

TRANSPORT FOR NSW (TfNSW)

QA SPECIFICATION R11

STORMWATER DRAINAGE

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REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 3/Rev 0	Various	Guide Notes added. Specification reformatted. "Superintendent" changed to "Principal", "Contractor" to "you". Minor editorial changes.	GM, RNIC	27.02.04
	1.2	Expanded to describe structure. Changes to reference – G3 to G21/ G22 Occupational health and safety requirements. References transferred to Annexure R11/M.		
	2.4	Additional requirement for precast pits and junction boxes and manufacturing methods.		
	3.3.3	Extra Over Earthworks Pay Items may be applicable.		
	3.5	Earthworks must comply with the Earthworks specification.		
	3.7	Minor wording revision.		
	3.7	Witness point added.		
	3.7	Requirement of precast unit manufacture details included.		
	3.7	Design requirements for individual rung-ladders (step-irons) in pits.		
	3.8	Reference to RTA Q Annexure Q/L, AS 3725 deleted.		
	3.8	Minor wording revision.		
	3.8 (d)	Minimum compaction level of select fill material adjacent to box culverts specified.		
	3.8 (e)	Minor wording revision.		
	3.8	Moisture control during compaction of backfill included.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 3/Rev 0 (cont'd)	4 4 (b) R11P2 Annexure R11/C	Included inspection requirements for video evidence of both invert and obvert of pipes and box culverts. Visual inspection requirement included. Minor revision - reference to Table 11.4 instead of 11.3. Witness point added. Schedule of Identified Records added.		
Ed 3/Rev 1	Various Foreword 2.4, R11/M	Minor editorial changes, direct imperative used. New clause after the Table of Contents. HB 77 replaced by AS 5100.	GM, RNIC	05.10.05
Ed 3/Rev 2	2.6.1 (a)	Reference table in AS3725 corrected.	GM, IC	20.04.07
Ed 3/Rev 3	3.6	Clarification that reinforcing steel and embedded items in box culvert slabs to also comply with RTA B80.	GM, IC	30.04.08
Ed 3/Rev 4	2.4	Restriction on use of precast units with preformed knockouts added. Markings on precast units clarified. Requirement for grates to be hinged added.	GM, IC	04.08.08
Ed 3/Rev 5	Global 1.3 3.3.2 4 4.2 Annex B	Term “unsuitable material” replaced by “inadequate foundation material”. Some clauses rearranged and reworded. “Inadequate foundation material” added to Definitions list. Requirement to notify Principal of inadequate foundation material in sides of trenches added. Sub-clause headings 4.1 and 4.2 added. CCTV inspection added. Measurement and Payment descriptions reworded to clarify intent. Table B.2 – Definition of “bed zone” added	GM, IC	15.02.10
Ed 3/Rev 6	2.4 Annex A	New sub-headings inserted. Requirement for covers and grates not to rock in frame inserted. Ductile iron permitted for use in grates. Hinge and fastening requirements for grates clarified. Ladder requirements inserted. Project Specific Requirements – nomination of requirement for fastening device	GM, IC	16.08.10

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 3/Rev 7	2.4.4 2.4.5	Hinge in grates requirement deleted New sub-clause heading inserted	GM, IC	22.09.10
Ed 3/Rev 8	Pay Items R11P2, R11P3 & R11P4 Annex M	Clarification that no additional payment for offsite disposal will be made under Pay Item R44P6 added. Referenced documents updated.	GM, IC	29.09.10
Ed 3/Rev 9	3.6	Base slab of precast reinforced concrete box culverts mandated to be cast in-situ reinforced concrete.	GM, IC	23.12.10
Ed 3/Rev 10	2.1.1 2.1.2 2.2 (I) 2.3 (I) 2.5.3 3.7 3.7.3 3.7.4 3.7.6 4.2 Annex L	Maximum permissible chloride ion content specified. Markings on both surfaces of precast components other than headwalls specified; markings on headwalls must at least be on exposed side. Clause reference in AS 4058 for specifying pipe requirements updated. Clause reworded - purchaser's requirements in AS 4058 Clause 6.1 for RC pipes reproduced and RTA requirements matched against them. Numbering made consistent with that in AS 4058. Butt joints for connection with an existing pipeline prohibited. Clause reworded - purchaser's requirements in AS 4139 Appendix A Clause A1 for FRC pipes reproduced and RTA requirements matched against them. Numbering made consistent with that in AS 4139. Butt joints for connection with an existing pipeline prohibited. Precast drainage structures – required product drawing and installation details clarified. Subheadings for 3.7.1 to 3.7.8 added. Requirement for compliance with RTA Model Drawings for cast-in-place drainage structures inserted. Wording in Witness Point changed. Requirements for precast headwalls inserted. CCTV inspection and reporting to be in accordance with WSA 05. Table reorganised.	GM, IC (M Andrew)	16.09.11

