural applications –Polyethylene rural pipe*
AS 2698.3	*Plastics pipes and fittings for irrigation and rural applications –Mechanical joint fittings for use with polyethylene micro-irrigation pipes*
AS 2845.1	*Water supply – Backflow prevention devices – Materials, design and performance requirements*
AS 2845.2	*Water supply – Backflow prevention devices – Registered air gaps and registered break tanks*
AS 2845.3	*Water supply – Backflow prevention devices - Field testing and maintenance of testable devices*
AS 3000	*Electrical installation (known as the Australian/New Zealand Wiring Rules)*
AS/NZS 3008.1.1	*Electrical Installations –Selection of cables - Cables for alternating voltages up to and including 0.6/1 kV - Typical Australian installation conditions*
AS/NZS 3500	*Plumbing and Drainage*
AS/NZS 3500.0	*Plumbing and drainage Part 0: Glossary of terms*
AS/NZS 3500.1	*Plumbing and drainage – Water services*
AS 3500.1.1	*National plumbing and drainage - Water supply – Performance requirements*
AS 3500.2.1	*National Plumbing and Drainage Sanitary plumbing and drainage - Performance requirements*
AS 3500.2.2	*National Plumbing and Drainage Sanitary plumbing and drainage - Acceptable Solutions*
AS/NZS 3808	*Insulating and sheathing materials for electrical cables*
AS/NZ 3879	*Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ASA pipes and fittings*
AS/NZS 4129	*Fittings for polyethylene (PE) pipes for pressure applications*
AS/NZS 4130	*Polyethylene (PE) pipes for pressure applications*
AS/NZ 4158	*Thermal-bonded polymeric coatings on valves and fittings for water industry purposes*

(b) Legislation

Water Act 2000

Electricity Safety Act 2002

Work Health and Safety Act 2011

(c) Other

Department of Energy and Water Supply, *Queensland Water Recycling Guidelines*, December 2005

(d) Authorities

The rules and regulations of the relevant local electricity supply authority.

The rules and regulations of the relevant local water supply authority.
The requirements of any other Authority having jurisdiction over the installation.

SC6.4.6.27.2 Irrigation pipework

(1) Standards
All pipes shall be supplied, installed and joined in accordance with the manufacturer's recommendations and all relevant, current Australian Standards.

(2) Class of pipe

(a) Main line pipes (pressurised) of nominal 80mm diameter and larger shall be minimum Class 12 uPVC rubber ring jointed (RRJ) or PN12.5 (Poly pipe).

(b) Main line pipes (pressurised) of nominal diameter less than 80mm shall be minimum Class 12 uPVC solvent welded joint (SWJ) or PN12.5 (Poly pipe).

(c) All lateral line pipes (non pressurised) shall be minimum Class 6 (uPVC) or PN6.3 (Poly pipe), except for lateral line pipe work under road pavements which shall be Class 12 (uPVC) or PN12.5 (Poly pipe).

(d) Supply line to a drinking fountain or a water tap shall be a minimum of 32 mm Class 12 uPVC or PN12.5 (Poly Pipe). Copper pipe is not acceptable.

(e) Copper pipe to a Water meter, drinking fountain and water tap assemblies shall be minimum Type B.

(f) All irrigation pipe work under pavements (road or otherwise) shall be encased in a conduit.

(3) Conduit crossings

(a) All conduits used to encase irrigation line pipes shall be 100mm Class 9 PVC SWJ Pipe as standard unless otherwise approved by the Superintendent. Storm water or waste water pipe used as conduit is not acceptable.

(b) Conduit crossing ends shall be sealed with duct tape to stop the ingress of soil and material from entering the conduit.

(c) Conduit crossings within road reserves and medians are to have the outer 50mm of conduit sealed with expanded foam, to stop the transportation of water through the conduit.

(d) Where underground bores or conduits crossings have been installed, a stainless steel tag shall be used to mark the start and finish of the conduit. The tag shall be a minimum of 38mm diameter and 1.6mm thick. It is to be nailed, glued or set into the surface of the crossing. The marker shall be engraved with the words "Irrigation Water", given a unique number and recorded on the as constructed drawings.

(4) Pipe fittings

(a) All fittings for uPVC pipe shall be minimum Class 18 PVC SWJ.

(b) All fittings for poly pipe shall be metric compression fittings, Plasson or Philmac.

(c) All fittings for low density pipe shall be barbed type, with all joints fitted with stainless steel cobra clamps – or approved equivalent.

(d) All threaded fittings, except sprinklers, shall be sealed using PTFE thread tape and Liquid Teflon.

(5) Pipe installation generally

(a) Interior of pipes shall be kept free of dirt and debris at all times.

(b) Where pipe work is left unfinished during installation, the open ends of pipes shall be sealed off with plastic secured to the end of the pipe or have end caps fitted.

(c) Pipes laid in a common trench shall be separated by a minimum of 100mm.

(d) Refer to SC6.4.4.8 Standard drawings SD-13.1, Figures 1 to 6 for pipe alignments for all irrigation works in road reserves.

(6) UPVC rubber ring jointed pipe – installation (i.e. Main line pipes of nominal 80mm diameter and larger).

(a) All uPVC rubber ring jointed pipe work shall be installed in accordance with the manufacturer's recommendations and AS 2032.

(b) All uPVC rubber ring jointed pipe work shall be laid in a minimum of 100mm sand bedding and surround.

(c) All connections and changes of direction horizontally and vertically in rubber ring joint (RRJ) pipe work shall be installed with concrete thrust blocks.

(d) Thrust block design and size shall follow pipe manufacturers recommendations ("Thrust Block Design – Pressure Pipeline Fittings" Iplex uPVC Design Manual). Thrust blocks shall be 15 MPA concrete in accordance with AS 2032. All thrust blocks are to be cast in situ against undisturbed ground and shall have neatly formed sides.

(e) The ends of pipes used for rubber ring joint (RRJ) connections shall have a smooth chamfer 15 degrees to the outer edge and shall be free of all burrs and rough edges. Rubber rings and lubricant used shall be in accordance with the pipe manufacturer's recommendations.

(f) Each pipe length shall be laid in the following direction; water flow runs from the socket end to the spigot end of the pipe, with the exception of ring mains.

(g) Trenches may be curved to avoid obstructions within the limits of the curvature of the pipe.

(7) UPVC Solvent welded joint pipe installation (i.e. main line pipes of nominal diameter less than 80mm or lateral line pipes).

(a) All uPVC Solvent welded joint pipe work shall be installed in accordance with the manufacturer's recommendations and AS 2032.

(b) All uPVC solvent welded joints shall be primed and cemented.

(c) Primer and solvent cement shall conform to AS/NZ 3879.

(d) Primer is to be "Priming Fluid (red)".

(e) Solvent is to be "Christy's PVC Red Hot Blue Glue" or approved Type "p" solvent cement.

(f) All pipes shall be primed before cementing the joint.

(g) Pipe ends shall be free of all burs and rough edges.

(h) All uPVC solvent welded joints shall not be subjected to water pressure for at least 24 hours after cementing the joint.

(i) All mainline uPVC solvent welded joint pipes shall be laid in a minimum of 100mm sand bedding and surround.

(8) Polyethylene pipe installation

(a) All polyethylene pipe work shall be installed in accordance with the manufacturer's recommendations and AS 2033.

(b) Poly pipe shall be laid with sufficient allowance for contraction and expansion of the pipe.

(c) Pipe ends shall be free of all burs and rough edges and shall be chamfered with the appropriate tool before jointing.

(d) Polyethylene tapping saddles are only to be used to connect sprinklers and dripper tube to polyethylene pipe work.

(9) Trenching

(a) All pipe work shall be laid in trenches, with the exception of:

(i) pipes which are installed in underground conduits; or

(ii) pipes which are installed above ground due to obstacles i.e. bridges, walls, etc.

(b) Trenches shall:

(i) be sufficiently wide to allow adequate working clearance;

(ii) be excavated in straight lines between bends or pits;

(iii) have vertical sides and be a constant depth for the full length of the trench; and

(iv) be of adequate depth to allow for pipe bedding and adequate cover to the pipe as specified.

(c) Trenches for multiple pipes shall be sufficiently wide to allow adequate working clearance and a minimum of 100mm separation between pipes.

(d) Pipes shall be firmly and evenly supported with bedding material or approved backfill material in the centre of the trench.

(e) Minor adjustment to the irrigation systems design layout will be permitted to clear underground obstructions.

(f) Trenching machinery shall be avoided within 1m of existing services. Hand trench to expose existing services, prior to connection or use of trenching machinery.

(g) Cover to pipes

The minimum and maximum depth of cover to pipes shall be as noted in Table SC6.4.6.27.1.

Table SC6.4.6.27.1 Depth of cover to pipes

Pipe	Minimum	Maximum
Main lines in road reserves (UPVC and Polyethylene)	600mm	750mm
Main lines all other locations (UPVC and Polyethylene)	400mm	600mm
Lateral lines - all locations	300mm	500mm
Drinking fountain and water tap supply lines. (except in land fill sites)	300mm	400mm
Drinking fountain and water tap supply lines in land fill sites	450mm	600mm
Dripper tube (turf)	75mm	100mm
Dripper tube (garden)	Surface	Surface

Note—depth of cover is defined as the distance from the top of the pipe to the finished surface level or from the top of the pipe to the underside of paving, concrete or road pavement. Refer to SC6.4.4.8 Standard drawings SD-18.1 for Typical Pipe Trench details.

(10) Pipe bedding

(a) A minimum of 100mm sand bedding and surround is required for:

(i) all main lines;

(ii) all uPVC Rubber Ring Jointed pipes;

(iii) all pipes under road pavements;

(iv) all pipes laid on solid rock;

(v) all pipes where rubble, rocks and/or debris is encountered in the trench;

(vi) all potable water lines; and

(vii) all electrical conduits.

(b) Bedding sand shall be clean sand with rounded grains free of any rocks, debris and organic matter and graded such that 100 per cent passes a 4.75mm sieve size.

(c) Pipe work, other than those listed in clause SC6.4.6.27.2(10)(a) may be laid without sand bedding, provided the trench is free of rubble, rocks and /or debris.

(d) Pipe work, other than those listed in clause SC6.4.6.27.2(10)(a), in locations where the natural earth contains rocks, debris and any materials that may damage pipes over time or where excessive ground movement is likely to occur shall be laid in a minimum of 75mm sand bedding and surround.

(11) Approved backfill to trenches

(a) Excavated material may be used as backfill, provided that the material is free of rubble, rocks, debris, organic material and any sharp or solid objects and/or materials that may damage the pipe over time.

(b) Where material excavated from the trench is unsuitable for backfill, clean sand, garden loam shall be used as backfill.

(c) Backfill to trenches shall be compacted with a wheel roll or plate compactor. Completed backfill is to be mounded 50mm higher than the surrounding surface for the full length of the trench, to allow for further consolidation.

(d) Backfill to trenches under road pavements and pathways shall be crusher dust material placed in 150mm compacted layers.

(e) On completion of backfilling operations, all excess material is to be either reused on site where possible or shall be removed from the site.

(12) Exposed pipes

(a) Any exposed pipe shall be constructed of stainless steel or lagged copper and shall comply with AS/NZS 3500 standards for exposed pipe.

(b) All above ground works are to conform to AS/NZS 3500.1, Section 5.7 "Support and fixing above ground".

(c) Bracing around the pipes is to be lined with an appropriate material to prevent damage to the pipe.

(d) Pipes are to be labelled “potable” or "non potable" in accordance with Australian Standards.

(13) Proximity to other services

Table SC6.4.6.27.2 lists the separation required between water pipes and electricity and gas services. Separation for all other services shall be as outlined in AS/NZS 3500.1 Section 5.3 entitled “Proximity to other services”.

Service	Separation
Electrical Cables with Warning Tape or Mechanical Protection (Water Pipes DN65mm and below)	100mm
Electrical Cables with Warning Tape or Mechanical Protection (Water Pipes larger than DN65mm)	300mm
Electrical Cables with no Warning Tape or Mechanical Protection	600mm
Consumer Gas Pipe with Marker Tape 150mm above complying with AS2648.1 (Water Pipes DN65mm)	100mm
Consumer Gas Pipe with Marker Tape 150mm above complying with AS2648.1 (Water Pipes larger than DN65mm)	300mm
Consumer Gas with no Marker Tape or Mechanical Protection	600mm

SC6.4.6.27.3 Control system

(1) Scope

This section covers the furnishing of all labour, materials and services in connection with the fabrication, factory testing, delivery and site installation of the irrigation controller and associated cabinets.

(2) Network requirements

(a) Townsville City Council operates an irrigation control system that consists of a Motorola Irrinet Supervisory Control and Data Acquisition (SCADA) System. This system is commonly known as the Irrigation Central Control (ICC). The ICC System communicates to irrigation controllers throughout the Townsville region over UHF wireless telemetry communication networks.

(b) All irrigation controllers shall be operated via the ICC System unless an alternative controller system is approved by the Superintendent

(c) Contractors are required to provide an approved irrigation controller to adequately service the proposed irrigation system. The Controller shall provide for the number of stations including master valve and fertigation control valve required for:

(i) the current irrigation system to be installed; and

(ii) defined future requirements of the controller.

(d) Irrinet M Slave, Irrinet M and Irrinet ACE controllers by Motorola are the approved irrigation controllers.

(e) All irrigation controllers must be capable of communicating with the ICC System across the telemetry communication network. Each controller must be fitted with an approved radio transceiver and antenna.

The transceiver must have the correct frequency configuration to communicate on the network.

(f) Each irrigation controller shall be allocated a logical address by Maintenance Services – Irrigation Design Unit for communications to the ICC System.

(g) All irrigation controller system components shall operate within the ranges specified by the manufacturer.

(3) Irrigation controller selection

(a) Irrigation controllers are to be selected from Table SC6.4.6.27.3.

Table SC6.4.6.27.3 Controller selection list

Controller Name	Power Type / Source	Valve Capacity
AC Irrinet M Slave 12 - 24	AC / 240 V Mains	12 to 24
AC Irrinet M Slave 36 - 48	AC / 240 V Mains	36 to 48
AC Irrinet M 12 - 24	AC / 240 V Mains	12 to 24
AC Irrinet M 36 - 48	AC / 240 V Mains	36 to 48
AC Irrinet ACE 24 - 48	AC / 240 V Mains	24 to 48
XR 1 - 4	DC / 6 V Solar	1 to 4

(b) AC powered irrigation controllers are the preferred option of the Superintendent. DC powered irrigation controllers are not acceptable unless approved by the Superintendent.

(4) Operating environment
Ambient conditions

(a) All equipment mounted inside cabinets and cubicles shall be suitable for operation in temperatures up to 60 °C. Measures shall be taken to ensure that high ambient temperatures and full load operation do not cause temperatures to exceed maximum allowed operating temperatures.

(b) Since all cabinets are to be mounted outdoors, particular consideration shall be given to minimise heating by direct solar radiation.

(5) Irrigation controller specification (general)

(a) General requirements

(i) The irrigation controller cabinet and component parts shall conform in all respects to the highest standards of design and workmanship and appropriate requirements of the latest applicable state or local codes.

(ii) When mounting accessories to the back panel, use fine threaded tapped screws.

(iii) The irrigation controller cabinet shall be completely wired, and assembled, with all devices and controls installed as shown in SC6.4.4.8 Standard drawings SD-5.1 through SD-5.10 and SD-20.1 through SD-29.1 so that the entire assembly is an operating unit ready for installation and the wiring of field devices.

(iv) Wiring shall meet the latest requirements of the AS 3000 and applicable workplace safety codes.

(b) Wiring

(i) All wire shall be 0.5mm²/PVC 105/ stranded, insulated for 600 V.

(ii) A "bootlace ferrule" shall be used on wires connected to terminals which have only a screw for securing the wire. Ferrules shall be properly crimped using a professional crimping tool.

(iii) All manufacturer terminal block wiring shall be restricted to the panel side of the blocks. The manufacturer shall connect no more than two wires to any terminal point. The field side of the terminal blocks shall be left completely free of wires and jumpers. Wiring on terminal blocks shall be so arranged that not more than one wire to the field side of any terminal point will be connected with the exception of the earth.

(iv) All multiple common connections shall be wired via bridging links on the terminal blocks.

(v) Horizontal and vertical wiring between the terminal blocks and the devices shall be enclosed in ducts except wiring between the ducts and the devices may run exposed for distances not exceeding 100mm. Duct loading shall not exceed 75 per cent rated fill at any point.

(vi) All exposed wiring shall be formed neatly with square corners and where possible, grouped in packs. Each pack shall be bound with plastic ties and be substantially supported throughout its full length. Cabled wire is not acceptable.

(vii) Splicing of wires on electrical circuits is not acceptable.

(c) Terminal blocks

Terminal blocks shall be provided for all wiring which exits the panel. All terminal blocks shall be mounted and of the colour as shown in SC6.4.4.8 Standard drawings SD-5.1 through SD-5.10 and SD-20.1 through SD-24.8.

(d) Consumer power

(i) The irrigation control cabinet shall be equipped with a (Clipsal 4CC6 or approved equivalent) enclosed consumer panel. Consumer power shall be wired direct into the consumer panel. The consumer panel shall enclose a neutral link and an earth bus with the panel structure connected to the bus so as to effectively earth the entire structure. A solder-less clamp type terminal lug shall be provided at the end of the earth bus for a 6mm² stranded earth cable to be attached from the external earth-stake.

(ii) Whenever the electrical diagrams indicate an earth for a circuit at the panel, a single wire for each circuit earthed shall be run independently to the earth bus and fastened thereto using a ring lug and a machine screw inserted in a tapped hole.

(iii) Earthing of the enclosure and back panel from the consumers panel shall be made using 4mm² stranded earth cable.

(iv) The consumer panel shall be wired with a main isolation switch an RCD/MCB and a suitably rated "Isatrol" mains filter unit, din-rail mounted within the consumer panel to provide power to the GPOs. One double GPO and one single GPO are to be mounted on the face cover of the consumer panel. Care shall be taken when positioning the GPOs not to cover the access screw holes to the consumer panel.

(v) Each device requiring 240 V AC power shall have an individual line plug and plug into an allocated GPO on the consumer panel.

(vi) Power will be supplied as a single phase voltage at 50 Hz and 240 V ± 10 per cent.

(vii) All 240 V connections are to be tool proof and either housed in the consumer panel or behind a protective cover.

(6) Irrigation controller specifications (specific)

(a) Irrinet M Slave, Irrinet M and Irrinet ACE.

(i) Each controller's maximum valve output is listed in Table SC6.4.6.27.3 including master and fertigation valves. The controller shall have as a minimum, two inputs from electronic pulse water meter and rain switch.

(ii) The general control voltage shall be 24 VAC for controller outputs used for water valve operation.

(iii) The 24 VAC power is via the PELV system with common tied to earth.

(iv) The irrigation controller cabinet layout, dimensions and wiring are shown in SC6.4.4.8 Standard drawings SD-5.1 through SD-5.10 and SD-20.1 through SD 29.1.

(v) The irrigation controller cabinet shall be a B&R NI (NI06062/S) or (NI06063/S) with dual key lock (NI030) or approved equivalent as shown within SC6.4.4.8 Standard drawings SD-5.1 through SD-5.10 and SD-20.1 through SD-29.1. The controller pole, mast and cross arms shall be coated with 2PAK Epoxy Paint in Heritage Green colour.

(vi) Control equipment shall be selected from the Preferred Equipment list - Controller and Telemetry Components within SC6.4.4.8 Standard drawings SD-5.1 through SD 5.10 and SD-20.1 through SD-29.1, unless otherwise specified by the Superintendent.