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 3/ Rev 11	1.2.1 1.2.5 Annex M	Standard clause on Annexure A added, subsequent clauses renumbered. Previous Clause 1.2.5 consolidated with preceding clause (both dealing with testing). Spec title for referenced document R116 updated.	GM, IC (M Andrew)	06.10.11
Ed 3/ Rev 12	1.3 3.3.2, 3.3.3 Annex B	“Contaminated material” added to Definitions list. Sub-clauses relating to payment (covered under Annex B) removed. Clarification added that additional payment will be made under Pay Item R44P8 for activities associated with removal of contaminated material.	GM, IC (M Andrew)	17.10.11
Ed 3/ Rev 13	3.6 3.6.3 Annex B	Sub-headings to 3.6.1, 3.6.2, 3.6.3, and 3.6.4 added. Sealing of joints between precast box culvert units specified. Pay Item P6 amended to include sealing of joints.	GM, IC	29.02.12
Ed 3/ Rev 14	2.1.1 2.1.2 2.2 (I) (a) (ii) 2.7.1	Chloride ion content reverted back to 0.8 kg/m ³ . Requirements for markings on inside of pipes clarified. Default installation environment changed back to “normal”. Material for bed and haunch zones at pipe connections mandated to be flowable fill.	GM, IC	10.04.12
Ed 4/Rev 0	Global 2.1 2.1.2, 2.5.3 2.2 (I) (d) (i) (A) 2.5	Clauses rearranged and reworded. Heading retitled “Concrete Components – General”. Markings requirements for precast concrete members in clause 2.5.3 consolidated with marking requirements in clause 2.1.2. Lettering size requirement omitted. “watertightness testing” mandated only in type testing. Individual sub-clauses rearranged within this clause and reworded. New heading titled “Design and Other Documentation” inserted to form new sub-clause 2.5.3. Remnants of previous clause 2.5.3 renumbered as 2.5.4 with heading retitled “Precast Concrete Pits”. Subsequent sub-clauses renumbered.	GM, IC	26.09.12

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 4/Rev 0 (cont'd)	2.7.2	Clause reworded.		
	3.1	Previous clauses 3.1, 3.2 and first paragraph of 3.3.1 consolidated as sub-clauses within clause 3.1 "General".		
	3.2	Previously clause 3.4. Individual sub-clauses rearranged within this clause and reworded. Headings for sub-clauses 3.2.1 and 3.2.3 changed. New heading titled "Earth Structures for Open Drains" inserted for sub-clause 3.2.2.		
	3.3	First paragraph on erosion and sedimentation relocated to sub-clause 3.3.1. Heading added to form sub-clause 3.3.2. Previous clause 3.3.3 "Backfill of Trenches and Disposal of Surplus Excavated Material" relocated to clause 3.7.		
	3.3.1	Heading "Excavation of Trenches for Pipe Installation" added. Requirement not to over-excavate added. Requirement for side zones to comply with density and stiffness of Type HS3 support reworded and relocated to clause 3.4 as support type is more relevant under pipe installation clause.		
	3.4	Previously clause 3.5. Headings inserted to form new sub-clauses 3.4.1 to 3.4.5.		
	3.4.1	Clause reworded to clarify that, for pipes under embankments, filling of embankment required prior to excavation of trench for pipe installation.		
	3.4.2	Relocated here from under clause 3.3 and reworded stating that pipe support to be HS3.		
	3.7	Previously clause 3.8. Clause heading retitled "Backfilling, Compaction and Disposal of Surplus Excavated Material". New sub-clauses 3.7.1 "Backfill of Trenches" and 3.7.3 "Disposal of Surplus Excavated Material", relocated here from under clause 3.3.		
	Annex M	Referenced documents updated.		
Ed 4/Rev 1	3.7.2	Minimum characteristic value of relative compaction for backfill material within Selected Material Zone corrected to 102%.	GM, IC	12.04.13

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 4/Rev 2	3.4.5	Sub-heading inserted to relocated last para of previous clause 3.4.5, to form new sub-clause 3.4.5. Subsequent sub-clause renumbered.	GM, IC (W Stalder)	29.05.13
	3.6	Retitled “Construction of Drainage Structures Other Than Pipes and Box Culverts”.		
	3.6.1	Under clause 3.6, “drainage structures other than pipes and box culverts” is abbreviated to “drainage structures”, and statement added to this effect.		
	3.6.2	Previous contents of sub-clause 3.6.2 relocated to clause 3.6.6 and replaced by new sub-clause titled “Construction”, incorporating content from previous sub-clause 3.6.4 “Installation”, clause 3.6.5 “Foundation”, and part of previous sub-clauses 3.6.3 “Cast-in-Place Concrete Drainage Structures” and 3.6.6 “Precast Units”. Foundation for precast drainage pits changed from unreinforced concrete to bedding of DGB20 or controlled low strength flowable fill material.		
	3.6.3	Part of previous sub-clause 3.6.6 under new sub-heading title “Precast Headwalls”. Subsequent sub-clauses renumbered.		
	3.6.6	Content of previous sub-clause 3.6.2 moved here.		
	3.7.1	Retitled “Backfilling”. Last para of previous sub-clause 3.6.3 on backfilling relocated here.		
	Annex M	Referenced documents updated.		
Ed 5/Rev 0	Global	Clauses rearranged and reworded to improve clarity.	GM, CPS	09.12.14
	Guide Notes	Guide Note 1 on appropriate spec (whether R53 or B80) for concrete work, and Guide Note 4 on Pay Item P7 for all other excavation, deleted. Subsequent Guide Notes renumbered.		
	1.1	Scope extended to include construction of pedestrian and fauna crossings under roadways using box or pipe culverts.		
	1.3	Definition for “Select Fill” added.		
	2	Clause title changed to “Manufactured Drainage Products”. Soil and gravel materials previously under this clause now moved to clause 3.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 5/Rev 0 (cont'd)	2.1	Entire previous clause 2.1 deleted; chloride ion content requirement in sub-clause 2.1.1 incorporated into other clauses; sub-clause 2.1.2 moved to become clause 2.5. Subsequent clauses renumbered.		
	2.1	Previously clause 2.2. Chloride ion content requirement added as item (II) (c).		
	2.4	Previously clause 2.5. Clause title changed to “Other Precast Drainage Products”. Note added on meaning of “other drainage products”.		
	2.4.1	New sub-clause incorporating previous sub-clauses 2.5.2 and 2.5.3. Table 1 reformatted; column on applicability of spec Q clause 7.3 deleted and replaced by footnote. Requirement to submit design documentation deleted, and replaced by engineer’s certification of product drawings.		
	2.4.2	New sub-clause, incorporating requirement for manufacture of precast concrete members to be in accordance with B115 (previously in sub-clause 2.5.1) and chloride ion content (previously in sub-clause 2.1.1).		
	2.4.4	Requirements for supply of access covers and grates clarified.		
	2.5	Previously sub-clause 2.1.2.		
	3	New clause titled “Soil and Gravel Materials”. Subsequent clauses renumbered.		
	3.1.1	Previous sub-clause 2.7.1, on Type BH Select Fill requirements.		
	3.1.2	Previous sub-clause 2.7.2, on Type SO Select Fill requirements.		
	3.2	Previous sub-clause 2.7.3, on material for weepholes.		
	3.3	Previous sub-clause 3.2.3, on fill material for open drains. Previous sub-clause 3.1.1 “Scope” of construction of stormwater drainage deleted. Subsequent sub-clauses renumbered.		
	4.2.2	Previous sub-clause 3.2.2, retitled “Embankments in Open Drains”. Previous sub-clause 3.2.3 “Material for Diversion Banks” moved to clause 3.3.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 5/Rev 0 (cont'd)	4.2.3	Requirement for rock mattresses to comply with spec R55 added.		
	4.3.1	Previous sub-clause 3.3.1. Installation conditions requirements moved here from previous sub-clause 3.4.1.		
	4.3.2	Requirements for excavation for box culverts previously under sub-clause 3.5.1 moved here.		
	4.4.1	Select Fill requirements for pipe support moved here from previous sub-clauses 2.7.1 and 2.7.2.		
	4.5.2	New sub-clause added that precast crown unit installation to be in accordance with AS 1597.2.		
	4.5.3	Previous sub-clause 3.5.3, retitled "Sealing and Finishing".		
	4.6	New clause on construction of cast-in-place reinforced concrete box culverts. Subsequent clauses renumbered.		
	4.7.1, 4.7.2	Individual clauses rearranged within the two clauses.		
	4.7.2	Title changed to "Foundations for Precast Pits and Other Drainage Structures".		
	4.8	Previous clause 3.6.5, consolidated with requirements on weepholes moved from spec R44.		
	4.9.1	Backfill requirements for box culverts added. New clause added on minimum thickness of Select Fill surround to drainage structures within a rock fill embankment. Age of cast-in-place concrete structure reduced to 7 days (from 14 days) before backfilling can take place.		
	4.9.2	Table 2 on relative compaction requirements rearranged and reworded. Requirement to provide procedures for achieving adequate compaction of Select Fill around pipes in trenches added. (Requirement stated in Annex D in previous version, but not in main body of document.) Test Methods, including Table 3, for determining field density added. Previous clause 4.3 on rectification of nonconformities to be in accordance with spec Q deleted.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 5/Rev 3 (cont'd)	4.5.1 4.6	Upper limit for acid soluble chloride ion content deleted, as requirement is covered elsewhere. Existing requirement for concrete work for box culverts to comply with spec B80 clarified to include headwalls and wingwalls. Existing requirement for cast-in-place box culverts to comply with spec B80 clarified to include associated base slabs, headwalls and wingwalls.		
Ed 5/Rev 4	2.4.1, Annex L 4.3.1 Annex B	Clause references in RMS Q removed. Circumstance for trench width to comply with AS 3725 clarified. Pay Item P2 – trench width payable for multiple pipes clarified.	MCQ	30.11.18
Ed 5/Rev 5	4.4.2	Storage of pipes to be in accordance with manufacturer's recommended practice.	MCQ	05.04.19
Ed 5/Rev 6	Global	References to "Roads and Maritime Services" or "RMS" changed to "Transport for NSW" or "TfNSW" respectively.	DCS	22.06.20
Ed 5/Rev 7	Annex B	Scope of Pay Items P5 and P7 clarified.	EDCS	21.08.20