(vii) All firmware incorporated in CPUs and other intelligent modules shall be the latest released

version.

(viii) The radio telemetry equipment involves the installation of the following equipment:

(A) TX-3600 GME Transceiver with blind front panel, programmed with Parks Services frequencies;

(B) YB6-61 Yagi Antenna, UNV2 mounting bracket and RG58 coax cable terminated with a N88 N type male connector;

(C) PS123 GME Power Supply or DC1224X Aeon UPS (for Irrinet M controllers);

(D) IS50NX Surge Arrestor flange mounted with N type female connectors;

(E) RG58 Coax Fly Lead terminated with N88 N type and BNC113 male connectors; and

(F) Data cable connecting controller to transceiver.

(ix) The transceiver shall be mounted on the door such that the indicator lights are visible when the door to the panel is opened. The antenna cable and data cable are to be feed from the controller via the cabinet ducting towards the door hinge and onto the door bracket. The transceiver shall be mounted in such a way to allow for its easy removal. The mounting bracket is to be securely fastened to the back of the door. All cabling on the door shall be neat and fastened in place by cable ties, SC6.4.4.8 Standard drawings SD-26.2, SD-26.4 and SD-5.10 refers.

(x) A Surge Arrestor shall be mounted on the cabinet earth lug and suitably earthed refer SC6.4.4.8 Standard drawings SD-27.1 and SD-5.10. The coax fly lead shall be connected from the transceiver BNC connector to the “Equipment” side of the surge arrestor. The coax cable from the antenna will enter the panel and be terminated on the “Antenna” side of the surge arrestor.

(xi) Before the transceiver is powered up a qualified radio technician shall fit the antenna coax plug and carry out a SWR / radio check and set the modulation level.

(xii) The “data cable” shall connect the controller to the transceiver and shall be secured and neatly run through the ducting.

(xiii) PS123 GME Power Supply 240 VAC to 12 VDC is to be mounted on the door bracket to supply power to the Transceiver and Interposing Relays refer SC6.4.4.8 Standard drawings SD-5.5.

(xiv) DC1224X Aeon UPS (uninterrupted power supply) 240 VAC to 12 VDC is to be mounted on the door bracket to supply power to the Irrinet CPU memory and Transceiver, refer SC6.4.4.8 Standard drawings SD-20.1 through SD-29.1.

(xv) A separate 24 V AC power supply shall be provided as shown within SC6.4.4.8 Standard drawings SD-5.1 through SD-5.10 and SD-20.1 through SD-29.1:

(A) Irrinet M, Irrinet M Slave and Irrinet ACE controllers require 1 Powertech 240 V/24 V 150 VA Transformer part No. MP3045 to be direct mounted to supply power to the controller and field solenoids.

(xvi) The controller shall have two conduits connecting the cabinet to the ground. The following conduit types and sizes shall be used:

(A) M.D. 50 mm electrical conduit (24 V Control Cable); and

(B) H.D. 25 mm electrical conduit (240 V Power Supply).

(xvii) A Mini-Clik II Rain Switch or approved equivalent is to be installed on the controller pole. Construction details are given in SC6.4.4.8 Standard drawings SD-29.1. The device is to be set on a 13mm setting.

(b) Piccilo XR

(i) The output control voltage used is a DC Pulse through a 2 wire circuit suitable for activating DC latching coils used for water valve operation - Hunter ICV with DC Coil option or approved equivalent. With the Piccilo XR output voltage adjusted to 18 V (from the factory default of 12 V).

(ii) The controller assembly is powered by a 6 volt sealed lead acid battery which is charged via a solar panel and regulating semiconductors. SC6.4.4.8 Standard drawings SD-4.2.

(iii) The irrigation controller cabinet layout, dimensions and wiring are shown in SC6.4.4.8 Standard drawings SD-4.1 through SD-4.4.

(iv) The Irrigation controller cabinet shall be a B&R NI (NI03021/S) with single key lock (NI030) or

approved equivalent as shown within SC6.4.4.8 Standard drawings SD 4.1 through SD-4.4. The controller pole, mast and cross arms shall be coated with 2PAK Epoxy Paint in Heritage Green Colour.

(v) Control equipment shall be selected from the Preferred Equipment list - Controller and Telemetry Components within SC6.4.4.8 Standard drawings 4.5, unless otherwise specified by the Superintendent.

(vi) All firmware incorporated in CPUs and other intelligent modules shall be the latest released version.

(vii) The radio telemetry equipment involves the installation of the following equipment:

(A) Qty 1, CD51 Whip Antenna (cut to wave length) with .5M of RG58 coax cable terminated by a SMA type male connector;

(B) Qty 1, Antenna Mounting Bracket; and

(C) the radio telemetry component is integrated within the XR Controller unit. So no external transceiver is required.

(viii) The antenna coax SMA male plug shall be connected into the XR Controller SMA socket mounted on the top of the unit.

(ix) Before the XR Controller is powered up a qualified radio technician shall fit the antenna coax plug and carry out a SWR / radio check on site.

(x) A Kyocera Mini Module Solar Panel as detailed in SC6.4.4.8 Standard drawings SD 4.5 shall be fastened to the top of the enclosure refer SC6.4.4.8 Standard drawings SD-4.3. An external grade silicon base sealant shall be applied to the solar panel perimeter to maintain the enclosure IP rating.

(xi) The regulator components shall be installed as detailed in SC6.4.4.8 Standard drawings SD-4.2 and tested by an electronics technician prior to final connection of the battery and XR units.

(xii) A 6 V 12 AH SLA Battery is placed inside on the bottom of the enclosure and connected to the terminal blocks. Refer SC6.4.4.8 Standard drawings SD-4.1 and SD 4.2.

(xiii) The controller shall have one 25mm conduit connecting the cabinet to the first electrical pit.

(7) Controller location

The final location of the controller shall be determined by taking into consideration all of the following factors:

(a) radio path tests (to be carried out by a qualified radio technician) to ensure reliable communications from the controller to the ICC System Base Station;

(b) the location shall be clear of large trees or structures that may interfere with the performance of radio communications, or solar panel. In newly planted areas the location shall make allowance for future tree growth;

(c) safe 24 hour access for maintenance by maintenance services personnel and equipment;

(d) the location shall allow access by motor vehicle and elevated platform (antenna servicing); and

(e) the Controller shall not be installed less than 3 m from a roadway unless approved by the Superintendent.

(8) Cabinet installation

The pre-assembled Controllers shall be installed in the ground as follows:-

(a) The pre-assembled Controller cabinet support post shall be embedded in a 200mm diameter x 600mm deep hole with a 400mm deep concrete footing (N25 concrete minimum). The concrete shall be poured up to the underside of the conduits entering the support post. Covering the conduits in concrete is not acceptable. The Cabinet shall be installed at a height of 1200mm from the finished ground level to the underside of the cabinet (1090 mm for XR controllers Refer SC6.4.4.8 Standard drawings SD-4.4).

(b) XR Controller Cabinet is to be orientated with the door side facing north to maximise the absorption of solar radiation into the solar panel, unless approved by the Superintendent.

(9) Controller cabinet and controller wiring

(a) All conduits shall be terminated at the controller cabinet with a suitable conduit adaptor. All conduits shall be sealed with an external grade Butyl Mastic sealant, such as “Selleys Butyl Mastic” or similar approved to a depth of 25mm into the conduit to prevent vermin entering the controller cabinet.

(b) Earth stakes shall be located in the electrical pit adjacent the controller. The location of the earth stake is to be indicated on the as constructed drawing.

(c) Earth stake connections are to be sealed with cold gal paint.

(d) All field wired cables entering the controller cabinet shall be made secured – in this instance only by the application of sealant to the conduit end inside the enclosure (see clause (9)(a) above). From this point on, the double insulation shall be removed from the cable for ease of wiring to the terminal blocks.

(e) All single insulated cables inside control cabinets shall be loomed together and cable tied in a neat orderly manner to the panel so that the connections into the terminal strip are not stressed.

(f) All cables inside the controller cabinet shall be of sufficient length to ensure that all cores will reach their termination point without any stress or joining of cables.

(g) All field cables inside the controller cabinet shall be of sufficient length to ensure that all cores will reach the upper and lower most termination points without any stress or joining of cables.

(h) All cables to be connected within the controller cabinet shall be terminated with a bootlace ferrule, CABOC BLP 150 or similar approved. Pin lugs are not acceptable.

(10) Field electrical wiring

(a) Cable types

(i) All electrical cabling shall conform to current Australian Standards.

(ii) All cables shall be Tyflo multi-core irrigation cables or similar approved with a minimum core size of 1.5 mm. Table SC6.4.6.27.4 details cable specifications.

Table SC6.4.6.27.4 Multicore cable specifications

Nominal core dia.	Conductor no. and size	Amp rating	Resistance Ohms/Klm	Number of cores
1.5 mm	7/0.50	16	13.6	3,5,7,9,13
2.5 mm	7/0.67	23	7.4	2,7
4 mm	7/0.85	30	4.6	2

(iii) All cables shall have an outer sheath of flexible 75□C PVC to AS/NZS 3808, over an Inner core of a sheath of HDPE, over a multi-strand plain copper wire.

(iv) Inner cores are to be readily available in 13 colours namely- Black, Blue, Green, Dark Brown, Brown, Grey, Light Blue, Orange, Pink, Red, Violet, White and Yellow.

(b) Cable installation

(i) A 7 core cable shall be run continuously from the controller to the water meter assembly solely for the operation of Master Valve, Pulse Meter and Fertigation. The black core shall be common, red core shall be Master Valve control, brown core shall be Fertigation control and run to the Fertigation Venturi Point and the blue and white shall be Pulse Meter and Pulse Meter common respectively.

(ii) An additional 20% of the total number of cables or 2 extra cores (whichever is the greater) shall be provided as spares. Designated spares shall run from the controller to the furthest most point from the controller in the cable run. The spares are to be marked at the controller. At the furthest point all spares shall be connected together and sealed with heat shrink so that a continuity test can be performed at the controller to confirm the total number of spares.

(iii) All extra low voltage cables shall be installed inside a conduit. The conduit size used shall be a minimum size of 50mm or 2.5 times the combined size of all the cables being installed, whichever is the greater.

(iv) The single insulation on the cable core shall not be cut or damaged when the outer sheath (double

insulation) is removed. All cables shall have the insulation removed from the cores using appropriate cable strippers. Use of a knife or other sharp blade is not acceptable practice.

(v) Cables shall be continuous between electrical inspection pits. Cable joints located between electrical inspection pits are not acceptable. Cable joints shall be kept to a minimum and shall only occur at valve take off points.

(vi) Where required each individual cable shall be joined using the appropriately sized insulated crimp links, to maintain a double layer of insulation at the joint after the heat shrink is installed, and shall be installed with a professional ratchet type crimping tool.

(vii) Bare conductors shall not be exposed.

(viii) Each individual cable joint shall be waterproofed by using ES-2 resign filled heat shrink three times the length of the insulated crimp link.

(ix) Multiple cables shall not be joined or heat “shrinked” together.

(x) All cut unused cables (spares) shall be sealed using ES-2 resign filled heat shrink.

(xi) Cable markers shall be attached to each cable at every electrical inspection pit indicating the individual cable number as shown on the design plan; refer SC6.4.4.8 Standard drawings SD-7.2. Cable markers shall be round 38mm diameter aluminium identification tags commercially available. Numbering shall be clearly stamped onto one side of the tag using a punch set with 13mm high numerals. Tags shall be fastened to the appropriate cable using a quality grade plastic cable tie attached at the mid-point of the cable loop.

(xii) The Black cable shall be used as the designated common.

(xiii) All spare cable in electrical inspection pits shall be left full length, individually sealed with heat shrink and grouped together.

(xiv) All continuous cable that passes through an electrical inspection pit shall have a loop of at least 1.5m in length and be neatly coiled and tied.

(xv) A draw wire is to be left in the conduit from the controller cabinet to the first electrical inspection pit.

(xvi) All electrical cable locations shall be recorded on the as constructed drawings.

(c) Electrical inspection pits

(i) Electrical inspection pits shall be heavy duty rectangular with rounded ends and fitted with a precast concrete lid, type P1 or P2.

(ii) The first electrical inspection pit shall be located a maximum of 1m from the Controller cabinet support base. A draw wire together with the electrical cables is to be installed in the conduits from the controller to the first electrical pit to allow for future works.

(iii) Electrical inspection pits shall be located adjacent to valve boxes and offset from the main irrigation line a maximum of 200mm as shown in SC6.4.6.27 Attachment A 17.2 (Plan View).

(iv) Electrical inspection pits shall be located at changes in direction and no more than 50m spacing.

(v) Electrical inspection pits shall be installed so that the top of the pit is flush with the finished surface level and matches the slope of the finished surface level.

(vi) All electrical inspection pit locations shall be recorded on the as constructed drawings.

(vii) All conduits shall enter at the end of an electrical pit. Side entry of conduits into electrical pits in not permitted.

(viii) All conduits shall enter an electrical pit at no greater than 45 degrees of the horizontal centre.

(ix) Electrical pits shall not be installed in drainage swales or places where water is collected during rainfall and irrigation.

(x) Electrical pits shall not be installed less than 3m from the road kerb, unless approved by the Superintendent.

(d) Electrical conduits

(i) All electrical conduit shall conform to current Australian Standards.

(ii) All conduit (extra low voltage electrical) buried in ground shall be Grey M.D.

(iii) All electrical conduits that are exposed above ground shall have a protective outer sheath of polyethylene pipe rating PN12.5. The sheath is to encase the conduit for the entire length of conduit above ground and for a depth of 150mm minimum below ground.

(iv) All electrical conduits that are exposed above ground shall be fixed in place so that they are vertical and shall be secured firmly to the accessory.

(v) Electrical conduit above ground shall be adequately secured to avoid damage by grass cutting operations.

(vi) All electrical conduit ends shall be neatly cut and free of burrs or rough edges.

(vii) The final 500mm of conduit entering an electrical inspection pit shall be M.D. corrugated flexible conduit which is to be connected to the M.D. PVC Conduit by a Socket. SC6.4.4.8 Standard drawings SD-17.2 (Electrical Pit), gives a typical construction drawing of the assembly.

(e) Electrical conduit trenching

(i) All electrical conduits shall be laid in trenches and bedded in sand.

(ii) Low voltage conduits (240 V) shall be installed with continuous electrical warning tape laid over the conduit for the entire length of the trench.

(iii) Low voltage conduit (240 V) shall not be installed in the same trench as irrigation lines.

(iv) Extra low voltage conduits (24 V) installed in the same trench as irrigation lines shall be bedded in sand and separated from the irrigation lines by a minimum distance of 100mm.

(v) Depth of cover to electrical conduits from finished surface level or from the underside of finished pavement level (e.g. pavers or concrete) shall be:

(A) 300mm minimum - for extra low voltage cables (24 V); and

(B) 600mm minimum - for low voltage cables (240 V). Refer SC6.4.4.8 Standard drawings SD-18.1.

(vi) Electrical conduits under roadways shall be a minimum 50mm M.D. Electrical conduit encased in a 100mm Class 9 PVC Pipe.

SC6.4.6.27.4 Water meter assembly

(1) Design and installation

(a) Water meter assembly components vary, as follows:

(i) For drinking fountains and water taps (potable water) the water meter assembly includes:

(A) isolation valve; and

(B) mechanical water meter (supplied by Townsville Water, a business unit of Townsville City Council).

(ii) For irrigation the water meter assembly includes:

(A) isolation valve;

(B) mechanical water meter (supplied by Townsville Water);

(C) master valve and electronic flow meter unit;

(D) RPZ back flow prevention device with two isolation valves;

(E) screen filter;

(F) lockable cover;

(G) cable and conduit; and

(H) protective bollards (depending on location).

Table SC6.4.6.27.5 Allowable water meter assembly component size combinations

Water Service	Townsville Water Water Meter	Irrigation Water Meter	Backflow	Master Valve
25mm	25mm	32mm Arad Multijet (1 pulse/10L)	25mm	25mm Hunter ICV*
32mm	32mm	32mm Arad Multijet (1 pulse/10L)	32mm	25mm or 40mm Hunter ICV*
50mm	50mm	Include in Master Valve (1 pulse/10L)	50mm	50mm Arad Hydrometer
80mm	80mm	Include in Master Valve (1 pulse/10L)	80mm	80mm Arad Hydrometer
100mm	100mm	Include in Master Valve (1 pulse/100L)	100mm	100mm Arad Hydrometer

*external master valve

(iii) All water meter assemblies with a 25mm and 32mm Water Service are to have a master valve external to the main assembly. Refer to SC6.4.4.8 Standard drawings SD-10.3 and SD-10.4.

(iv) Water meter assemblies with a water service sized, 50mm, 80mm and 100mm are to have a master valve as part of the main assembly. Refer to SC6.4.4.8 Standard drawings SD-10.1 and SD-10.2.

(b) Water meters

(i) All water meters and pipe work from the town mains to the water meter shall be supplied and fitted by Townsville Water.

(ii) The water meter type is selected by the following criteria:

(A) for drinking fountains and water taps a standard mechanical water meters shall be used.

(B) for irrigation refer to Table SC6.4.6.27.5 for water meter selection relative to the water service size.

(c) Master valves

(i) All irrigation systems shall be fitted with a master valve.

(ii) The master valve is to be selected by the following criteria:

(A) all water service assemblies sized 25mm and 32mm shall have an external master valve installed in a valve box and shall be fitted to the copper tail pipe of the backflow device. Refer to SC6.4.4.8 Standard drawings SD-10.3 and SD-10.4 for installation details; and

(B) all water service assemblies sized, 50mm, 80mm and 100mm shall be fitted with an assembly mounted master valve. The master valve is to consist of a flange mounted Arad Hydrometer including water (flow) meter module as detailed in Table 5 and 24VAC Solenoid actuator; or approved equivalent. Refer to SC6.4.4.8 Standard drawings SD-10.1 and SD-10.2 for installation details.

(d) Backflow devices design and installation

(i) Backflow prevention is to conform to AS 2845.1, AS 2845.2 and AS 2845.3.

(ii) The Backflow device shall be selected on the required size:

(A) 25mm, 32mm, and 50mm - Tyco Backflow System RP03 or similar to the following specification. The assembly shall be connected with the “ring and tail” to allow easy removal or replacement of the device in accordance with AS/NZS 3500.1. Main valve and internals shall be of stainless steel construction and to have pressure rating of 1600 kPa and a temperature rating of 90ºC. All internal parts and elastomers are to be accessible through a top entry point of the main valve to allow inline maintenance. Valve shall also be fitted with test points with BSPT threads to allow testing to AS 2845.3; and

(B) 80mm and 100mm - Tyco Backflow System RP03 or similar to the following specification. The main valve shall be constructed from ductile iron and coated with Rilsan Nylon 11 to AS/NZ 4158. All internals shall be constructed from stainless steel and to have pressure

rating of 1600 kPa and a temperature rating of 60ºC. Main valve body shall not form part of the wetted check valve sealing area or mechanism. All internal parts and elastomers are to be accessible through a top entry point of the main valve to allow inline maintenance. Valve connection shall be flanged to AS/NZS 4087. Valve shall also be fitted with test points with BSPT threads to allow testing to AS2845.3.

(iii) The velocity through the backflow device shall not exceed 2.2 m/s.

(iv) All backflow devices shall be reduced pressure zone (RPZ) rating.

(v) All backflow devices sized 25mm, 32mm, and 50mm shall be fitted with a locking mechanism, which prevents the two isolation valves and the three test cocks from unauthorised opening. The backflow device is to be lockable at a single point. A council standard series A padlock is to be fitted to the locking mechanism.