GUIDE NOTES

(Not Part of Contract Document)

1. STANDARD DRAWING FOR ANCHOR BLOCKS (CLAUSE 4.4.3)

There are currently no TfNSW standard drawings for anchor blocks. Every anchor block design is different, and must be specially designed for each individual project.

2. STONE PITCHING

Stone pitching for lining of open drains is not covered in R11 because a more flexible protective treatment is preferred where soil is subject to erosion. However, if stone pitching is required for a specific project, the following changes should be made to R11.

Step 1:

In Clause 4.2.3, add “and stone pitching” to paragraph 2 so that it reads:

Use wire mattresses and stone pitching only where shown on the Drawings.

Step 2:

Insert an additional Clause 4.2.5, as follows:

4.2.5 Stone Pitching

Construct stone pitching from sound durable stones or blocks of rock not less than 100 mm thick, firmly bedded on a layer of compacted Type BH Select Fill. Fill the voids between the stones or blocks and bedding, and between adjacent stones or blocks, with mortar complying with TfNSW R53.

The exposed surface of each stone or block must be approximately planar and not less than 0.05 m² in area. Spaces between adjacent stones or blocks must not exceed 25 mm in width. At the surface, the mortar must be raked to a depth of 12 mm in the joints between adjacent stones or blocks.