(e) Isolation valves

(i) All isolation valves fitted to the water service assembly shall be tested and approved to Australian Standards.

(ii) All isolation valves fitted to the water service assembly shall be selected on the following criteria:

(A) all water meter assemblies sized 25mm, 32mm and 50mm shall be fitted with brass ball valves; and

(B) all water meter assemblies sized 80mm and 100mm shall be fitted with resilient seated gate valves.

(f) Strainer

All water meter assemblies shall be fitted with a brass strainer immediately downstream of the isolation valve and upstream of the back flow device. Refer SC6.4.4.8 Standard drawings SD-10.1 to SD-10.4 for details.

(g) Water meter assembly installation

(i) The water meter assembly shall be supported by the appropriate size Support Stands as detailed in SC6.4.4.8 Standard drawings 10.5 and set into a concrete footing as detailed SC6.4.4.8 Standard drawings SD-10.1 to SD-10.4. A minimum distance of 300 mm from the underside of the assembly to the finished ground level is required.

(ii) A lockable stainless steel sheet metal cover shall be fitted over the water meter and master valve to prevent vandalism and weather damage. Water meter assembly covers shall be built from 316 Stainless Steel as detailed in SC6.4.4.8 Standard drawings SD-31.1 and SD-31.2 and for water meter assemblies sized:

(A) 25mm, 32mm, the cover shall be held in place using U-bolts; and

(B) 50mm, 80mm and 100mm the cover shall be fastened between each set of tightened flanges, using flange bolts.

(iii) Each cover shall be locked using a 40mm KA1 series lock.

(iv) A minimum of two recycled plastic bollards shall be provided at each water meter assembly as directed by the Superintendent, to protect the assembly from vehicle damage, except in garden beds.

Bollards shall be nominal 100mm diameter blue recycled plastic, embedded 450mm minimum into a 350 mm diameter concrete footing. The top of the bollards shall be 900mm above finished ground level.

(v) All cables running from the water meter to the ground shall be encased in a protective outer sheath of polyethylene pipe rating PN12.5. The conduit shall be firmly installed vertical to the ground so as not to be easily damaged by grass cutting operations.

(vi) Copper pipes shall be Type B.

(vii) All fittings to the backflow device shall be either copper of brass. PVC or Poly fittings are not acceptable.

(2) Valve assembly

(a) Design and installation

(i) The valve assembly includes:

(A) solenoid valve;

(B) ball valve;

(C) brass barrel union; and

(D) valve box.

(ii) Refer SC6.4.4.8 Standard drawings SD-10.6, SD-14.3 and SD-14.4 for standard details. Valves shall be connected to the main line via a tee.

(b) Solenoid valves

(i) Refer SC6.4.4.8 Standard drawings SD-10.6, SD-14.3 and SD-14.4 for solenoid valve assembly details.

(ii) Solenoid valves used shall be sized in accordance with Table SC6.4.6.27.6.

Table SC6.4.6.27.6 Approved solenoid valves

Manufacturer	Model	Size	Maximum flow rate (litres per minute).
Hunter	ICV	25mm	100
Hunter	ICV	40mm	250
Hunter	ICV	50mm	360
Hunter	ICV	80mm	700

(iii) Electronic solenoids for AC systems shall be 24 volt coils.

(iv) Electronic solenoids for DC systems shall be 12 volt 2 wire latching coils.

(v) Solenoid valves shall be wired in the following order:

(A) the first controller output shall be assigned to the master valve control;

(B) stations are to be wired to the controller outputs from output 2 on. Station 1 (Controller output 2) is to be located on one side of the site. The last station is to be located on the opposite side of the site. The controller outputs are to follow a logical geographical pattern from one side to another; and

(C) the same wire colour shall be maintained along the entire length of the cable run between the controller and each individual solenoid valve.

(vi) Only one valve shall be allocated per controller output.

(vii) Doubling up of stations on the same output is not allowed.

(viii) Valve boxes shall not be installed within 3m of the road kerb unless approved by the Superintendent.

(ix) The distance from a valve to the first sprinkler or first drip emitter shall not exceed 50m.

(c) Gate and Ball valves

(i) A Ball valve shall be installed on the upstream side of the Solenoid valve. A brass barrel union shall separate the Ball valve from the Solenoid valve to allow for ease of maintenance. Refer to SC6.4.4.8 Standard drawings SD-10.6, SD-14.3 and SD 14.4.

(ii) Ball valves shall be tested and approved to AS 3500.1.

(d) Valve boxes

(i) The valve assembly is to be located in a heavy-duty lockable valve box fitted with a stainless steel lock-down bolt in the lid.

(ii) Valve boxes shall be Heavy Duty Carson or similar approved.

(iii) Valve boxes used are to be of adequate size to ensure that there is sufficient space around the valve assembly to allow for ease of maintenance.

(iv) Valve boxes shall not require removal to facilitate maintenance of the valve assembly.

(v) All valve boxes shall be:

(A) supported on bricks so that the box does not rest on any pipes;

(B) installed so that the top of the box is flush with the finished turf surface level for turf areas, or 50mm to 100mm above the finished mulch surface level for garden areas;

(C) installed so that the clearance from the underside of the valve box lid to the top of the stem of the valve is; 150mm maximum – 50mm minimum for non drip valves and 75mm maximum – 50mm minimum for drip valves, refer SC6.4.4.8 Standard drawings SD-10.6, SD-14.3 and SD-14.4;

(D) installed so that the clearance from the underside of the valve housed within the valve box to the bottom of the box is at least equal to or greater than 50mm;

(E) the pipe holes shall be sealed with Geofabric around the openings to prevent the ingress of foreign material in the valve box;

(F) cutting of valve boxes for entry/exit of pipe work shall be keep to a minimum, boxes cannot be cut higher than 1/3 its height. Over cut boxes are not acceptable; and

(G) installed in association with its housed components so as not to require excessive cutting of the valve box to the satisfaction of the Superintendent.

(vi) All valve box lids shall be clearly marked with the identification of the contents using the follow key:

(A) IV = Isolation Valve;

(B) MV = Master Valve;

(C) A1 = Controller A Station 1 (Refer SC6.4.4.8 Standard drawings SD-8.1) for valve key; or

(D) 3 digit DTMF number as supplied by the Superintendent, for example “045” identifying the Irrinet System number.

(vii) Valve box lids shall be engraved by using a 50mm to 75mm high Signet 14474 / 14494 zinc Stencil Set or approved equivalent as a template. The engraving finish shall be evenly 1.5mm deep at its deepest point and between 4mm to 8mm wide by using an engraving power tool fitted with a spherical engraving bit. The finished engraving shall then be painted with a Signet 12205 White Marker or approved equivalent. Note excessively deep engraving will weaken valve box lids and is not acceptable.

(viii) No valve boxes shall be installed in drainage swales or places where water is collected during rainfall.

(ix) Stainless steel re-enforcing plates may be fitted to valve box lids to repair damaged threads only.

(x) Conduit connecting valve boxes with electrical inspection pits and other Valve Boxes is to be M.D. corrugated flexible conduit of a minimum 500mm and maximum 1500mm in length. SC6.4.4.8 Standard drawings SD-17.2 gives a typical construction drawing of the assembly.

(e) Valve nest enclosures

(i) Refer to SC6.4.4.8 Standard drawings SD-33.1 through SD-33.4 for valve nest enclosure details.

(ii) Valve nest enclosures may be installed where groups of more than three valves can be located together.

(iii) Allowance must be made for larger lateral pipe sizes to offset increased friction losses where longer lateral pipe lengths are required.

(iv) Allowance must be made for increase lateral sizes and quantity leaving the one location.

(v) Where three or more laterals leaving a valve nest cover share a common trench, bedding sand must be used to back fill trenches.

(vi) Lateral pipes leaving a valve nest cover must be run parallel in trenches (not twisted).

(vii) Valves inside a valve nest cover must be clearly identifiable via round 38mm diameter aluminium identification tags commercially available. DTMF numbering shall be clearly stamped onto one side of the tag using a punch set with 13mm high numerals. Tags shall be fastened to the appropriate solenoid valve using a quality grade plastic cable tie.

(viii) Electrical cables shall be cable tied to each solenoid valve control valve.

(ix) Enclosures shall be fitted with a pad lock and keyed to fit council “F” series.

(x) Solenoid valves shall be connected to a common copper manifold via individual brass barrel union and ball valve.

(xi) Copper manifolds (from 40mm to 80mm) must be of sufficient size to allow multiple stations to run simultaneously in program where required.

(xii) Copper manifolds connecting to PVC mainline shall be done via Cop-A-Mate flange or approved similar, installed 25mm above ground level.

(xiii) Copper manifolds connecting to Poly mainline shall be done via metric female compression fitting installed 25mm above ground level.

(xiv) Install Valve Nest Cover using 10mm 316 S.S dyna bolts fastened to 200mm diameter by 300mm deep concrete footings poured on site.

(xv) Top of concrete footings shall be installed level and 25mm above finished ground level.

SC6.4.6.27.5 Sprinklers, turf valves and drip irrigation

(1) Sprinkler design

(a) Sprinklers used shall be in accordance with Table SC6.4.6.27.7.

Table SC6.4.6.27.7 Approved sprinklers

Manufacturer	Model	Type
Hunter	PGP	Gear
Hunter	MPR	Rotating Nozzle**
Toro	570	Static
Rainbird	3500	Gear
Rainbird	5000 Plus	Gear
Rainbird	5505	Gear
Rainbird	6504	Gear

** Use on Toro 570 Body.

(b) Sprinkler uniformity shall not exceed a scheduling coefficient of 1.3 (5 per cent Window) SC6.4.4.8 Standard drawings SD-19.1, provides a definition of the scheduling coefficient and the process for calculation.

(c) Where possible, individual sprinkler stations shall be fitted with either all full circle sprinkler arcs or all part circle sprinkler arcs.

(d) All sprinklers on the same valve shall provide “matched precipitation”. The ratio of water supplied shall be even across all arcs of coverage. Sprinklers of different pressure and / or precipitation rate on the same station are not acceptable.

(e) The variation in flow between any sprinklers on a single station is not to exceed 10 per cent.

(f) All sprinklers are to be run at the manufacturer’s recommended pressure.

(g) All sprinkler heads on each individual station shall be the same type.

(h) Locations which are susceptible to low head drainage shall be fitted with either internal check valves, or Hunter or similar approved external check valves.

(i) No water shall be applied by design to locations where over spray is undesirable, (i.e. adjacent non-irrigated areas, roads, footpaths, private property etc.). The manufacturer’s published throw distance shall govern for design purposes.

(j) On roadway corners no water shall be applied by design to the road pavement whilst no unirrigated areas shall exceed 1m from the road edge. The manufacturers published throw distance shall govern. Examples of acceptable sprinkler layouts are given in SC6.4.4.8 Standard drawings SD-16.1.

(k) All static sprinklers are to be fitted with “fixed pattern” nozzles.

(l) Sprinklers are to be designed and installed in such a way that no electrical boxes, control cabinets, transformers, meter assemblies and the like are hit by direct water streams.

(2) Sprinkler installation

(a) No sprinklers shall be fitted until all main lines, lateral lines and risers have been flushed clean.

(b) Sprinklers shall be placed 150mm clear from walls, garden edges, pathways and the back face of concrete kerbs or concrete garden edges.

(c) Sprinklers shall be installed as detailed in SC6.4.4.8 Standard drawings SD-12.1 Figure 2, slightly above the finished surface level.

(d) Sprinklers shall be installed plumb unless placed on a slope in which case they shall match the slope of the surface.

(e) Where directed by the Superintendent sprinklers in grassed areas shall be installed with a sod of turf (300mm square) placed around them at the finished surface level to help stabilise the sprinkler.

(f) Sprinklers shall be connected to pipes (lateral lines) via either a tapping saddle or a BSP/F Tee and a flexible swing hose riser. All swing hose risers shall face downstream of the solenoid valve. Refer to SC6.4.4.8 Standard drawings SD-12.1 Figure 1.

(g) In locations where soils may be of a corrosive nature, 316 stainless steel bolt and nuts shall be used on all tapping saddles.

(h) The flexible swing hose riser used shall be either:

(i) 25mm safety yellow industrial hose, with nylon type elbows secured with stainless steel hose clamps; or

(ii) HR Products E-Z riser tube and E-Z riser elbows. (for sprinklers with 15mm and 20mm inlets).

The length of the flexible swing hose riser shall be no less than 500mm and no greater than 750 mm.

(i) Nozzle diffuser screws shall not reduce the wetted throw of a sprinkler by more than 20 per cent of the undiffused radius of a sprinkler.

(3) Bollard sprinkler installation

(a) Bollard sprinklers shall be installed where approved by the Superintendent in locations where sprinklers may be obstructed by plants or plant growth.

(b) Bollard sprinklers shall be assembled and installed as detailed in SC6.4.4.8 Standard drawings SD-12.2.

(4) Turf valves

(a) All turf valves shall be plasson.

(b) Turf valves shall be installed with an articulated riser connected to the main line via a tee coupling. Connecting turf valves to main line with tapping saddles is not allowed.

(c) Turf valves that are to be used as a hose watering point for garden establishment shall be installed in a valve box.

(d) Turf Valves Systems where sprinklers are directly inserted into the turf valves may be installed without a valve box flush with the soil surface.

(e) Turf valves located under valve box lids shall have the lid of the valve box clearly marked with an engraving tool and paint with the letters “TV”.

(5) Drip irrigation design and installation

(a) All drip irrigation systems shall be installed with an RPZ backflow device.

(b) The length of the drip tube shall be determined, based on all drippers along the line having sufficient pressure to operate 100 Kpa above the pressure compensation point as nominated by the dripper manufacturer. The maximum allowable inlet pressure shall be 300 Kpa.

(c) All drip tube used shall be Netafim Uni Ram 16 - 0.4m spacing @1.6lph or approved equivalent.

(d) The maximum spacing for drip tube is as shown in Table SC6.4.6.27.8.

Table SC6.4.6.27.8 Dripper spacing

SOIL TYPE	LOCATION	
	Grassed areas	Gardens
Loam and Clay Soil	400mm maximum	500mm maximum
Sandy Soil	300mm maximum	400mm maximum

(e) Refer SC6.4.4.8 Standard drawings SD-14.1 and SD-14.2 for typical drip irrigation details.

(f) Pressure compensation shall be fitted to each individual drip irrigation station. The devices used shall be retro fitted to the solenoid valve. The following two options are acceptable:

(i) Hunter Accu-Set pressure regulator, refer SC6.4.4.8 Standard drawings SD-14.3; and

(ii) inline pressure regulation device as specified by the Superintendent, refer to SC6.4.4.8 Standard drawings SD-14.4.

(g) A 120 mesh Disc Filtration system shall be installed immediately up stream of the solenoid valve in accordance with the manufacturer's specifications to ensure that the correctly sized filtration system is used. The following two filtration systems are acceptable:

(i) Netafim Tech Filter, (rated at 120 mesh by Netafim); and

(ii) Arkal 120 mesh Disc Filter fitted into a Netafim Tech filter housing, may be used during construction and for a period no greater than 1 month after installation of the drip tube.

(h) The filter, pressure regulator valve and solenoid valve assembly shall be installed in a valve box. Barrel Union/s shall be fitted to allow for easily removal of the filter, refer SC6.4.4.8 Standard drawings SD-14.3 and SD-14.4. The order of component installation from upstream to downstream is to be: Barrel Union, Filter, Barrel Union, Solenoid valve and Pressure Regulator. The fitting of these devices and the size of the valve box shall allow for:

(i) the filter cartridge to be easily serviced and changed; and

(ii) the pressure regulator to be easily adjusted and serviced.

(i) Drip tube shall be installed:

(i) in turf with 75mm cover to the finished surface level.

(ii) drip Tube laid on the surface shall be fitted with holding pins placed every 1.5m along the tube. Holding pins are to be constructed from 2.3mm minimum diameter Stainless Steel wire of 304 grade. Refer to SC6.4.4.8 Standard drawings SD-15.1 for details.

(j) Drip tube shall not be installed:

(i) directly into heavy clay or rocky soils where conditions may cause damage to the drip tube. In these soil types the drip tube must be installed between a 50mm surround of imported loan soil; and

(ii) in areas subject to significant vehicle traffic, where these condition would cause damage to the drip tube.

(k) All dripper lines shall terminate to a flushing manifold on the downstream side of the line. The head loss in the manifold shall be sized to lose no more than 1m based on twice the flow rate of the flow during normal operation. Each flushing line shall be fitted with a ball valve and 1 m of industrial vacuum and delivery hose. The ball valve shall be installed to provide easy operation. The ball valve shall be positioned in the valve box to prevent the industrial vacuum and delivery hose from kinking. The hose is to be held in place with a stainless steel hose clip. See SC6.4.4.8 Standard drawings SD-14.1 and SD-14.2 for component layouts. The valve box shall be sized as follows:

(i) 25mm ball valve – Carson or equivalent round valve box; and

(ii) 40mm and 50mm ball valves – Carson or equivalent rectangular valve box.

(l) All high point(s) in the dripper layout shall be fitted with a Bermad vacuum relief valve (Model ARV). The vacuum valve is to be installed in a valve box. A section of drip tube shall cross connect all drip tubes to the vacuum relief valve. The vacuum relief valve shall not be fitted to the supply manifold. See SC6.4.4.8 Standard drawings SD-14.1 and SD 14.2 for a typical installation.

(m) Netafim HCNL drip tube and/or Hunter adjustable check valves (or approved equivalent) shall be fitted if

the fall in the drip irrigation system exceeds 3m. Each side of the check valve shall be fitted with independent Flushing Valves and Vacuum Relief Valves. The check valves shall be set to 3m. The two methods for installation of the check valves are:

(i) check valves fitted to each drip tube; and

(ii) check valves fitted to both the supply manifold and the flushing manifold.

(n) Each drip irrigation station shall be fitted with operation indicators. The operation indicators consist of a Toro 570 100mm pop-up sprinkler fitted with an SST nozzle set to zero flow, sealed with silicon and installed level with the ground. The operation indicators are to be installed in a garden bed or next to a tree (not be a tripping hazard) and be visible from the drip valve assembly. Additional operation indicators shall be installed at the ends of each station and connected using a HR Products E-Z riser tube and 15mm E-Z riser elbows.

(o) Prior to the installation of the drip irrigation system the area to be drip irrigated shall be soaked with water and allowed to dry. Any resulting subsidence or soil shrinkage shall be filled with soil up to the finished surface level. The process of soaking with water and filling to a finished surface shall be repeated until the required surface level is achieved. Drip tubes may then be laid with the correct cover.

(p) On slopes the drip irrigation tubes shall following the contour lines of the area.

(q) “Snaking” of dripper lines shall be avoided.

(r) The minimum size of the header manifold is to be 25mm low density poly pipe.

(s) Drip tube shall be laid in straight runs inside roundabouts.

(t) No drip tube shall be installed within 150mm from walls, garden edges, pathways and the back face of concrete kerbs or concrete garden edges.

(u) Drip tube shall only be connected to low density poly pipe 25mm and 32mm using FI Tees and Netafim elbow adapters (3/4 inch to 17mm) with all low density pipe fittings clamped using Cobra stainless steel clamps or similar approved type. The use of quick start connectors is not approved by the Superintendent.

(v) Drip tube shall only be connected to PN 6.3 Poly Pipe using poly tapping saddles and Netafim elbow adapters (3/4 inch to 17mm). The use of grommet connectors is not approved by the Superintendent.

(w) In locations where soils may be of a corrosive nature, 316 stainless steel bolt and nuts shall be used on all tapping saddles.