Step 3:

In Clause 4.9.2, add “or stone pitching” to Table R11.2, so that the second row reads:

Trimmed surface of excavated open drains to a depth of 150 mm, before placing lining or stone pitching or spreading topsoil for vegetation or fill material in embankments of open drains.

Step 4:

In Table R11.4, add the following additional rows:

Stone pitching	Location (plan)	Within 200 mm of the plan position shown on the Drawings or specified at any point.
	Level	Within 50 mm of the design level at any point provided that there is a continuous downgrade in the direction of flow not less than 0.5% at any point.

Step 5:

Add Pay Item R11P8 as follows:

Pay Item R11P8 Stone Pitching

The unit of measurement is the “square metre” of stone pitching, measured in place.

The rate includes the costs of excavation, other than that paid under another pay item in this or another specification, preparation of the foundation, placing and compaction of bedding material, supply of rock and mortar, placing the stone pitching, and all finishing work.



STORMWATER DRAINAGE

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VERSION FOR: DATE:

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FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW R11 Edition 5 Revision 6.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

PROJECT SPECIFIC CHANGES

Any project specific changes have been indicated in the following manner:

- Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. ***Additional Text***.
- Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. ~~Deleted Text~~.

TfNSW QA SPECIFICATION R11

STORMWATER DRAINAGE

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for construction of stormwater drainage systems, including the requirements for supply of manufactured drainage products.

The requirements set out in this specification also applies to the construction of pedestrian and fauna crossings under roadways using box or pipe culverts.

1.2 STRUCTURE OF SPECIFICATION

This Specification includes a series of annexures that detail additional requirements.

1.2.1 Project Specific Requirements

Project specific details of work are shown in Annexure R11/A.

1.2.2 Measurement and Payment

The method of measurement and payment must comply with Annexure R11/B.

1.2.3 Schedules of HOLD POINTS, WITNESS POINTS and Identified Records

The schedules in Annexure R11/C list the **HOLD POINTS** and **WITNESS POINTS** that must be observed. Refer to Specification TfNSW Q for the definitions of **HOLD POINTS** and **WITNESS POINTS**.

The records listed in Annexure R11/C are **Identified Records** for the purposes of TfNSW Q Annexure Q/E.

1.2.4 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements shown in Annexure R11/D and must be implemented.

1.2.5 Minimum Frequency of Testing

The Inspection and Test Plan must nominate the proposed frequency of testing to verify conformity of the item, which must not be less than the frequency specified in Annexure R11/L. Where a minimum frequency is not specified, nominate an appropriate frequency. Frequency of testing must conform to the requirements of Specification TfNSW Q.

You may propose to the Principal a reduced minimum frequency of testing. The proposal must be supported by a statistical analysis verifying consistent process capability and product characteristics. The Principal may vary or restore the specified minimum frequency of testing, either provisionally or permanently, at any time.

1.2.6 Referenced Documents

Unless otherwise specified, the applicable issue of a reference document, other than a TfNSW Specification, is the issue current at the date one week before the closing date for tenders, or where no issue is current at that date, the most recent issue.

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure R11/M.

1.3 DEFINITIONS

The terms “you” and “your” mean “the Contractor” and “the Contractor’s” respectively.

The following definitions are applicable to this Specification:

Contaminated material	Material classified as Restricted, Hazardous or Special Waste in accordance with EPA Waste Classification Guidelines.
Drainage structures	Devices to control stormwater flowing into and through a stormwater drainage system including pipe and box culverts, inlet and outlet structures, junction boxes, gully pits, drop structures, headwalls, wingwalls, energy dissipators, and ancillary hardware such as grates, frames and step irons, as well as subsurface drainage pipes at pits, headwalls and wingwalls.
Geocomposite membrane	A membrane comprising a plastic permeable core enclosed in a geotextile.
Open drain	An open channel constructed to intercept and redirect surface runoff water including catch drains, diversion drains, batter drains, inlet and outlet drains and diversion banks associated with stormwater drainage systems.
Inadequate Foundation Material	Material beneath or adjacent to the proposed drainage structure(s), which the Principal deems to be of insufficient strength to support the structure and loads on the structure, or material whose characteristics the Principal deems would adversely affect the performance or construction of the drainage structure.
Select Fill	Fill material of specified quality placed against or adjacent to structures. This material is different from Selected Material .
Stormwater drainage system	One or more drainage structures and/or open drains arranged to collect and convey surface runoff water.