SC6.4.6.27.6 Drinking fountain and water tap

(1) Drinking fountain

(a) A drinking fountain assembly includes:

(i) bowl - cast alloy, powder coated white;

(ii) turret - Ex 219 OD stainless steel tube powder coated "Heritage Green";

(iii) tap - BUB228C cam action Enware;

(iv) bubbler - Enware Type 61 push button bubbler with 3/8th - 1/2"x 3" male BSP tail;

(v) copper tube connection – 13mm Annealed Copper;

(vi) isolation valve;

(vii) precast concrete plinth base;

(viii) precast concrete pipe and aggregate backfill;

(ix) potable water supply line and water meter; and

(x) SC6.4.4.8 Standard drawings SD-32.1 contains the construction drawings for the fountain assembly.

(b) All pipe work to a drinking fountain shall comply with AS 3500. All pipe work installation to a drinking fountain, shall be carried out by a licensed plumber.

(c) The supply line to a drinking fountain shall be a “standalone” potable water line with its own water meter. Pipe work shall be a minimum 32mm PN12.5 Poly Pipe (from meter to isolation valve) laid in a trench with sand bedding and surround to the pipe and with 300 mm minimum cover over the pipe. Drinking

fountains and water taps may be installed on the same potable water line.

(d) The drinking fountain turret shall be installed on a precast concrete plinth base set on top of a 600 dia x 1.2m long reinforced concrete pipe embedded into the ground and backfilled with 20mm aggregate for drainage. Details of the base are given in SC6.4.4.8 Standard drawings SD-32.2. Alternately, the drinking fountain may be connected into an existing sewer drainage line.

(e) The Drinking fountain shall be isolated by a 15mm Ball Valve. The isolation valve shall be located a nominal 600mm from the drinking fountain adjacent the concrete plinth base and shall be installed in a circular valve box.

(f) The drinking fountain tap and bubbler shall be connected to the isolation valve with a flexible stainless steel hose.

(g) All bolts, screws and masonry anchor bolts fitted to the drinking fountain assembly shall be stainless steel.

(h) On completion and at commissioning of the drinking fountain the pressure shall be adjusted so the stream of water exiting the bubbler does not spill over the bowl.

(2) Water tap

(a) A water tap assembly includes:

(i) tap with vacuum breaker;

(ii) stainless steel support post;

(iii) concrete splash pad; and

(iv) potable water supply line and water meter.

(b) All pipe work to a water tap shall comply with AS 3500. All pipe work installation to a water tap shall be carried out by a licensed plumber.

(c) The supply pipe line to a water tap shall be a “standalone” potable water line with its own water meter. Pipe work shall be a minimum 32mm PN12.5 Poly Pipe (from the meter to copper tail pipe) laid in a trench with sand bedding and surround to the pipe and with 300mm minimum cover over the pipe. Water taps and drinking fountains may be installed on the same potable water line.

(d) Tap shall be a 15mm brass hose cock or similar approved connected to a 20mm copper tail pipe installed inside the support post.

(e) Support posts shall be 40mm x 40mm x 1.6mm stainless steel SHS fitted with a plastic cap and cast 350mm minimum into a 350mm dia x 450mm deep concrete footing.

(f) Splash pads shall be either:

(i) 600mm square x 100mm thick N25 concrete cast insitu; or

(ii) 600mm square x 50mm thick precast concrete.

(3) Fertigation

A fertigation point consisting of 25mm tested ball valve connected to the irrigation main line close down stream from the back flow assembly must be installed unless advised by the Superintendent. The fertigation point is to be housed in a round enclosure with the lid marked “FRT” for identification.

SC6.4.6.27.7 Effluent reuse systems

(1) Design and installation

(a) All works must comply with the *Queensland Water Recycling Guidelines*, current health and safety, environmental and related acts.

(b) Effluent reuse irrigation systems shall have:

(i) sprinklers fitted with lilac ID caps;

(ii) lilac coloured drip tubing;

(iii) lilac coloured valve box lids;

(iv) mainline and lateral pipe material (plastic) shall be lilac in colour or contain a lilac strip;

(v) all above ground pipe work shall be lilac coloured and/or clearly labelled “Recycled Water”, “Non Potable Water”; and

(vi) minimum separation of Pipe work for Potable and Recycles water systems shall be maintained at 300mm for below ground pipe work and 100mm for above ground pipe work.

SC6.4.6.27.8 Installations located in landfill sites

(1) Trenching in landfill sites

(a) When excavating in landfill sites or areas containing rock the trench shall be excavated to a minimum depth of 600mm.

(b) All trenching material removed from the trench shall be removed to the local refuse dump.

(c) All trenching spoil shall be totally removed from the surrounding surfaces and site and inspected by the Superintendent.

(d) Bedding sand shall be used to backfill to 200mm below finished soil level. The final 200mm shall be filled with an approved loam.

SC6.4.6.28 Minor concrete works

SC6.4.6.28.1 Introduction

(1) Scope

(a) This sub-section provide details for the supply and placement of concrete, including sprayed concrete, and ancillary requirements including excavation, preparation of foundations, forming up, placement of reinforcement and backfilling for work shown on the drawings but not having individual policy sub-sections. These works include kerb and channel, New Jersey type barriers, drainage pits and other supplementary structures, headwalls, box culverts, box culvert base slabs, driveways, footpaths, median toppings, retaining walls, footings, paving edge strips and works of a similar nature.

(b) The work also includes supply and placement of miscellaneous minor concrete work for water and sewerage construction such as valve chambers, thrust and anchor blocks, bulkheads, pumping stations, bedding, encasement and cast-in-situ access chambers.

(c) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in SC6.4.5 Construction management.

(2) Reference and source documents
Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this sub-section are as follows:
SC6.4.6.6 - Pipe drainage
SC6.4.6.10 - Earthworks (construction)
SC6.4.6.12 - Flexible pavements
SC6.4.5 Construction management.

(b) Australian Standards

AS 1012.1	*Sampling of fresh concrete*
AS 1012.3.1	*Determination of properties related to the consistency of concrete - Slump test.*
AS 1012.8.1	*Method of making and curing concrete - Compression and indirect tensile test specimens*
AS 1012.8.2	*Method of making and curing concrete - Flexure test specimens*
AS 1012.9	*Determination of the compressive strength of concrete specimens*
AS 1012.14	*Method for securing and testing cores from hardened concrete for compressive strength*
AS 1141.14	*Particle shape, by proportional caliper*
AS 1141.21	*Aggregate crushing value*
AS 1141.23	*Los Angeles value*
AS 1141.24	*Aggregate soundness – Evaluation by exposure to sodium sulphate solution*
AS 1289.3.3.1	*Calculation of the plasticity index of a soil*
AS 1289.5.1.1	*Determination of the dry density/moisture content relation of a soil using standard compactive effort*
AS 1289.5.2.1	*Determination of the dry density/moisture content relation of a soil using modified compactive effort*
AS 1289.5.4.1	*Compaction control test - Dry density ratio, moisture variation and moisture ratio*
AS 1379	*Specification and supply of concrete*
AS 1478.1	*Chemical admixtures for concrete, mortar and grout – Part 1: Admixtures for concrete*
AS/NZS 1554.3	*Welding of reinforcing steel*
AS/NZS 1859	*Reconstituted wood-based panels*
AS 2082	*Visually stress-graded hardwood for structural purposes*
AS/NZS 2271	*Plywood and blockboard for exterior use*
AS 2758.1	*Concrete aggregates*
AS 3600	*Concrete structures*
AS 3610	*Formwork for concrete*
AS 3799	*Liquid membrane-forming curing compounds for concrete*
AS 3972	*General Purpose and blended cements*
AS/NZS 4671	*Steel reinforcing materials*

(c) Other
NSW RTA, *Shotcrete design guidelines*

SC6.4.6.28.2 Excavation and foundations

(1) General
The foundation where specified, shall be formed at the required depth below the finished surface levels shown on the drawings. Rock foundations shall be neatly excavated to form a bed for the concrete, and shall be thoroughly scraped and cleaned. Soil foundation shall, as far as possible, be excavated neatly from the solid material to coincide with the under-surface of the concrete. Compaction requirements must meet the appropriate compliance standards as specified in sub-section SC6.4.6.10 Earthworks (construction).

All soft, yielding or other unsuitable material shall be replaced with sound material approved by the Superintendent, and the subgrade shall be compacted to provide a minimum relative compaction as specified in SC6.4.6.10 Earthworks (construction). If the subgrade is dry it shall be sprinkled with as much water as it will readily absorb, before the concrete is placed.

Preparation of the foundation is required in accordance with foundation type, as follows:

(a) concrete working base - remove projections above the plane surface, and loose material; and

(b) graded prepared subgrade - blind with sufficient sand to create a smooth surface free from hard projections. Wet the sand just before laying the underlay.

Editor's note—Provision of a vapour barrier for external slabs on ground prevents water loss to the subgrade and has the potential to reduce slab curling at edges and corners.

AS 2870 Section 5.5 provides additional requirements and detailing of damp proof membranes for concrete slabs and footings exposed to either saline or acid sulphate soils. AS 2870 Section C5.5 and CCAA T56 provide information on concrete exposed to saline soils.

Polymeric Film Underlay must be 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 concrete. Cut back as required after concrete has gained strength and forms have been removed.

The Contractor shall supply all necessary sheeting and bracing to safely support the excavation in accordance with statutory requirements. The excavation shall be kept free of water.

Prior to the construction of footings for cast-in-situ concrete walls on earth foundations, cover the latter with a mass concrete blinding slab. Unless otherwise specified, place precast concrete wall sections on a fresh mass concrete bedding layer while it is still in a plastic state. Ensure the following is adhered to:

(a) for earth foundation, place concrete not less than 50 mm thick; and

(b) for rock foundation, place the concrete at least 50 mm above the highest points of rock.

Place neither forms nor other materials on the bedding layer within 48 hours of the concrete being placed.

(2) Kerb and channel
Kerb and channel may be constructed in fixed forms, by extrusion or by slip forming, in accordance with AS 2876.

The foundation, concrete quality, curing and testing details shall be in accordance with AS 2876 except where placed on pavement courses, where the requirements of the respective pavement course must prevail. Kerb and channel will be constructed to the profile nominated on the drawings.

The top and face of the finished kerb and channel shall be true to line and the top surface shall be of uniform width, free from humps, sags or other irregularities. Kerb and channel shall have a steel float finish.

The level at any point on the surface of the kerb invert shall be within ±6 mm of the design level. When a straight edge 3 m long is laid on top of or along the face or invert of the kerb, the surface shall not vary more than 5 mm from the edge of the straight edge, except at kerb laybacks, grade changes or curves or at gully pits requiring gutter depression. The drainage invert shall be free draining and shall not pond water.

Unless shown otherwise on the drawings, contraction joints, shall be formed every 5 m of kerb invert length for a minimum of 50 per cent of cross sectional area. The joint shall be tooled 20 mm in depth to form a neat groove of 5 mm minimum width.

Unless shown otherwise on the drawings, expansion joints, 15 mm in width for the full depth of the kerb and channel, shall be constructed where the kerb invert abuts against kerb gully pits, both sides of kerb laybacks/ramps for vehicular or pedestrian access, retaining walls and overbridges. Expansion joints shall consist of a preformed jointing material of bituminous fibreboard.

Where kerb and channel is cast adjacent with a concrete pavement the same type of contraction, construction and expansion joints specified in the concrete base shall be continued across the kerb and channel.

All house stormwater outlets shall be provided and/or extended, to match the existing type and size of pipe, through the kerb as shown on the drawings providing correctly graded drainage outlet into channel. Pipework shall be in accordance with the requirements for UPVC pipes in sub-section SC6.4.6.6 Pipe drainage, or as directed by the Superintendent for other types of pipe.

At all driveway crossings, where shown on the drawings or where directed by the Superintendent, barrier kerb shall be discontinued to provide for vehicular or pedestrian access. At such locations, kerb laybacks/ramps shall be constructed in accordance with the drawings and Standards. Footpath crossovers shall be constructed to meet the laybacks as shown on the drawings, or reinstated to match existing materials where not otherwise shown.

After the new kerb and channel has been constructed and not earlier than 3 days after placing, the spaces on both sides of the kerb and/or gutters shall be backfilled and reinstated in accordance with the drawings, or as instructed by the Superintendent.

Backfill material behind the kerb shall consist of granular material, free of organic material, clay and rock in excess of 50 mm diameter, or material as approved by the Superintendent.

Backfill material behind the kerb shall be compacted in layers not greater than 150 mm thick, to a relative compaction of 95 per cent when tested in accordance with AS 1289.5.4.1, for standard compactive effort. The whole of the work shall be finished in a neat and workmanlike manner, free draining and free from surface undulations and trip hazards.

Pavement material adjacent to new gutter shall be backfilled in accordance with the drawings or as directed by the Superintendent.

Where specified in drawings, kerb only work shall be pinned as detailed in Standard drawings.

(3) New jersey type barriers, driveways and footpaths

For New Jersey type barriers, driveways and footpaths a subbase of approved quality and of minimum 150 mm compacted thickness, unless otherwise shown on the drawings, shall be placed over the subgrade. The surface shall then be checked for uniformity, line and level, and all irregularities shall be made good.

The subbase material shall be compacted to provide a minimum relative compaction as determined by AS 1289.5.4.1 of 100 per cent for standard compactive effort as specified in SC6.4.6.10 Earthworks (construction).

The finished subbase shall not deviate more than 15 mm under a straight edge 3 m long, subject to any

necessary allowance on vertical curves.

(4) Drainage pits and other supplementary structures
Where the excavation is in sound rock, and the Superintendent so directs, part of the concrete lining of gully pits and other structures may be omitted, provided that a neatly formed pit of the required dimensions is constructed, and provided that the wall of the pit adjacent to and parallel with the road is constructed of formed concrete in all cases.

(5) Retaining walls, headwalls and wingwalls
In the case of rock foundations for retaining walls, headwalls and wingwalls, the excavation shall be carried into the rock for a minimum depth of 150 mm. Where cut-off walls are to be provided, the depth of cut-off in rock foundations may be reduced to 100 mm.

Prior to the construction of cast-in-situ concrete walls on earth foundations, the latter shall be covered by a mass concrete bedding layer at least 50 mm thick and finished to a uniform surface. No forms or other materials shall be placed upon the bedding layer within a period of 48 hours after the concrete has been placed.

Unless otherwise specified, precast concrete wall sections shall be placed on a fresh mass concrete bedding layer while it is still in plastic state. In the case of soil foundations, the concrete shall be not less than 50 mm thick, and where the foundation is in rock, the concrete shall be of such thickness as is required to provide a uniform surface at least 50 mm above the highest points of rock.

SC6.4.6.28.3 Formwork

(1) General
Formwork shall be provided in accordance with AS 3610 to produce hardened concrete to the lines, levels and shapes shown on the drawings or specified elsewhere. It shall have adequate strength to carry all applied loads, including the pressure of fresh concrete, vibration loads, weight of workers and equipment, without loss of shape. Forms shall be mortar tight and designed to allow removal without risk of damage to the completed structure. Joints in the formwork shall be perpendicular to the main axis of the shape of the concrete.

Where concrete is placed in earth excavations, side forms shall be provided to prevent contact between concrete and the insitu earth.

Design of formwork for high sections shall be such that it shall not be necessary to drop concrete freely from a greater height than 1.2 m or to move concrete along the formwork after deposition.

Formwork material used shall be sound and suitable for the purpose intended and surface finish specified.

Provision shall be made for the accurate location and firm support of fittings, bolts, anchorages and formers of holes as shown on the drawings. Temporary fittings used for the support of the formwork shall be arranged to permit removal without damage to the concrete. The use of wires and or bolts extending to the surface of the concrete shall not be permitted except where shown on the drawings.

Forms for edges of concrete shall be filleted and for re-entrant angles chamfered as shown on the drawings.

Temporary openings shall be provided where necessary for cleaning out of formwork and inspection before concreting.

(2) Approval of formwork design
For box culverts and reinforced concrete retaining walls, detailed drawings, design calculations, description and/or samples of materials proposed for use shall be submitted for the Superintendent's concurrence before manufacture of the formwork is commenced.

(3) Provision for drainage

Where shown on the drawings, or where directed by the Superintendent, weepholes of 50 mm diameter shall be provided in retaining walls and wingwalls.

(4) Construction

The type and quality of material selected for formwork and the workmanship used in construction shall be such that the surface finish specified shall be obtained. Construction shall be such that the erection tolerances shall be obtainable.

Timber for formwork shall be well seasoned, free from defects and, where in contact with fresh concrete, free from loose knots.

Timber forms for exposed surfaces shall be constructed from plywood or particle board with hardwood or approved softwood studs and wales. The plywood used for forms shall comply with AS 2271, the hardwood shall comply with AS 2082 and the particle board with AS/NZS 1859.

Formwork for exposed surfaces shall be made from panels having uniform widths of not less than 1 m and uniform lengths of not less than 2 m, except where the dimensions of the member formed are less than the specified panel dimensions. Plywood panels shall be placed with the grain of the outer plies perpendicular to the studding or joists. Where form panels are attached directly to the studding or joists the panel shall be not less than 15 mm thick. Form panels less than 15 mm thick, otherwise conforming to these requirements may be used with a continuous backing of dressed material of 20 mm minimum thickness. All form panels shall be placed in a neat, symmetrical pattern.

Forms for all surfaces which will be completely enclosed or permanently hidden below the ground may be constructed from dressed or undressed timber, steel, plywood or particle board.

Mild steel form surfaces in contact with concrete shall have all bolt and rivet heads counter-sunk and all welds ground back to even and smooth surfaces.

(5) Erection

(a) General

(i) Dimensions and position of forms shall be carefully checked after the forms are erected. Forms shall be aligned accurately and the location of all fittings, hold formers, etc. checked prior to placing concrete. Departure of the forms from the surfaces shown on the drawings shall not exceed 1/300 of the space between supports for any surface visible in the completed work and 1/150 for hidden work. For tolerances in plan position and levels, refer to clauses SC6.4.6.28.5(7) Finishing of unformed surfaces and SC6.4.6.28.5(10) Treatment of formed surfaces.

(ii) Joints as erected shall be mortar tight.

(iii) The interior surface of the forms shall be treated to ensure non-adhesion of the mortar. Commercial quality form oil or grease will be acceptable, but the oil or grease used on forms against surfaces to be exposed shall not stain or discolour the concrete surface. The coating shall be uniformly spread in a thin film and any surplus shall be removed prior to placing concrete. In the case of unlined timber forms, the timber shall be thoroughly wetted before oiling. Forms shall be treated before placing reinforcement to ensure that the form release agent will not contaminate the surface of the reinforcing steel or construction joints.

(iv) Formwork hardware shall be treated with a form release agent and so arranged that it may be removed from the concrete without excessive jarring or hammering.

(b) Approval by the Superintendent

(i) The formwork shall be inspected by the Superintendent, and the placing of reinforcement in the spaces formed, where specified, shall not commence until the formwork is approved by the Superintendent.

(ii) Placing of concrete shall not commence until the reinforcement, where specified, has been accepted by the Superintendent, and all dirt, chips, hardened concrete, mortar and all foreign matter removed from the forms.

(iii) When an inspection is requested by the Contractor, a notice of not less than 24 hours, excluding Saturdays, Sundays and public holidays, shall be given to the Superintendent.

SC6.4.6.28.4 Materials for concrete

(1) Cement

Cement shall be Type GP Portland Cement complying with AS 3972.

When submitting details of the nominated mix in accordance with clause SC6.4.6.28.4(6) Testing of materials, the Contractor shall nominate the brand and source of the cement. On approval of the nominated mix by the Superintendent, the Contractor shall only use the nominated cement for the work.