2 MANUFACTURED DRAINAGE PRODUCTS

2.1 PRECAST REINFORCED CONCRETE PIPES

The manufacturer must implement and maintain a Quality Management System in accordance with AS/NZS ISO 9001 as a means of ensuring that the manufactured precast concrete pipes conform to the requirements of the Specification.

Precast reinforced concrete pipes must comply with AS 4058 and the following requirements:

- (I) Referring to Clause 6.1 of AS 4058, the following apply (the statements reproduced from AS 4058 are shown below in *italics*):
- (a) *Intended service requirements:*
 - (i) *Application:* drainage.
 - (ii) *Installation environment:* normal, unless specified or shown otherwise on the Drawings.
 - (b) *Pipe size class or DN:* as shown on the Drawings.
 - (c) *Pipe load class:* as shown on the Drawings.
 - (d) *Pipe pressure or watertightness class:*
 - (i) *Non-pressure drainage pipes:*
 - (A) watertightness: only type testing is required, in accordance with AS 4058.
 - (B) New Zealand application: not applicable.
 - (C) nominated field test pressure: not applicable.
acceptance criteria: not applicable.
 - (ii) *Pressure pipes:* not applicable.
 - (e) *Jacking loads:* not applicable, unless pipe jacking is specified in the Drawings or approved or directed by the Principal.
 - (f) *Pipe joint type:* flexible, spigot and socket joint with rubber ring. Flush or butt joints must not be used.
 - (g) *Confirm effective pipe length with supplier:* not applicable.
 - (h) *Elastomer type for elastomeric seal joints:* must be natural rubber.
 - (i) *Type tests and routine tests other than those “required” by Table 5.1 of AS 4058:* not applicable.
 - (j) *Means of demonstrating finished product compliance:* in accordance with AS 4058.
 - (k) *Place and rate of delivery:* advise purchaser of place and rate of delivery.
 - (l) *Place of acceptance:* advise purchaser if other than the place of manufacture.
 - (m) *Specific requirements for cement:* cement must comply with Clause 2.2.1 of AS 4058.
 - (n) *Type of admixtures:* no variation from those permitted in Clause 2.2.5 of AS 4058.
 - (o) *Other specific material requirements:* other than the maximum chloride ion content specified in part II(c) of this clause, no variation from those permitted in Clauses 2.2 to 2.4 of AS 4058.
 - (p) *Finishing and repair material specifications:* no variation from those permitted by Clause 3.4.5 of AS 4058.
 - (q) *Special pipe surface treatment or lining:* not required, unless specified on the Drawings or directed by the Principal.
 - (r) *Marking requirements, if other than on the outside of the pipe:* must be duplicated on the inside of the pipe, in accordance with Clause 2.5 of this Specification.
- (II) In addition:
- (a) the design diameter as defined in AS 4058 must not be less than 95% of the nominal size shown on the Drawings for all classes of pipes up to and including Class 4;
 - (b) aggregates used in manufacture of reinforced concrete pipes must comply with Specification TfNSW R53;

- (c) the acid-soluble chloride ion content in concrete where steel reinforcement is present must not exceed 0.8 kg/m^3 when tested in accordance with AS 1012.20.

2.2 FIBRE-REINFORCED CONCRETE PIPES

The manufacturer must implement and maintain a Quality Management System in accordance with AS/NZS ISO 9001 as a means of ensuring that the manufactured precast concrete pipes conform to the requirements of the Specification.

Fibre-reinforced concrete pipes must comply with AS 4139 and the following requirements:

- (I) Referring to Clause A1 in Appendix A of AS 4139, the following apply (the statements reproduced from AS 4139 are shown below in *italics*):
 - (a) *Nominal pipe size:* as shown on the Drawings.
 - (b) *Intended application:* drainage.
 - (c) *Pipe load class and installation conditions:* as shown on the Drawings.
 - (d) *Type of joint:* flexible, elastomeric, double V-ring joints, type (b)(i), as shown in Figure M1 in Appendix M of AS 4139. Elastomeric seals must comply with AS 1646. Butt joints must not be used.
 - (e) *Tests other than those required by Clause 11.1 of AS 4139, “strength requirement”:* not applicable.
 - (f) *Any other special requirement:* see (II) below.
 - (g) *Specific requirements concerning repair of defects:* not applicable. Pipes supplied with repaired defects must not be used in the Works.
 - (h) *Statement of information supplied by manufacturer:* provide to the Principal, before commencement of delivery to the Site, all the information listed in Clause A2 of AS 4139 as well as the maximum recommended angular joint deflection.
 - (i) *Place and rate of delivery:* advise purchaser of place and rate of delivery.
- (II) In addition:
 - (a) the internal diameter must not be less than 95% of the nominal size shown on the Drawings for all classes of pipes.

2.3 PRECAST REINFORCED CONCRETE BOX CULVERT UNITS AND LINK SLABS

Design, testing, manufacture, and delivery to site of precast reinforced concrete box culvert units and link slabs must be in accordance with Specification TfNSW R16.

2.4 OTHER PRECAST DRAINAGE PRODUCTS

In Clause 2.4, references to “other drainage products” means drainage products other than precast reinforced concrete pipes, fibre-reinforced concrete pipes and precast reinforced concrete box culvert units and link slabs.

2.4.1 Design of “Other Drainage Products”

Where the supplier of the drainage product is responsible for its design, the design must be in accordance with the Standards shown in Table R11.1 for the particular type of structure or component.

Table R11.1 - Design Standards for “Other Drainage Products”

Item	Description	Standard
1	Members subject to traffic and/or earth pressure loading ⁽¹⁾	AS 5100
2	Concrete water retaining structures:	
(a)	capacity > 25,000 litre ⁽¹⁾	AS 3735
(b)	capacity ≤ 25,000 litre	AS 3600
3	Other concrete components	AS 3600
4	Other non-concrete components	appropriate AS

Notes:

⁽¹⁾ Design and development must also comply with TfNSW Q.

Submit to the Principal as part of the Quality Records the following:

- (a) product drawings, including full dimensions of the product, reinforcement details, cover (if reinforced concrete), recommended attachment to adjoining structures and design lifting points, and certified by a structural engineer eligible for Corporate Membership of Engineers Australia and experienced in the design of structures;
- (b) details of methods for manufacture, testing and installation including where applicable, clearance to pit shaft ends, pipe to pit jointing, headwall to cast-in-situ curtain wall structure attachment and step iron positioning.

A Hold Point applies to the supply of precast members subject to traffic and/or earth pressure loads, and concrete water retaining structures with capacity greater than 25,000 litres (items 1 and 2(a) in Table R11.1).

HOLD POINT

Process Held:	Supply of precast concrete members subject to traffic and/or earth pressure loading, and water retaining structures with capacity greater than 25,000 litres.
Submission Details:	At least 7 days prior to the date of delivery, submit the documents specified in Clause 2.4.1.
Release of Hold Point:	The Principal will consider the documents and may audit the Quality Records prior to authorising the release of the Hold Point.

Where any of the above documents have been submitted previously to the Principal, not more than 36 months prior to their intended use, in lieu of re-submission of the documents, you may advise the Principal of the previous submission, and certify their applicability to this Contract.

2.4.2 Manufacture of “Other Drainage Products”

Manufacture of precast concrete members must be in accordance with Specification TfNSW B115, except that the concrete used must comply with Specification TfNSW R53 or TfNSW B80 as specified on the Drawings and in accordance with this Specification.

2.4.3 Precast Concrete Pits

If precast units are proposed for use to construct drainage pits, the base units (or any other riser units to which incoming drainage pipes will be joined) must be manufactured specifically to suit the design configuration of the particular pit with pre-formed knockouts only in the walls that require them. Standard precast pit base units with thinned wall sections on all four sides are not acceptable.

2.4.4 Access Covers and Grates

Metal access covers, grates and frames must comply with AS 3996. Covers and grates must not dislodge or rock in their frame when subjected to traffic loading. Covers and grates must be of the lift-out type, unless otherwise specified or shown on the Drawings.

Access covers must be Load Class D, unsealed, solid-top or recessed with concrete infill, and manufactured from cast iron.