Documentary or other acceptable evidence of the quality of the cement shall be furnished by the Contractor if required by the Superintendent.

If the Contractor proposes to use cement which has been stored for a period in excess of 3 months from the date of testing, a re-test shall be required at the Contractor's expense before the cement is used.

All cement shall be transported in watertight containers, and shall be protected from moisture until used. Caked or lumpy cement shall not be used.

(2) Water

Water shall be free from injurious amounts of materials harmful to concrete and to its reinforcement and neither salty nor brackish.

Water which is not potable for human beings shall not be used in reinforced concrete.

(3) Fine aggregate

Fine aggregates shall consist of clean, hard, tough, durable uncoated grains, uniform in quality, and shall conform to the requirements of AS 2758.1 in respect of bulk density, water absorption (maximum 5 per cent) material finer than 2 micrometres, impurities and reactive materials.

Fine aggregates shall be evenly graded within the absolute limits shown in Table SC6.4.6.28.1 Fine aggregate grading, and shall not deviate from the proposed grading by more than the amounts in Table SC6.4.6.28.1.

Table SC6.4.6.28.1 Fine aggregate grading

Australian Standard Sieve	Proportion Passing (% of Mass)	Deviation from Proposed Grading (% of Mass of Sample)
9.50mm	100	
4.75mm	90 - 100	±5
1.18mm	40 - 85	±10
300µm	8 - 30	±10
150µm	2 - 10	±5
75µm	0 - 4	±3

(4) Coarse aggregate

Coarse aggregate shall consist of clean, hard, durable, crushed stone, crushed river gravel, screened river gravel or metallurgical furnace slag and shall conform to the requirements of AS 2758.1 in respect of particle density, bulk density, water absorption (maximum 2.5 per cent), material finer than 75 micrometres, weak particles, light particles, impurities and reactive materials, iron unsoundness and falling or dusting unsoundness. In all other respects, the coarse aggregate shall comply with this sub-section. If required, coarse aggregate shall be washed to satisfy these requirements.

The percentage of wear shall be determined by AS 1141.23, and the loss of weight shall not exceed 30 per

cent.

When required by the Superintendent, coarse aggregate shall be tested for conformance for any or all of the properties set out below:

(a) crushing value - AS 1141.21
The aggregate crushing value shall not exceed 25 per cent;

(b) soundness - AS 1141.24
The loss of mass when tested with sodium sulphate shall not exceed 12 per cent; and

(c) particle shape - AS 1141.14
The proportion of misshapen particles (2:1 ratio) shall not exceed 35 per cent.

Coarse aggregate shall be evenly graded within the absolute limits shown in Table SC6.4.6.28.2 Course aggregate grading and shall not deviate from the grading of the samples submitted under clause SC6.4.6.28.4(6) Testing of materials by more than shown.

Table SC6.4.6.28.2 Coarse aggregate grading

Australian Standard Sieve (mm)	Proportion Passing (% of Mass			Deviation Proposed Grading (% of Mass of Sample)
	40mm Nominal For Walls exceeding 150mm thickness	20mm Nominal For all other structures	Extrusion Concrete	
53.0	100			±10
37.5	95 - 100			±10
26.5		100		±5
19.0	30 - 70	95 - 100		±5
13.2			100	
9.50	10 - 35	25 - 35		
4.75	0 - 10	0 - 10		
2.36	0 - 2	0 - 2		

(5) Admixtures
Chemical admixtures and their use shall comply with AS 1478.1. Admixtures shall not contain calcium chloride, calcium formate, or triethanolamine or any other accelerator. Admixtures or combinations of admixtures other than specified below, shall not be used.

During the warm season, (October to March inclusive), a set retarding admixture approved by the Superintendent shall be used to control slump within the limits stated in clause SC6.4.6.28.5(4) Consistency. The dosage shall be varied to account for air temperature and haul time in accordance with the manufacturer's recommendations. A copy of the NATA endorsed Certificate of Compliance with AS 1478.1 shall be submitted to the Superintendent, together with the proposed “dosage chart” in accordance with SC6.4.6.28.4(6) Testing of materials. If the Contractor proposes to vary the admixture between the warm and cool seasons such variation shall require approval by the Superintendent by providing the necessary certificate of compliance.

(6) Testing of materials
The Contractor shall submit to the Superintendent a copy of a NATA Certified Laboratory Test Report on the quality and gradings of the aggregates proposed to be used in the work.

The materials shall only be used after receipt of the Superintendent's notification of acceptance, and then only as long as the materials accord with the Specification.

SC6.4.6.28.5 Handling and treatment of concrete

(1) Measuring

All materials shall be measured by weight, except that:

(a) water may be measured by volume with an approved adjustable water-measuring and discharging device;

(b) cement may be measured by bags as packed by the manufacturer in which case batches shall be proportioned on the basis of one or more unbroken bags of cement, and for this purpose one bag of cement shall be assumed to weigh 40 kg. Bulk cement shall be weighed in an individual hopper and shall be kept separate from the aggregates until the components of the batch are discharged from the batching hopper; and

(c) measurement by volume for smaller works may be undertaken with the prior approval of the Superintendent.

(2) Measuring by weight, on-site mixing

Where concrete is to be mixed on site, and where mix control is likely to be less efficient than at a central batching plant, the weights of cement, fine and coarse aggregate shown in Table SC6.4.6.28.3 Materials in batch containing 1 bag (40 kg) cement may be used as a guide to produce the classes of concrete specified. Small changes in the proportions of fine and coarse aggregate may be required to improve density or workability of the concrete. The use of proportions shown in Table SC6.4.6.28.3 shall not relieve the Contractor of his obligation to provide concrete of the specified compressive strength.

Table SC6.4.6.28.3 Materials in batch containing 1 bag (40 kg) cement

MPa	Cement kg	Fine Aggregates kg	Coarse Aggregates kg	Total Aggregates kg
10	40	130	250	380
15	40	100	190	290
20	40	88	126	214

The proportions set out in Table SC6.4.6.28.3 make allowance for moisture contents of aggregates of 6 per cent for fine aggregates and 1 per cent for coarse aggregates. Where the moisture content of aggregates exceeds 8 per cent or 3 per cent respectively, the proportions of the mix shall be changed to compensate for the excess water in the aggregate.

(3) Measuring by volume, on-site mixing

Where measurement by volume is approved, the proportions of the materials shall be such as are required to produce a mix free of voids and having the specified strength at 28 days.

The nominal proportions given in Table SC6.4.6.28.4 Volume batching may be used as a guide for volume batching.

Table SC6.4.6.28.4 Volume batching

MPa	Parts by Volume		
	Cement	Fine Aggregate	Coarse Aggregate
10	1	3	6
15	1	2.25	4.5
20	1	2	3

The volumes of fine and coarse aggregates for each batch shall be measured in boxes or bins. The aggregates shall be measured loose (i.e. without compaction) in the boxes and shall be struck off level. Measurements by shovels or like methods will not be permitted. Batch proportions shall be so arranged that each batch contains 1 bag of cement. One 40 kg bag of cement shall be assumed to have a volume of 27.5 litres.

(4) Consistency

A sufficient quantity of water shall be added to the mix so that the consistency of the concrete is such that it can be placed in the forms, compacted and worked into all corners without permitting the ingredients to segregate, or excess free water to collect on the surface. If required by the Superintendent, the Contractor shall determine the consistence of the concrete in accordance with AS 1012.3.1. Except for extruded concrete, the

nominated slump shall not exceed 80 mm, plus the field tolerance of ±15 mm.

In the case of concrete placed by an extrusion machine, the water in the mix shall be only sufficient to produce a slump of 10 mm to 15 mm.

(5) Mixing and delivery

(a) General

(i) Concrete may be mixed either at the site or at a central mixing plant. All concrete shall be mixed with mechanically operated mixers. In an emergency, hand mixing may be permitted. Submit proposal for concrete mixing other than pre mixed concrete for approval by superintendent.

(ii) Any concrete which exhibits signs of segregation shall not be used.

(b) Machine mixing at site

(i) The mixing of concrete shall be done in a batch mixer which will ensure a uniform distribution of the materials throughout the batch.

(ii) The mixer shall be of such capacity that one or more whole bags of cement may be used per batch of concrete. The volume of the mixed material shall not exceed the manufacturer's rated capacity of the mixer.

(iii) The mixing time for each batch shall not be less than 1.5 minutes after all ingredients are assembled in the mixer, and prior to any portion of the batch being removed.

(iv) The entire contents of a batch shall be discharged from the mixer before any materials are placed therein for the succeeding batch.

(c) Mixing in an emergency

(i) In the case of breakdown of the mechanical mixing equipment, hand mixing in small quantities so as to complete a section of the work or reach a suitable construction joint is permitted.

(ii) Hand mixing shall be done on a water-tight platform of sufficient size to allow the mixing of at least two batches simultaneously. The amount of cement used shall be 10 per cent more than the amount specified for machine mixed concrete.

(iii) The fine aggregate and cement shall first be mixed until a uniform colour is obtained, and then spread on the mixing platform in a thin layer. The coarse aggregate, which shall have been previously drenched with water, shall then be spread over the fine aggregate and cement in a uniform layer, and the whole mass turned over as further water is added with a rose sprinkler. After the water is added, the mass shall be turned at least three times, not including shovelling into barrows or forms, until the mixture is uniform in colour and appearance. Hand-mixed batches shall not exceed 0.25 cubic metres each.

(d) Ready-mixed concrete

(i) The concrete shall be mixed and delivered in accordance with the requirements of AS 1379 relating to:

(A) mixing and delivery; and

(B) use of non-agitating equipment,

(ii) The water used for flushing the chutes and for cleaning shall be discharged in an area acceptable to the Superintendent. The chutes shall be long enough to permit delivery to the whole of the area enclosed by the forms.

(6) Placing and compacting concrete

No concrete shall be mixed or placed, without the approval of the Superintendent, while the air temperature is, or is likely to be within 24 hours, below 5 °C or while the shade temperature exceeds 38 °C. All concrete shall be placed in the dry. Prior to placing concrete the area shall be clean and moist but free from any ponding of water.

The concrete shall be mixed in the quantities required for immediate use and shall be placed in position as rapidly as possible. Any concrete which has developed initial set, or which does not reach the forms within 30 minutes after the water has been added (except when transported in agitator trucks) shall not be used.

The concrete shall be deposited in the forms, without separation of the aggregates. Concrete shall not be dropped freely from a height greater than 1.2 m, or be deposited in large quantities at any point and moved or worked along the forms. Conveying equipment, including open troughs and chutes, where used, shall be made of metal, or have metal linings. Where used on steep slopes, troughs and chutes shall be equipped with baffles, or be placed in short lengths in such a way that the direction of flow of the concrete is changed. The concrete shall be placed in horizontal layers in one continuous operation between the ends of the work and/or construction joints. Care shall be taken to fill every part of the forms and to work the coarser aggregate back from the face. The freshly placed concrete shall be compacted by continuous spading, slicing or by vibrator units. Vibrators shall not be left in one position for more than 30 seconds, and shall not be permitted to rest on reinforcement.

Exposed surfaces of the concrete shall be struck off and finished with a wooden float. Where shown on the drawings corners and edges shall be left neatly rounded or chamfered. Re-entrant angles shall be neatly filleted.

Concrete shall not be moved after it has been in the forms for more than 10 minutes.

In the case of concrete placed by an extrusion machine, small quantities of cement-sand slurry, comprised of two parts of plasterer's sand and one part of cement (by volume), together with sufficient water to bring it to a semi-fluid condition, shall be placed in the special receptacle in the machine, if the machine is so equipped and shall be fed onto the surface of the concrete at a rate sufficient to produce a smooth and uniform finish.

(7) Finishing of unformed surfaces

(a) Surfaces other than wearing surfaces

Unformed surfaces shall be compacted and tamped so as to flush mortar to the surface, screeded off and finally dressed with a wooden float to an even surface. Care shall be taken to drain or otherwise remove promptly any water which comes to the surface. A capping of mortar will not be permitted.

All future contact surfaces shall be left rough, with the coarse aggregate at the surface firmly embedded but not forced below the surface.

(b) Wearing surfaces

Where a concrete wearing surface is shown on the drawings the concrete shall be thoroughly compacted and the surface screeded off by a vibrating screed, or hand screeded where the distance between forms perpendicular to the direction of screed is no greater than 2 m. Immediately following compaction and screeding the concrete shall be tested for high or low spots and any necessary corrections made. The surface shall be finished true and uniform and free from any glazed or trowelled finish and shall be finally dressed with a wooden template or float, or by the use of belting in an approved manner. The departure from grade shall not exceed 5 mm in any 3 m length.

Where an asphaltic concrete wearing surface is specified, the surface of the concrete, after being compacted, screeded and corrected, shall be dressed with a wooden float and finally broomed to produce a rough surface.

(c) Finished levels and location

The unformed surface of concrete structures not adjacent to road pavements shall not vary more than 25 mm in plan position and not more than 25 mm from the specified levels. In the case of barriers, drainage pits, culvert slabs and other structures adjacent to road pavements, the finished concrete shall not vary more than 10 mm from the specified levels and alignment. Barriers, footpaths and similar shall not deviate from level or alignment by more than 5 mm from a straight-edge 3 m long, subject to any necessary allowances on vertical and horizontal curves.

(8) Curing and protection

All exposed surfaces of the freshly placed concrete shall be kept moist either by the use of plastic sheeting,

damp sand or commercial curing compounds, in accordance with AS 3799, for a minimum period of 3 days. During this time the work must be adequately protected from the effects of excessive surface evaporation, rain, running water, vandalism and other causes likely to damage the concrete. All costs involved in making good or replacing any work that has been damaged due to the above mentioned factors shall be borne by the Contractor.

Curing for concrete shall generally be in accordance with the appropriate surface exposure classification in AS 3600.
If it is proposed to use a liquid membrane-forming curing compound submit the following information:

(a) certified test results for water retention to AS 3799 Appendix B;

Editor's note—It is likely that polyvinyl alcohol (PVA-based) products will not comply with water retention requirements.

(b) evidence of compatibility with concrete, and with applied finishes including toppings and render, if any, including methods of obtaining the required adhesion.

For visually important surfaces, evidence that an acceptable final surface colour will be obtained.

(9) Removal of forms

All forms shall remain in place, after placement of concrete, for minimum periods specified hereinafter. These periods may be extended by the Superintendent if the air shade temperature falls below 10 °C during the periods specified.

Mass retaining walls, headwalls, wingwalls, gully pits, sumps, and similar drainage structures	48 hours
Footpaths, driveways and similar	17 hours
Sides of reinforced concrete walls when height of each day pour is:	
• under 0.6 metres	1 day
• 0.6 m to 3 m	2 days
• 3 m to 6 m	3 days
• 6 m to 9 m	5 days
Supporting forms under deck slabs of culverts	10 days

To permit the satisfactory finishing of barriers, forms shall be removed in not less than 12 hours nor more than 48 hours after placing concrete, depending upon weather conditions.

Care shall be taken in removing forms so that the concrete will not be cracked, chipped or otherwise damaged. The use of crowbars or other levering devices exerting pressure on the fresh concrete to loosen the forms will not be permitted.

No superimposed load shall be allowed on any part of a structure until the concrete has reached at least 70 per cent of the design strength.

Hole formers such as pipes and bars shall be removed as soon as the concrete has hardened sufficiently for this to be done without damage to the concrete.

(10) Treatment of formed surfaces

All concrete surfaces shall be true and even, free from stone pockets, depressions or projections beyond the surface. All arrises shall be sharp and true, and mouldings shall be evenly mitred or rounded. Care shall be exercised in removing forms to ensure this result. Formed concrete surfaces shall be presented for inspection by the Superintendent within 1 day of stripping of formwork and finishes in accordance with the classes of surface finish in AS 3610 as follows:
Non-visible surfaces - Class 4

Visible surfaces - Class 2

As soon as the forms are removed from mass or reinforced concrete work, all rough places, holes and porous spots shall be repaired by removing defective work and filling with stiff cement mortar having the same proportions of cement and fine aggregate as used in the concrete, and shall be brought to an even surface with a wooden float.

Any tie wires or other fitments extending to outside surfaces, shall be cut back after removal of forms, to a depth of at least 40 mm with sharp chisels or cutters. All cavities caused by removal of fitments or tie wires shall be wetted and carefully packed with cement mortar, as above.

The surfaces of bolt cavities, tie wire holes, and all defects in concrete shall be coated prior to the placing of mortar, grout, or fresh concrete, with an approved bonding agent, in lieu of wetting with water. The method of application of such agent and the conditions in which it is to be used shall generally be as laid down by the manufacturer.

The formed surfaces of concrete structures not adjacent to road pavements shall not vary more than 25 mm in plan position and not more than 25 mm from the specified levels. In the case of drainage pits and other structures adjacent to road pavements, the finished concrete shall not vary more than 10 mm from the specified levels and alignment.

(11) Joints

Submit proposed methods, timing and sequence of sawing joints for approval by superintendent a minimum of 7 days prior to works commencing.

Where horizontal construction joints are found to be necessary in walls, or cast-in-situ drainage structures the joints may be made at the base of walls and at other locations in the walls where approved by the Superintendent. In order to provide for bond between the new concrete and the concrete which has already set, the surface on which the new concrete is to be placed shall be thoroughly cleaned of loose material, foreign matter and laitance. The surface shall be roughened or keyed and saturated with water. After any excess water has been removed, the surface shall be thinly coated with a neat cement grout.

Retaining walls shall be provided with vertical expansion joints as shown on the drawings. The expansion joints shall consist of jointing material of approved quality, and of thickness shown on the drawings, and a depth sufficient to fill the joint. The jointing material shall be neatly cut to fit the surface of the concrete.

Where barriers are extruded or cast in place, narrow transverse vertical grooves, 20 mm deep, shall be formed neatly in the surface of the freshly placed concrete to produce contraction joints for the control of cracking. The contraction joints, shall be at intervals of 3 m.

In barriers, unless shown otherwise on the drawings, expansion joints, 15 mm in width for the full depth of the barrier, shall be constructed at intervals not exceeding 15 m and where the barrier abuts against gully pits. Expansion joints shall consist of a preformed jointing material of bituminous fibreboard.

In footpaths, median toppings and driveways, unless otherwise shown on the drawings, expansion joints, 15 mm in width for the full depth of paving, shall be constructed at intervals not exceeding 15 m and where the pavement abuts against gutters, pits and structures. Expansion joints shall consist of a preformed jointing material of bituminous fibreboard.

All unreinforced paving shall be provided with narrow vertical grooves, 20 mm deep to induce contraction joints for the control of cracking. The joints shall be formed in the freshly placed concrete in a neat regular pattern to form “slabs” no bigger than 2 m^2. The ratio of the longest side to the shortest side shall not exceed 1.6.

(12) Strength of concrete

When tested in accordance with AS 1012.9, the concrete shall have a characteristic compressive strength not less than that shown on the drawings or if not shown shall have a compressive strength not less than that specified in Table SC6.4.6.28.5 Concrete strength requirements for the particular class of work. The cement content restrictions shown in Table SC6.4.6.28.5 refer to Portland cement. Where General Purpose Blended

cements are utilised the acceptable minima are indicated in brackets.

The characteristic strength shall be determined from the average of not less than two specimens, moulded from each class of concrete being used in the work, and selected to represent the whole of the concrete placed at the time of moulding.

In general, two pairs of test specimens shall be moulded for each 15 cubic metres of concrete, or part thereof, one pair being intended for the 7 day test if required and the other pair for a 28 day test.

Table SC6.4.6.28.5 Concrete strength requirements

Use	Charac-teristic Strength MPa	Minimum Portland Cement per cu metre (Minimum GB Blended Cement)	Coarse Aggregate Nominal Size	Characteristic Cylinder Strength Required	
				7 days	28 days
		kg	mm	MPa	MPa
Foundations, mass retaining walls	20	270 (330)	40	15	20
Mass concrete footings, pitching, linings etc.	20	270 (330)	20	15	20
Miscellaneous minor concrete work	20	270 (330)	20	15	20
Reinforced concrete culverts, drainage structures, driveways footpaths, headwalls, base slabs, sign structures. Large footings, retaining walls	32 50	320 (380) 350 (455)	20 20	24 36	32 50
Extruded concrete Safety Barriers	25 40	270 (330) 330 (380)	14 20	15 24	20 40

Note—the total cement and Portland cement quantities indicated as minima are aimed at providing suitably durable concrete for exterior public works under normal circumstances.

The strengths specified at 28 days shall be increased by multiplying by factors as shown in Table SC6.4.6.28.6 Concrete age conversion factors for tests at ages in excess of 28 days.

Table SC6.4.6.28.6 Concrete age conversion factors

*Age of test specimen in days of date of testing	Factor
28	1.00
35	1.02
42	1.04
49	1.06
56	1.08
70	1.10
84	1.12
112	1.14
140	1.16
168	1.18
196	1.20
224	1.22
308	1.24
365 and greater	1.25
*For intermediate ages the factor shall be determined on a pro-rata basis	

If the test specimens fail to achieve the specified characteristic strength, the Contractor may, with the approval of the Superintendent, arrange for cores to be taken from the work. If the average strength of such cores complies with the specified requirements nominated in Table SC6.4.6.28.5 Concrete strength requirements, the concrete will be accepted.

If cores taken fail to satisfy the strength requirements, the concrete shall be removed.

(13) Sampling concrete

Equipment and facilities shall be provided by the Contractor for the taking and storage of samples of any materials or concrete being used, or intended to be used in the work.

Concrete test specimens shall be cylinders 300 mm long and 150 mm diameter, moulded concurrently in the presence of the Superintendent or Superintendent's representative, in accordance with AS 1012.8, from samples taken in accordance with AS 1012.1.

SC6.4.6.28.6 Reinforcement for concrete

(1) Fibre reinforced concrete

Footpath/Bikeways/Driveways.
The concrete shall be reinforced with a mixed dose of High Performance Polymer and Discreet Graded Fibrillated filament fibres. These fibres shall be provided as a coarse filament in an engineered contoured sinusoidal profile of not less than 600 denier and discreet graded fibrillated filament fibres of not greater than 6 denier. These fibres are to be manufactured from virgin polypropylene and added to the concrete by the concrete company, at the rate of 4.6 kg per cubic metre. The 4.6 kg consists of 3.8 kgs of HPP and 0.8 kgs of discrete Graded Fibrillated filament fibres.

Two bags of “Novomesh” HPP as supplied by Tapex Concrete Fibres Qld or approved equivalent added per cubic metre, will be deemed suitable for council’s use. Where footpaths/bikeways are not subject to wheel loads one bag of fibres per cubic metre will suffice.
Any alternate product must have prior written approval obtained from council.

(2) Steel reinforcement

Steel reinforcement shall comply with AS/NZS 4671 *Steel reinforcing materials*.
The type and size of bars shall be as shown on the drawings.

If changes are proposed to reinforcement shown on the drawings, submit details to superintendent for approval 2 days prior to commencing works.
Steel reinforcement shall be free from loose or thick rust, grease, tar, paint, oil, mud, millscale, mortar or any other coating, but shall not be brought to a smooth polished condition.

Damaged galvanising must be repaired in accordance with AS/NZS 4680 Section 8 and notification of repairs made to the superintendent for approval.

The Contractor shall supply evidence satisfactory to the Superintendent that steel reinforcement complies with AS/NZS 4671. Test certificates shall show the results of mechanical tests and chemical analysis.

Where the material cannot be identified with a test certificate, samples shall be taken and testing arranged by the Contractor. The samples shall be selected randomly and consist of three specimens each at least 1.2 m in length. The cost of all samples and tests shall be borne by the Contractor.

Plastic bar chairs or plastic tipped wire chairs shall be capable of withstanding a load of 200 kg mass on the chair for one hour at 23 ± 5 °C without malfunction. The Contractor shall demonstrate that the proposed chairs conform with these requirements.

(3) Bending

Reinforcement shall be formed to the dimensions and shapes shown on the drawings. It shall not be bent or straightened in a manner that will injure the material, and bars with kinks or bends not shown on the drawings will not be accepted. Heating of reinforcement for purposes of bending will only be permitted if uniform heat is applied. Temperature shall not exceed 450 °C and the heating shall extend beyond the portion to be bent. Heated bars shall not be cooled by quenching.

(4) Splicing

(a) General

All reinforcement shall be furnished in the lengths indicated on the drawings. If splicing is required, it shall be in accordance with the provisions of AS/NZS 4671.
The cost of any test ordered in connection with splices not shown on the drawing shall be borne by the Contractor.

(b) Lapped splices

Laps in reinforcing bars, wire or fabric shall be as shown on the drawings. Laps not shown on the drawings shall be as follows for unhooked bars:

Plain bars, Grade 250 40 bar diameters
Deformed bars, Grade 400 35 bar diameters
Hard-drawn wire 50 bar diameters

Splices in reinforcing fabric shall be so made that the overlap, measured between outermost transverse wires of each sheet of fabric is not less than the spacing of those wires plus 25 mm.

(5) Marking

Bars of identical shape shall be made up in bundles of three and securely tied together by soft iron wire. Each bundle shall have a stout metal label of not less than 40 mm diameter attached to it. Each metal label shall be punched with the appropriate marking in accordance with the steel list shown on the drawings. If called for on the drawings the marking shall incorporate a prefix, and bars with different prefixes shall be stored separately.

(6) Storage

Reinforcement shall be stored above the surface of the ground and shall be protected from damage and from deterioration by exposure.

(7) Delivery and receipt of reinforcement

Unless the Contractor elects to have the reinforcement inspected at the site, no reinforcement shall be delivered to the site until all tests and inspections have been satisfactorily completed and permission to deliver has been granted by the Superintendent.

The Contractor shall give 10 working days notice to the Superintendent for carrying out inspection and testing. The Superintendent will carry out the inspection and testing with reasonable expediency, but the Contractor shall not be entitled to an extra as a result of any delays in this connection.

(8) Placing

Reinforcement shall be accurately placed as shown on the drawings and shall be securely held by blocking from the forms, by supporting on concrete or plastic chairs, or metal hangers, and by wiring together at all intersections or at 0.5 m centres, whichever is the greater distance, using annealed iron wire of diameter not less than 1.25 mm. Steel shall not be supported on metal supports which extend to the surface of concrete, on wooden supports, or on pieces of coarse aggregate. Reinforcement shall have the minimum cover shown on the drawings or otherwise approved by the Superintendent.

The Superintendent may approve the use of tack welding instead of wire ties on reinforcing wire. All welding of reinforcing steel shall be in accordance with AS 1554.3. Tack welding of cold-worked and hard grade bars shall not be permitted.

The reinforcement in each section of the work shall be approved by the Superintendent before any concrete is deposited in the section and adequate time shall be allowed for inspections and any corrective work which may be required. Notice for inspection shall not be less than four normal working hours.

Splices shall be staggered where practicable and when not shown on the drawings they shall be arranged as directed by the Superintendent.

Bars forming a lapped splice shall be securely wired together in at least two places, unless welded.

The clear cover of any bar, including stirrups, to the nearest concrete surface shall be as shown on the drawings. Where not so indicated it shall be as stated below:

(a) concrete normally in contact only with air:

(i) slabs: 40 mm;

(ii) other than slabs: 45 mm; and

(b) concrete in contact with earth or fresh water:

(i) slabs of box culverts: 50 mm; and

(ii) other than culverts: 50 mm.

(9) Cores, fixings and embedded items general

Cores, fixings and embedded items identified on shop drawings showing the proposed locations, clearances and cover, and indicating proposed repositioning of reinforcement must be presented for inspection by the superintendent.

If cutting or coring of hardened concrete is proposed, provide details to the superintendent for approval.

For adjoining elements to be fixed to or supported on the concrete, provide for the required fixings. If required, provide for temporary support of adjoining elements during construction of the concrete.

If in external or exposed locations, galvanize anchor bolts and embedded fixings, or propose alternative materials such as stainless steel.

Fix cores and embedded items to prevent movement during concrete placing. In locating cores, fixings and embedded items, reposition but do not cut reinforcement, and maintain cover to reinforcement.

Isolate embedded items so that water cannot track to concrete providing minimum cover to reinforcement.

SC6.4.6.28.7 Backfilling

(1) General

Backfilling at barriers, paving, etc., and minor concrete works shall not commence until after the concrete has hardened and not earlier than three days after placing.

No superimposed load on any part of what will become a load bearing structure within 21 days after placing concrete shall occur unless the structure is effectively and independently supported to the satisfaction of the Superintendent (approval must be sought at a minimum of 3 working days prior to loading upon evidence of early strength) or until the Contractor can demonstrate that 85% of the design strength of the concrete has been achieved.

Selected backfill shall be placed against retaining walls and cast-in-place box culverts for a horizontal distance equal to one-third of the height of the wall. It shall consist of granular material, free from clay and stone larger than 50 mm gauge. The Plasticity Index of this selected backfill material shall not be less than 2 or more than 12 when tested in accordance with AS 1289.3.3.1. The material shall be placed in layers not exceeding 150 mm and shall be compacted to provide a relative compaction as specified in sub-section SC6.4.6.10 - Earthworks (construction).

(2) Treatment at weepholes

Drainage adjacent to weepholes shall be provided by either a layer of broken stone or river gravel consisting of clean, hard, durable particles graded from 50 mm to 10 mm such that:

(a) the maximum particle dimension shall not exceed 50 mm; and

(b) no more than 5 per cent by mass shall pass the 9.5 mm A.S. sieve.

The broken stone or river gravel, enclosed in a filter fabric suitable for drainage without scour, shall be continuous in the line of the weepholes, extend at least 300 mm horizontally into the fill and extend at least 450 mm vertically above the level of the weepholes.

Alternatively the Contractor may provide a synthetic membrane of equivalent drainage characteristics at no extra cost to the Principal. It shall be stored and installed in accordance with Manufacturer's instructions. The use of a synthetic membrane shall be subject to the Superintendent's approval.

SC6.4.6.28.8 Sprayed concrete

(1) References

NSW RTA – *Shotcrete Design Guidelines*.

(2) General

Sprayed concrete is concrete pneumatically applied at high velocity on to a surface. Application may be either a wet or dry process. A sound homogeneous product shall be provided with surface finish reasonably uniform in texture and free from blemishes.

The minimum depth of sprayed concrete to be applied shall be 75 mm.

Sprayed concrete lining in open drains shall be coloured to match the adjoining rock colour.

Sprayed concrete shall have a minimum cement content of 380 kg/m3 as discharged from the nozzle and shall have a minimum compressive strength of 25 MPa at 28 days when tested by means of 75 mm diameter cores taken from in-place sprayed concrete.

Cores shall be secured, accepted, cured, capped and tested in accordance with AS 1012.14. Equipment and facilities shall be provided by the Contractor for the taking of cores from the work. The Contractor shall arrange for a laboratory with appropriate NATA registration for the curing and testing of the cores. Copies of test results shall be forwarded to the Superintendent.

The cost of all work and material required in the taking, handling, delivery and testing of cores shall be borne by the Contractor.

At least 14 days prior to applying any sprayed concrete the Contractor shall submit to the Superintendent details of his proposed procedure, plant, materials and mix proportions. Materials shall comply with AS 3600.

(3) Test panels

Not less than 7 days before applying concrete, the Contractor shall prepare at least three test panels for each mix proposed, in conditions similar to those in the works and in the presence of the Superintendent. The test panels shall be made by applying a 75 mm thickness of sprayed concrete to a hardboard panel approximately 750 mm square. The sprayed concrete shall be applied to the panels in the same manner, using materials including steel reinforcing fabric, equipment, pressures and curing that will be used in the Works. The panels shall be submitted to the Superintendent for examination.

The Contractor shall cut four 75 mm diameter cores from one test panel for each proposed mix approximately 48 hours after the panel has been sprayed. The cores shall be tested as for cores from in-place sprayed concrete. One core shall be compression tested at 3 days, one core at 7 days and the remaining two cores at 28 days.

Should any of the cores reveal defects such as lack of compaction, dry patches, voids or sand pockets or should the test panel exhibit an unacceptable surface finish, the Contractor shall modify the mix design and/or method of placement and prepare fresh test panels for testing and inspection.

Sprayed concrete shall not be applied to the Works until the Contractor produces test panels for the approval of the council.

(4) Surface preparation

Earth surfaces shall be graded, trimmed and compacted and shall be dampened prior to applying the sprayed concrete. The Contractor shall take any precautions necessary to prevent erosion when the sprayed concrete is applied.

Rock surfaces shall be cleaned of loose material, mud and other foreign matter that might prevent bonding of the sprayed concrete onto the rock surface. The rock surface shall be dampened prior to applying the sprayed concrete.

Corrugated steel pipes shall be cleaned of loose material, mud and any other foreign matter.

The Contractor shall remove free water and prevent the flow of water which could adversely affect the quality of

the sprayed concrete.

(5) Application of sprayed concrete

Application shall begin at the bottom of the area being sprayed and shall be built up making several passes of the nozzle over the working area. The nozzle shall be held so that the stream of material shall impinge as nearly as possible perpendicular to the surface being coated. The velocity of discharge from the nozzle, the distance of the nozzle from the surface and the amount of water in the mix shall be regulated so as to produce a dense coating with minimum rebound of the material and no sagging. Rebound material shall be removed after the initial set by air jet or other suitable means from the surface as work proceeds and disposed of.

Spraying shall be discontinued if wind causes separation of the nozzle stream.

Concrete shall not be sprayed in air temperatures less than 5 °C.

Construction joints shall be kept to a minimum. A joint shall be formed by placing or trimming the sprayed concrete to an angle between 30° and 45° to the sprayed concrete surface. The joint edge shall be cleaned and wetted by air-water jet before recommencing concrete spraying.

When spraying around reinforcement, concrete is to be sprayed behind the reinforcement before concrete is allowed to accumulate on the face of the reinforcement.

Adjoining surfaces not requiring sprayed concrete shall be protected from splash and spray rebound. Splash or rebound material on these adjoining surfaces shall be removed by air-water jet or other suitable means as work proceeds.

(6) Curing

Curing shall commence within one hour of the application of sprayed concrete and may be by water or by colourless wax emulsion curing compound complying with AS 3799 and applied in accordance with manufacturer's specifications.

In water curing, the surface of the sprayed concrete shall be kept continuously wet for at least 7 days.

SC6.4.6.28.9 Summary of limits and tolerances

The limits and tolerances applicable to the various clauses in this Specification are summarised in Table SC6.4.6.28.7 – Summary of limits and tolerances below:

Item	Activity	Limits/Tolerances	Clause
1.	**Foundation**		
	(a) Relative Compaction	³95% RDD(standard compactive effort) within 0.3 m below subgrade	SC.6.4.6.28.2(1)
	Barriers, Footpaths etc.		
	(a) Finished Subbase	To be trimmed and compacted so that the levels do not vary more than 15 mm under a straight-edge 3 metres long.	SC6.4.6.28.2(2)
	(b) Relative Compaction of Subbase	³100% (standard compactive effort)	SC6.4.6.28.2(2)
3.	**Formwork**		
	(a) Position of Forms	Forms shall be aligned accurately so that departure of the forms from the surfaces specified on the drawings shall not exceed 1/300 of the space between supports for any surface visible in the completed work and 1/150 for hidden work.	SC6.4.6.28.3(5)
4.	**Fine Aggregate**		

Item	Activity	Limits/Tolerances	Clause
	(a) Grading	To be evenly graded within the absolute limits and shall not deviate from the grading of sample aggregate as per Table SC6.4.6.28.1.	SC6.4.6.28.4(3)
5.	**Coarse Aggregate**		
	(a) Percentage of wear	Loss of weight shall not exceed 30%	SC6.4.6.28.4(4)
	(b) Crushing Value	Crushing value shall not exceed 25%	SC6.4.6.28.4(4)
	(c) Soundness	The loss of mass when tested with sodium sulphate shall not exceed 12%	SC6.4.6.28.4(4)
	(d) Particle Shape	The proportion of misshapen particles (2:1 ratio) shall not exceed 35%	SC6.4.6.28.4(4)
	(e) Grading	To be evenly graded within the absolute limits and shall not deviate from the grading of sample aggregate as per Table SC6.4.6.28.2.	SC6.4.6.28.4(4)
6.	**Aggregate Moisture Content**	Where moisture content of fine aggregate exceeds 8%, or moisture content of coarse aggregate exceeds 3%, the proportion of mix shall be changed.	SC6.4.6.28.5(2)
7.	**Consistency**	In accordance with AS 1012.3, Method 1 the slump shall not exceed the nominated slump ±15 mm.	SC6.4.6.28.5(4)
		In the case of concrete placed by extrusion machine, the slump will be between 10 mm and 15 mm.	SC6.4.6.28.5(4)
8.	**Ready-Mixed Concrete**		
	(a) Mixing & Delivery	The time taken from the introduction of water until the concrete is completely discharged shall be not more than 1.5 hours. Where non-agitating equipment is used the concrete shall be completely discharged not more than 30 minutes after the addition of water.	SC6.4.6.28.5(5)
9.	**Placing & Compacting of Concrete**	Concrete shall not be placed without the approval of the Superintendent if the air temperature within 24 hours is likely to be below 5 ˚C or the shade temperature is likely to exceed 38 ˚C.	SC6.4.6.28.5(6)
10.	**Finishing of Unformed/Formed Concrete Surfaces**		
	(a) Wearing Surface	To be finished true and uniform so that departure from designed grade shall not exceed 5 mm in any 3 metre length.	SC6.4.6.28.5(7)(b)
	(b) Finished Surfaces		
	(i) Not Adjacent to Roads	≤25 mm Plan position	SC6.4.6.28.5(7)(c)
		≤25 mm Level	SC6.4.6.28.5(10
	(ii) Adjacent to Roads	≤10 mm Alignment	SC6.4.6.28.5(7)(c)
		≤10 mm Level	SC6.4.6.28.5(10)
	(iii) Culvert Inverts	≤25 mm Alignment	SC6.4.6.28.5(7)(c)
		≤10 mm Level	SC6.4.6.28.5(10)

SC6.4.6.29 Boundary fencing

SC6.4.6.29.1 Introduction

(1) Scope

The work to be executed under this sub-section includes setting out, clearing of fence line, supply of material and erection of fencing and gates, in accordance with the drawings or as directed by the Superintendent.

(2) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections

SC6.4.6.11 - Clearing and grubbing

SC6.4.6.28 - Minor concrete works

(b) Australian Standards

AS 1289.5.4.1 - *Compaction control test - Dry density ratio, moisture variation and moisture ratio.*

AS 1725.1 – *Chain link fabric fencing - Security fences and gates.*

AS 2423 - *Coated steel wire fencing products for terrestrial, aquatic and general use.*

(c) Queensland Department of Transport and Main Roads publications - *Manual of Uniform Traffic Control Devices* (Queensland) (MUTCD)

SC6.4.6.29.2 Materials

(1) General

All materials shall be supplied by the Contractor and shall be of dimensions, manufacture and quality in accordance with the requirements of this policy and all galvanised wire fencing products shall conform to AS 2423.

For each type of material to be supplied, the Contractor shall submit to the Superintendent for approval the source, manufacturer, and also the type if applicable.No materials shall be used until approved by the Superintendent.

(2) Galvanised posts, braces and rails

All posts, bracing and rails shall be galvanised iron pipe in accordance with AS 1725.1. The pipes shall be to the dimensions shown on the drawings.

All pipe joints shall be welded. All welds shall be satisfactorily cleaned and painted with a cold galvanising compound to the satisfaction of the Superintendent.

(3) Chain wire

Galvanised chain wire mesh, 1200 mm high, 1450 mm high or 1830 mm high for Manproof Fencing shall be of 3.15 mm diameter wire woven to a 50 x 50 mm square mesh. Chain wire shall be supplied in lengths of not less than 30 m. The zinc coating shall be uniform, continuous, free from imperfections and thoroughly adherent. The coating shall be applied to the wire before the mesh is woven. The weight of the zinc coating shall not be less than 290 g/sq m of wire surface.

Where specified, the chain wire shall be coated in black PVC after galvanising.

(4) Wire netting

Wire netting shall be standard quality galvanised 1.40mm diameter wire, 40mm mesh, 1.05m wide for normal use and 1.60mm diameter wire, 50mm mesh, 0.90m wide where used in creek crossings.

(5) Gates

Gates shall be of galvanised tubular steel construction, 3.6m in width by 1.5m or 1.2m (as specified) in height, and shall be fitted with substantial hinges, catch, drop bolts and locking chains unless otherwise shown on the

drawings or directed by the Superintendent.

Where required, gates shall have stout and well supported rabbit-proof mesh to a height of at least 900mm above ground level.

(6) Reinforced concrete posts

(a) Strainer posts
Concrete strainer posts shall be approximately 150 x 150 square in section and lengths as shown on the drawings. Each post shall be provided with 12mm dia holes to suit the spacing of the wires shown on the drawings for the particular type(s) of fencing to be erected.

The posts shall be reinforced longitudinally with not less than four reinforcing bars each 12mm diameter. All posts shall have suitable stirrup reinforcement to control diagonal cracking. Longitudinal reinforcement shall have 25mm minimum cover. End cover on reinforcement shall be 25mm.

(b) Intermediate posts
Intermediate Posts shall generally conform to the requirements for Strainer Posts, except that the longitudinal reinforcing bars may be 9mm dia.

(7) Prestressed concrete posts

(a) Strainer posts
At least four longitudinal high carbon deformed high tensile strands (or equivalent) of 5mm diameter, shall be provided. The strands shall be tensioned to a stress of 800 MPa minimum prior to placing concrete. Cross sectional dimensions of the posts shall be as shown on the drawings.

Concrete shall have a minimum compressive strength of 32 MPa at 24 hours. In lieu of holes for wires, grooves may be provided to suit the spacing of the wires shown on the appropriate drawings for the particular types of fencing to be erected. The grooves shall be at least 5mm deep and 5mm wide at the surface of the post.

(b) Intermediate posts
Intermediate posts and strainer stays shall generally conform to the requirements for Strainer Posts except that two only high tensile, high carbon deformed strands shall be required.

Cross sectional dimensions shall be as shown on the drawings.

(8) Steel posts (rural fencing)
Steel posts shall be "STAR" pattern. Posts shall be drilled to suit the spacing of the wires shown on the Drawing(s), and shall be black varnished or galvanised. The total weight of 300 posts each 1.65m long shall be at least 1 tonne.

(9) Galvanised pipe posts (rural fencing)
Galvanised pipe posts shall be used where shown on the drawings. The pipes shall be of the dimensions shown on the drawings and shall be of first grade quality in accordance with AS 1725.

(10) Wires

(a) Plain wire
Plain wire shall be standard galvanised drawn annealed steel wire of diameters shown on the drawings.

(b) High tensile plain wire
High tensile wire shall be galvanised and of diameters shown on the drawings.

(c) Barbed wire
Barbed wire including barbs shall be 2.5mm diameter galvanised drawn annealed steel wire, with clusters of four barbs spaced at 90mm maximum. Alternatively barbed wire may be of 1.6mm diameter high tensile steel wire, with clusters of barbs spaced at 90mm maximum.

(d) Cable wire

Cable wire shall consist of three pairs of 2 x 3.15mm galvanised iron wire tightly twisted around posts and located as shown in the drawings.

(e) Tie wire
The wire shall be 2mm diameter galvanised wire.

(11) Concrete backfilling
All concrete backfilling of post holes specified on the drawings shall be of minimum 20 MPa 28 day compressive strength and shall conform to the requirements of sub-section SC6.4.6.28 Minor concrete works.

SC6.4.6.29.3 Construction

(1) General
Fencing shall be erected prior to the commencement of other work on a particular section of the work, unless directed otherwise by the Superintendent.

All fencing shall be erected in a workmanlike manner, and when completed shall be sound, strong and of neat appearance.

For a clear width of one metre on either side of the fence line, and for the full length of the line, all logs, boulders, stumps, roots, undergrowth and rubbish shall be removed and disposed of by the contractor in accordance with SC6.4.6.11 Clearing and grubbing. Trees within this area shall be removed only as directed by the Superintendent and approved by council's authorised officer.

If trees on or adjacent to the fence line are to be retained the arrangement of the fencing at the trees shall be as directed by the Superintendent.

Wire shall not be strained around or against any trees to be left in the fence line, and strainer posts are to be provided on both sides of each tree.

Where minor irregularities occur in the ground the vertical alignment of the fence shall not follow these irregularities, but shall be aligned to a uniform grade between definite changes in the natural slope of the ground.

All boundary fencing is to be erected on the common boundary line (where practicable) which has been surveyed and marked with pegs by a registered cadastral surveyor. The placement of the proposed fence (including footings), relative to the marked boundary line, is to be such that no (or minimal) loss of accessible land results for either property owner once the fence is erected. Any deviation of the proposed fence line away from the marked property boundary is to be mutually agreed to by all parties prior to erection of the fence.

The Contractor shall maintain the fencing at all times in a condition secure against the ingress or egress of stock, and shall take such precautions as are necessary to prevent people or stock from stepping into holes excavated for the construction of fencing.

Where old fencing is to be replaced by new fencing, all holes left after removal of the old fencing shall be backfilled and rammed firmly in layers of maximum depth 150mm.

The Contractor shall be held responsible for any loss, damage, or injury to buildings, goods, crops, livestock, property of any kind or persons due to negligence on the Contractor's part.

(2) Chain link fencing

(a) Erection of posts
All posts shall be erected vertically and set in concrete blocks approximately 250mm diameter and 600mm deep except for end, corner, strainer and gate posts which shall be set in concrete blocks approximately 250mm diameter and 900mm deep unless otherwise shown on the drawings. Concrete shall have a minimum compressive strength of 20 MPa at 28 days and shall conform to the requirements of sub-section SC6.4.6.28 Minor concrete works.

Galvanised weather caps shall be fitted to all galvanised posts.

Strainer posts shall be used at ends of fencing, angles, intersections with other fencing, gates and at intermediate points. Distances between strainer posts shall not exceed 120m.

(b) Erection of wire

All wire shall be spaced as shown in the drawings. Wire shall be securely fastened and strained to an even tension between strainer posts.

Where specified, or shown on the drawings, chain wire mesh shall be erected on the outside of the posts and fastened with two turns of tie wire to each cable wire on both sides of each post and at intervals of not more than 900mm between posts and to each post midway between cable wires.

(3) Stock-proof fencing

(a) Erection of posts

All posts shall be erected vertically. Reinforced concrete posts shall be erected in neatly cut holes sunk in earth, or in rock where this is encountered. Steel posts, except where placed in rock, shall be driven with suitable driving equipment, care being taken not to damage the tops of the posts during driving.

Where prestressed posts are proposed to be used, they shall be either erected as for reinforced concrete posts or shall be driven. Where driven, the Contractor shall use a suitable post driver which shall be equipped with two sets of guiding rollers, to hold the post vertical and in position during driving.

A steel cap with a plywood cushion shall be used to protect the top of the post during driving.

If the post cannot be driven for the full depth specified, or if it becomes significantly damaged, or cannot be driven vertically, it shall be removed. The same post if undamaged, or a new post, shall be erected as described for reinforced concrete posts.

Posts shall be sunk to the depths shown in Table SC6.4.6.28.1 Post depth in ground.

Table SC6.4.6.29.1 Post depth in ground

Type of Post	Depth	
	Earth	Rock
Concrete Corner Posts and Strain Posts	900	*600
Concrete Intermediate Posts	600	*450
Steel Posts	450	450
Note —*permitted only in cases where posts of the correct length are provided (see below), otherwise the depth of sinking shall be the same as for earth.		

Cutting of concrete posts will not be permitted, and in order to take advantage of the lesser depth of sinking permitted in rock, it will be necessary to use posts manufactured in lengths to suit the depth of sinking. Where rock is encountered, steel posts shall be sunk in drill holes of sufficient diameter to permit them to be refilled with cement mortar consisting of one part of cement to two parts of clean sand.

Earth shall be backfilled around intermediate posts in layers of maximum depth 150mm for the full depth of the hole and up to ground level. The relative compaction of the rammed material shall be not less than that of the original undisturbed ground.

Where concrete posts are placed in rock, the space around the posts shall be tightly filled with cement mortar consisting of one part of cement to two parts of sand, or concrete where this is available.

Strainer posts shall be used at ends of fencing, angles, intersections with other fencing, gates and at intermediate points. These posts shall be backfilled with approved concrete to their full depth.

Distances between strainer posts shall not exceed 120m in the case of fencing using steel intermediate posts, and 90m in the case of fencing for the retention of cattle (for which only concrete posts are permitted). Junctions with existing fencing shall be made in an approved manner.

(b) Erection of wires

All wire shall be placed as shown on the drawings. Wires shall be securely fastened and strained to an even tension between strainer posts with an approved wire strainer. Where barbed wire is to be used, it shall be tied in position at the top of intermediate posts, and where additional barbed wires are called for they shall be secured to the sides of the posts as shown on the drawings.

Where concrete posts are used and the barbed wires are secured either to the tops or sides of the posts by tie wire, the tie wire shall be stretched tight and shall fit snugly against the sides of the posts to prevent movement of the barbed wire.

Where prestressed posts are used, wires shall be securely tied so that they seat firmly in the grooves.

All joints in wires shall be as shown on the drawings.

(4) Crossing of watercourses and depressions

The crossing of all watercourses and depressions, shall be made secure by longer posts, suitably strutted as directed by the Superintendent. Additional cable wire and chain wire/wire netting shall be provided as necessary to make the fence stock proof.

The fence shall allow the passage of floodwater without the accumulation of debris. If directed by the Superintendent, flood gates shall be provided in accordance with clause SC6.4.6.29.3(6) Flood gates.

(5) Connections to existing fences

Existing cross fences shall be connected to the new fence using a strainer post with braces in each direction of strain (including cross fence) and the wires in both fences properly fastened to the post.

(6) Flood gates

(a) General

Suitable provision for the passage of flood waters past the fence shall be made at all watercourses. In all cases flood gates shall be of the type indicated on the drawings, or as directed by the Superintendent, and shall be erected so as to prevent the accumulation of flood debris, while remaining stock-proof or rabbit-proof.

(b) Small watercourses

Flood gates, in accordance with the drawings, shall be provided in small gullies at the locations indicated on the drawings or as directed by the Superintendent. The opening of each flood gate shall provide a waterway area at least twice that of the culvert opposite to which it is placed, or as otherwise directed by the Superintendent.

(c) Large gullies and creeks

Flood gates, in accordance with the drawings, shall be provided in gullies and creeks at the locations indicated on the drawings, or as directed by the Superintendent.

A 9mm galvanised wire rope shall be carried over the gully in one span, threaded through a strainer post and tied back to an anchor at an adjacent concrete intermediate post. Turnbuckles are to be provided at each end to tension the wire rope. Netting shall be suspended from the wire rope and shall be overlapped and securely tied. The netting shall be of sufficient length to lie on the ground for a distance of not less than 1.0m on the downstream side.

Ballast, of sound timber securely tied to the netting, shall be provided at the downstream end of the netting.

The sides of the gully shall be trimmed, as necessary, to ensure that the flood gate shall be stock-proof or rabbit-proof. The flood gate shall have sufficient movement of the suspended portion under the flow of

flood waters to prevent damage to the fence and the accumulation of debris against it. Each strainer post shall be stayed in three directions, as shown on the drawings.

(7) Erection of gates

Where gates are specified or shown on the drawings, they shall be erected so that they swing away from the road. Double gates shall be supplied if directed by the Superintendent, otherwise a single gate only shall be supplied.

At the location of gates the surface shall be levelled and shall be nearly horizontal. The area where the gates swing shall be similarly levelled.

The gates shall be hung as indicated in the drawings.

(8) Where required, existing fencing is to be removed as shown on the drawings.

No fencing is to be removed if there is a risk of egress or ingress of stock. If the existing fence is a rabbit-proof fence, then the contractor shall ensure that at night and weekends and other such times when work is not in hand that the whole of the fence is maintained in a rabbit-proof condition, even if temporary fencing is required.

All material removed in demolishing existing fencing shall be disposed by the Contractor as provided by clause SC6.4.6.29.3(9) Removal and disposal of surplus material and rubbish.

(9) Removal and disposal of surplus material and rubbish

All surplus material, offcuts, timber, roots and other debris resulting from the fencing contract shall be removed or otherwise disposed of to the satisfaction of the Superintendent.

The contractor shall not burn any timber, vegetation or refuse on site unless specifically approved by council's authorised officer.

(10) Cattle grids

Cattle grids shall be erected in accordance with the drawings.

The cattle grid shall be evenly bedded on a continuous layer of compacted sand or other granular material approved by the Superintendent. The bedding material shall be compacted so that the relative compaction as determined by AS 1289.5.4.1 is not less than 95 per cent.

Cattle grids shall be installed on raised abutments with approach ramps where possible. Alternatively, a cattle grid may be placed over an excavated pit, in which case adequate drainage shall be provided.

Crossfall for single lane cattle grids shall be level and for two lane cattle grids each section shall have a crossfall conforming to the crossfall of the approach road.

The cattle grid construction shall include all activities associated with the cattle grid including any adjustments to the fencing as shown on the drawings.

Advance signposting, in accordance with MUTCD, shall be provided on each approach to the cattle grid in accordance with sub-section SC6.4.6.24 Signposting.

SC6.4.6.30 Control of traffic

SC6.4.6.30.1 Introduction

(1) Scope

This sub-section provides standards, advice and guidelines for work necessary to provide for the safe movement of traffic and the protection of persons and property through and/or around the work site.

The extent of work includes the design, construction, maintenance and removal of temporary roadways and detours, the provision of traffic controllers, signposting, roadmarkings, raised pavement markers, lights, barriers and any other items required. All temporary traffic arrangements required by works are included under this sub-section except where specified otherwise.

Control of traffic shall be in accordance with Manual of Uniform Traffic Control Devices (MUTCD), this sub-section, and the drawings.

(2) Reference and source documents

Documents referenced in this sub-section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this sub-section one as follows:

SC6.4.6.4 - Stormwater drainage
SC6.4.6.5 - Drainage structures
SC6.4.6.6 - Pipe drainage
SC6.4.6.9 - Open drains
SC6.4.6.10 – Earthworks (construction)
SC6.4.6.11 Clearing and grubbing
SC6.4.6.12 - Flexible Pavements
SC6.4.6.13 - Asphaltic concrete
SC6.4.6.16 - Sprayed bitumen surfacing

(b) Australian Standards

AS 1742 – *Manual of uniform traffic control devices*
AS 1742.3 - *Manual of uniform traffic control devices – Traffic control for works on roads*
AS 1743 - *Road Signs - Specifications*
AS 1744 - *Standard alphabets for road signs*
AS/NZS 1906 - *Retroreflective materials and devices for road traffic control purposes*
AS/NZS 4602 - *High visibility safety garments*

(c) Austroads publications

Guide to Road Design - Part 3 Geometric Design
Guide to Traffic Management – Part 6 Intersections, Interchanges and Crossings
Guide to Road Safety – Part 9 Roadside Hazard Management

(d) Queensland Department of Transport and Main Roads publications

Manual of Uniform Traffic Control Devices (Queensland) (MUTCD).

(e) Other

International Erosion Control Association (IECA), *Best Practice Erosion and Sediment control council*

(3) Traffic guidance scheme

The Contractor shall construct the work with the least possible obstruction to traffic.

Two weeks before undertaking work which would involve any obstruction whatsoever to traffic the Contractor shall submit, for the Superintendent's approval, a Traffic guidance scheme in accordance with Part 3 of the MUTCD.

The Traffic guidance scheme shall include:

(a) design drawings for any temporary roadways and detours in accordance with clause SC6.4.6.30.2(3) Design drawings, showing pavement, wearing surface and drainage details;

(b) details of arrangements for construction under traffic in accordance with Part 3 of MUTCD;

(c) a signpost layout plan showing:

  (i) location, size and legend of all temporary signs;

  (ii) temporary regulatory signs and temporary speed zones, and

  (iii) all traffic control devices such as temporary traffic signals, linemarking, pavement reflectors, guideposts, guard fence and barrier boards; and

(d) working times when traffic control measures are in place to minimise disruption to traffic during periods of peak flows.

The Contractor shall obtain all necessary approvals for temporary traffic arrangements except where specified otherwise.

Where the Traffic guidance scheme involves Regulatory traffic control signs or devices and/or where a disruption to traffic (including pedestrian) to the existing road is likely to be significant, the contractor must undertake consultation with all stakeholders and where identified, must include changes to bus routes and the establishment of temporary bus stops, relocation of any taxi ranks and parking bays for people with disabilities, establishment of any work zones on the roadway amd arrangements for the safe movement of pedestrians past the work site as part of the application to council for approval.

In the case of an intersection with a State controlled road approval from the Department of Transport and Main Roads (DTMR) must also be obtained.

The Traffic guidance scheme shall be in accordance with the requirements of this sub-section and the drawings.

Special consideration to the safety of pedestrians and workers shall be given in the preparation of the Traffic guidance scheme. Particular care shall be taken when requiring reversal of traffic flows or the separation of unidirectional flow by medians or other physical separation.

An approved copy of the Traffic guidance scheme must be kept on site at all times. This must be used to check the arrangement and maintenance of traffic control devices.

For staged works and complex traffic guidance schemes, the Contractor shall conduct a regular safety audit during the construction phase including risk assessments for the workers safety as recommended in *Guide to Road Safety – Part 9 Roadside Hazard Management.*

For non-complex traffic guidance schemes such as short term and mobile works not involving full or part road closure or works involving relatively simple part-roadway closures, the Contractor is required to carry out risk assessments considering factors such as traffic volume and speed, road geometry and width and general behaviours of road users. A fully protected work site will be required if identified risks cannot be tolerated.

(4) Side roads and property accesses

The Contractor shall provide safe and convenient passage for vehicles, pedestrians and stock to and from side roads and property accesses connecting to the roadway. Work that affects the use of side roads and existing accesses shall not be undertaken without providing adequate alternative provisions to the prior satisfaction of the Superintendent.

Where interuptions to access is required, they are to be kept to a minimum and the contractor must advise the property owners of any interruption to access by way of a letter drop at least 24 hours before the intended interruption. The contractor shall repeat this advice verbally to the property owner where possible before proceeding with the access closure. All interuptions to access must have the the approval of the superintendent.

(5) Traffic controllers

The Contractor shall advise the Superintendent of the names of proposed traffic controllers with a signed declaration that they are appropriately trained in the duties of traffic controllers in accordance with the MUTCD.

In situation where restricted sight distance is identified by the Superintendent, an additional traffic controller shall be placed at the tail end of the queue.

(6) Approved clothing for work personnel

All personnel shall wear high visibility clothing to the requirements of the MUTCD.

(7) Temporary speed zoning

Where a temporary speed limit has been approved by the council, or in the case of a gazetted or State controlled road the District Manager of DTMR, the Contractor shall arrange for the supply of appropriate temporary speed zoning signs, including posts and fittings, for erection. Where and when directed by the Superintendent, the Contractor shall erect these signs, cover the signs when the speed zone is not in use and remove the signs when the speed zone is no longer required as part of the provision for traffic. A diary recording operation times of the speed zone shall be kept by the Contractor.

(8) Plant and equipment

During the day plant and equipment working in a position adjacent to traffic and having a projection beyond the normal width of the item, for example, a grader blade, shall have a fluorescent red flag attached to the outer end of the projection. During poor light conditions or at night, an additional traffic controller with an illuminated red wand shall direct traffic around such plant and equipment.

At night, where traffic is permitted to use the whole or portion of the existing road, all plant items and similar obstructions shall be removed from the normal path of vehicles to provide a lateral clearance of at least 6 m where practicable, with a minimum clearance of 1.2 m.

Plant and equipment, within 6 m of the normal path of vehicles, shall be lit by not less than two yellow steady lamps suspended vertically from the point of the obstruction nearest to a traffic lane and one yellow steady lamp at each end of the obstruction on the side furthest away from the traffic lane.

SC6.4.6.30.2 Temporary roadways and detours

(1) Approval

The design of all proposed temporary roadways and detours; to be undertaken in accordance with this policy sub-section

(2) Design standards

The standard of alignment and grading adopted shall be in accordance with specific provisions of this policy and shall otherwise be in accordance with the *Guide to Road Design – Part 3 Geometric Design*

Intersections shall be designed in accordance with the Guide to Traffic Management – Part 6 Intersections, Interchanges and Crossings.

Design drawings, geometric standards, design speed, wearing surface type and pavement design of the proposed temporary roadways and detours shall be submitted by the Contractor with the Traffic Guidance Scheme.

(3) Design drawings

Design drawings submitted for approval should show:

(a) alignment and grading at a horizontal scale of 1:2000 for rural roads and 1:500 for urban roads. Where the temporary road rejoins the existing road, levels showing the full cross section shall be extended along the existing road for a minimum length of 200 m;

(b) a sight distance diagram if opposing traffic is to use a single carriageway;

(c) intersections, and any other locations where traffic may be required to make turning, merging or diverging movements, at a scale of 1:500;

(d) pavement marking details;

(e) sufficient cross sections to indicate the feasibility of making connections between various parts of the work;

(f) sufficient dimensions, especially lane widths, to make clear the geometry and clearances of the proposed works;

(g) a north point or some other location method to orientate the plan;

(h) roadside furniture;

(i) drainage structures (existing/temporary and proposed); and

(j) pavement and surfacing type.

(4) Drainage

Drainage structures and drains shall be constructed in accordance with the following sub-sections:

(a) SC6.4.6.4 - Stormwater drainage;

(b) SC6.4.6.6 - Pipe drainage;

(c) SC6.4.6.5 - Drainage structures; and

(d) SC6.4.6.9 - Open drains.

Drainage proposed in accordance with clause SC6.4.6.30.1(2) Traffic guidance scheme shall be able to cope with upstream rainfall run off resulting from all rainfall intensities up to that expected for a once in five year frequency, without overflow over the road.

Pavements shall be designed and constructed to not pond water on the wearing surface or shoulders. Temporary formations to be constructed shall not dam water.

(5) Construction of earthworks and pavement

Temporary roadways shall be constructed in accordance with the following specifications:

(a) *Best Practice Erosion and Sediment Control*;

(b) SC6.4.6.11 Clearing and grubbing;

(c) SC6.4.6.10 Earthworks (construction); and

(d) SC6.4.6.12 Flexible Pavements.

(6) Surfacing

The wearing surface width shall extend across the full width of the traffic lanes plus the width for each shoulder, or as otherwise demonstarted.

The wearing surface shall be carried onto any existing connecting roadway so as to finish square to the existing roadway centreline.
Surfacing shall be constructed in accordance with:
SC6.4.6.16 - Sprayed bitumen surfacing; and
SC6.4.6.13 - Asphaltic concrete

(7) Road safety barrier

Corrugated steel road safety barrier shall be erected on all temporary embankments where the vertical height between the edge of the shoulder and the intersection of the embankment slope and natural surface exceeds 2m.

Road safety barrier shall be erected in accordance with:
SC6.4.6.25 - Non-Rigid Road Safety Barrier Systems.

(8) Opening to traffic

Temporary roadways and detours (including portable or temporary traffic signals sites) shall not be open to traffic until they have been inspected, approved and authorised in writing.

All signposting, pavement marking, guardfence and portable or temporary traffic signals shall be completed before the opening of temporary roadways to traffic.

The opening of temporary roadways shall be arranged so that sections of existing roadway being replaced are not disturbed for a minimum of 48 hours in the event of temporary roadway failure and there is a warrant to redirect traffic back onto the existing roadway. The determination to redirect traffic shall be by the Superintendent.

The redirection of traffic back onto the existing roadway shall be the responsibility of the Contractor.

Unless otherwise approved by the Superintendent, traffic shall be switched to a temporary roadway or detour only where the Contractor's usual workforce will be on site for a minimum of 2 days thereafter.

(9) Maintenance

The Contractor shall be responsible for the maintenance of temporary roadways and detours and shall ensure the road surface is kept safe for traffic. Any potholes or other failures shall be repaired without delay.

(10) Removal

Upon completion of the work the temporary roadways and/or detour arrangements shall be removed and the area restored to a condition equivalent to that which existed prior to the commencement of the work.

SC6.4.6.30.3 Arrangements for traffic

(1) Construction under traffic

Where a temporary roadway or a detour is not provided or available then, subject to the approval of the Superintendent, construction under traffic may be permitted provided a minimum of 3.5 m lane width is available for through traffic on a two lane roadway and where 3.5 m lanes are available in both directions for through traffic when working on multilane roads.

The carriageway/s shall be restored to a safe and trafficable state for through traffic prior to cessation of work each day in accordance with the approved Traffic guidance scheme.

Full details of temporary signposting, traffic control devices and traffic control methods, in accordance with the appropriate arrangement diagrams in MUTCD, are to be submitted for the Superintendent's approval at least 5 working days before undertaking any work which would involve construction under traffic.

(2) Opening completed work

The Contractor shall give the Superintendent at least 5 working days written notice confirming the date of opening completed work to traffic. The procedure for opening shall be determined through consultation between the Superintendent, the Contractor and the council.

The Contractor shall be responsible for the removal of all temporary traffic control devices no longer required for the safety of traffic, when the works or part thereof are opened to traffic.

SC6.4.6.30.4 Traffic control devices

(1) Arrangement of traffic control devices

The arrangement and placement of traffic control devices shall be carried out in accordance with the approved Traffic guidance scheme, and MUTCD. The arrangement diagrams illustrate the more common examples of the arrangement of traffic control devices and set out the minimum requirements.

All temporary traffic control devices, when no longer required, shall be covered and/or removed without delay in order to maintain unambiguous safe guidance to traffic.

(2) Maintenance of traffic control devices

All traffic control devices shall be maintained in accordance with MUTCD so that they are in good order and in the correct positions day and night. They shall be neat and clean, and signs shall be clear and legible at all times.

To ensure the preceding clause is complied with, the Contractor shall inspect the site at least once every 24 hours for the maintenance of all traffic control devices.

The Contractor may need to be contacted outside normal working hours to arrange for adjustments or maintenance of traffic control devices. The Contractor shall notify the Superintendent and the council in writing, the names, addresses, and means of communicating with personnel nominated for this purpose.

(3) Adequate traffic control devices

Where the Contractor fails to provide and maintain adequate traffic control devices specified in this sub-section, the Superintendent shall arrange to have such items provided and maintained.

(4) Regulatory traffic control signs and devices

A regulatory traffic control sign or device shall be in accordance with the MUTCD, and shall require approval by the council, or in the case of a gazetted or State controlled road, the District Manager of DTMR, before its erection. This approval should be obtained through the Superintendent, refer to clause SC6.4.6.30.1(6) Temporary speed zoning.

(5) Signs

Signs shall be designed and manufactured in accordance with AS 1743. Details of each letter shall be as shown in AS 1744.

The reflective material used on signs shall be Class 2 material complying with AS 1906.1 except where otherwise specified.

(6) Supplementary signs

Signs supplementary to the MUTCD are shown in SC6.4.6.30 Attachment A Supplementary temporary warning signs to MUTCD. Approval must be obtained from DTMR prior to their use.

(a) Heavy Machinery Crossing

This temporary sign, shown as Sign SW5-22, if approved, may be used in lieu of W5-22, trucks entering.

(b) Cycle Hazard Grooved Road

This temporary sign, shown as Sign ST1-10, if approved, may be used in addition to T1-10 of AS 1742.3 where the road is grooved and is a hazard to cyclists.

(c) Tar Spraying Possible Short Delay

This temporary sign, shown as Sign ST3-1, if approved, may be used in addition to T3-1 for bituminous surfacing works.

(7) Flashing arrow signs

Flashing arrow signs shall comply with MUTCD.

(8) Barrier boards

Barrier boards shall comply with MUTCD.

Trestles supporting the barrier boards may be manufactured of timber, metal or other suitable material and shall be yellow. The trestles shall provide firm supports for the barrier board and be kept in place by sandbags suitable devices. The bases of the trestles shall not protrude beyond the ends of the boards.

(9) High visibility mesh fencing

High visibility mesh fencing shall be constructed where shown on the drawings, Traffic Guidance Scheme or as directed by the Superintendent.

High visibility mesh fencing shall be constructed in accordance with MUTCD, containment fences.

The mesh fencing shall be approximately 1 m in height and of a red-orange colured flexible material as approved by the Superindendent.

(10) Temporary post-mounted delineators
In addition to the requirements of MUTCD, temporary post mounted delineators shall be provided in conjunction with high visibility mesh fencing which is erected parallel to and in close proximity to traffic.

(11) Cones and bollards
Traffic cones and bollards shall comply with MUTCD and be placed in accordance with the arrangement diagrams in MUTCD.

Unless cones are firmly fixed in position they shall be used only while work is in progress, or in locations where there is an employee in attendance who shall reinstate any of the cones which have been dislodged by traffic. Otherwise they shall be removed and bollards or barriers substituted.

Cones and bollards used under night conditions shall be reflectorised in accordance with MUTCD.

(12) Traffic warning lamps
Traffic warning lamps shall comply with MUTCD and shall be installed in accordance with MUTCD. The Contractor shall ensure that warning lamps are in good working order, correctly aligned and positioned with respect to the direction of traffic flow each night, before the site is left unattended.

(13) Temporary pavement markings
All pavement markings shall be reflectorised and consist of painted lines, roadmarking tape and/or raised pavement markers in accordance with the relevant Australian Standards or as otherwise approved by the Superintendent and shall be provided in accordance with MUTCD.

Where the adjoining roadway is edgelined, temporary roadways shall be similarly edgelined.

(14) Temporary linemarking
Where temporary linemarking is required on the final wearing surface, only pavement marking tape shall be used.

Where the pavement linemarking has become ineffective in the opinion of the Superintendent, remarking shall be undertaken within 48 hours of direction by the Superintendent.

Where a single carriageway is opened adjacent to or used in lieu of an existing dual carriageway length, pavement arrows indicating the direction of flow of traffic shall be placed at not more than 500 m or at a spacing nominated by the Superintendent. The arrows shall be removed if the section is then reincorporated as dual carriageway.

Immediately before or after placement of new markings all superseded pavement markings shall be obliterated or removed to the satisfaction of the Superintendent.

On a final surface, obliteration by painting shall not be permitted.

(15) Raised pavement markers
Where raised pavement markers have become ineffective in the opinion of the Superintendent, they shall be replaced within 24 hours of direction by the Superintendent.

All superseded raised pavement markers shall be immediately removed from the pavement by the Contractor.

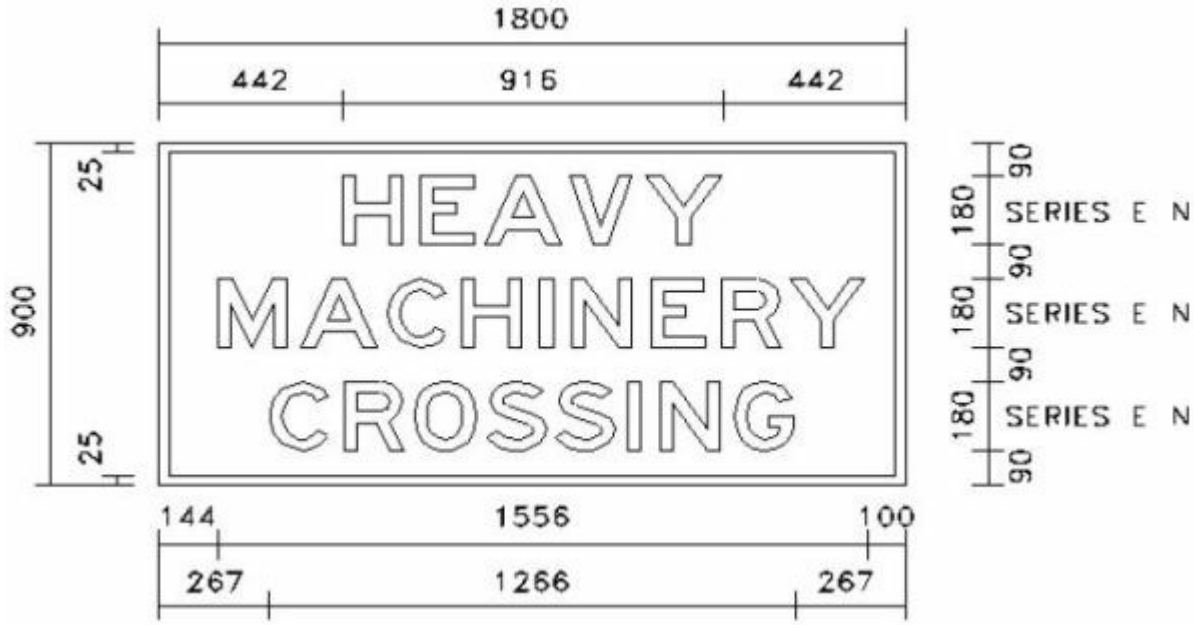
Attachment A Supplementary temporary warning signs to MUTCD

SC6.4.6.30 Attachment A Supplementary temporary warning signs to MUTCD

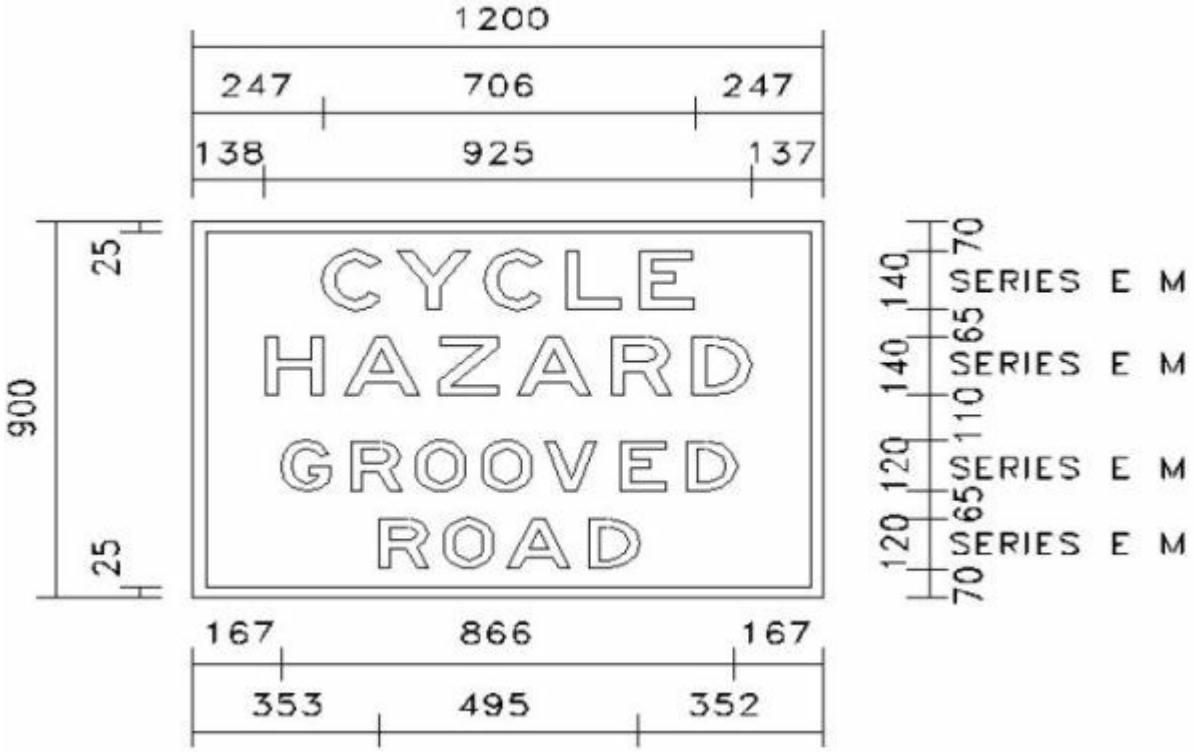
(1) Black letters and border on yellow reflectorised ground.

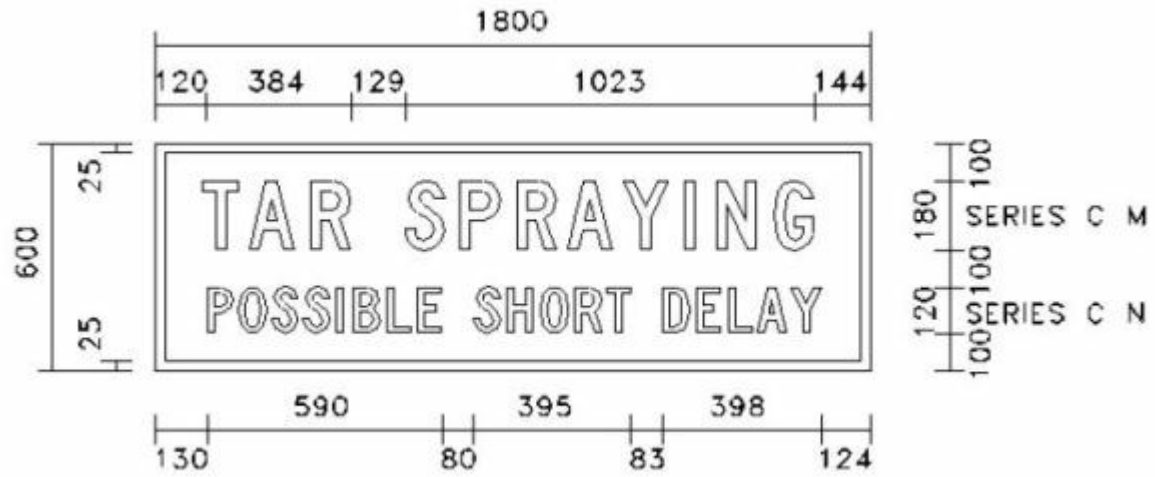
(2) Dimensions are in mm.

SW5-22



ST1-10




1800
120
384
129
1023
144
600
25
25
TAR SPRAYING
POSSIBLE SHORT DELAY
180
100
SERIES C M
120
100
SERIES C N
100
590
395
398
130
80
83
124

ST3-1