Grates and frames must be Load Class D, bicycle safe in all directions and manufactured from galvanized structural steel or ductile iron unless otherwise specified or shown on the Drawings. Where specified in Annexure R11/A, grates must include a fastening device which prevents their opening without the use of a tool.

Surface openings for grates in footpaths must comply with the requirements of AS 3996 for pedestrian areas.

Submit, with each delivery of covers and grates, certificates of compliance, supported by appropriate type test and batch release test reports in accordance with AS 3996.

2.4.5 Ladders

Ladders, including individual-rung (step-iron) ladders, must comply with AS 1657.

Ladders must be fabricated from steel, and hot-dip galvanized in accordance with AS/NZS 4680 after fabrication.

2.5 MARKING ON PRECAST UNITS

For all precast units with inner and outer surfaces, such as pipes or pits, markings must be made on both surfaces of the component.

For precast headwalls, markings must be made, as a minimum, on the side of the unit that will be exposed after installation.

Markings on the inside of pipes must, as a minimum, include the following:

- (a) manufacturer's name or registered mark;
- (b) date of manufacture;
- (c) pipe load class.

and may be painted on if located on the obvert of the pipe.

Markings for other precast units must include, in addition to items (a) and (b) above, the following:

- (i) location of manufacture;
- (ii) maximum mass of unit in kilograms;

- (iii) any other identification necessary to directly relate the unit to tested samples, e.g. batch number;
- (iv) inspection status.

2.6 CERTIFICATE OF CONFORMITY

Prior to incorporating into the Works any supplied manufactured drainage products, provide the Principal with a signed certificate stating that the materials used and the finished product conform to the requirements of this Specification.

The certificate described above must describe the item and identify the inspection and test records that verify conformity of the item, and must be available for inspection as part of the Quality Records.

HOLD POINT

Process Held:	Incorporation into the Works of any supplied manufactured drainage product.
Submission Details:	Certificate of conformity, at least 7 days prior to incorporation into the Works.
Release of Hold Point:	The Principal may inspect the Quality Records prior to authorising the release of the Hold Point.

3 SOIL AND GRAVEL MATERIALS

3.1 BEDDING AND SUPPORT FILL MATERIAL

3.1.1 Type BH Select Fill

Type BH Select Fill for Bed and Haunch zones must have the following properties:

- (a) a particle size distribution, determined by Test Method TfNSW T201, within the limits set out in Table 6 in AS 3725 (or Table 5.1 in AS 1597.2); and
- (b) a Plasticity Index, determined by Test Method TfNSW T109, of not more than 6.

3.1.2 Type SO Select Fill

Type SO Select Fill for Side and Overlay zones of pipes and box culverts and adjacent to other drainage structures must have the following properties:

- (a) a maximum particle dimension of 53 mm; and
- (b) a Plasticity Index, as determined by Test Method TfNSW T109, of between 2 and 12.

3.2 MATERIAL ADJACENT TO WEEPHOLES

Material placed adjacent to weepholes must be clean, graded, hard and durable crushed stone or river gravel conforming to the following requirements:

- (a) maximum particle dimension of 53 mm; and
- (b) no more than 5% by mass passes the 9.5 mm AS sieve.

3.3 FILL MATERIAL FOR EMBANKMENTS IN OPEN DRAINS

Material for construction of embankments in open drains, such as diversion banks, must have:

- (a) a particle size distribution, determined by Test Method TfNSW T107, such that between 20% and 60% inclusive by mass of material passes the 425 micron sieve; and
- (b) a Plasticity Index, as determined by Test Method TfNSW T109, of between 15 and 30.

4 CONSTRUCTION

4.1 GENERAL

4.1.1 Setting Out

Set out the stormwater drainage systems as shown on the Drawings in sufficient detail to identify:

- (a) the locations, lengths and levels at outlets and inlets of pipes and box culvert structures;
- (b) the locations and levels of gully pits, junction boxes, energy dissipators, and inlet and outlet structures;
- (c) the locations and levels of the ends of wingwalls and headwalls; and
- (d) the locations and levels of open drains.

The inlet or outlet locations or design levels or the drainage structure length may be amended by the Principal to suit the actual site conditions.

HOLD POINT

Process Held:	Construction of each drainage system.
Submission Details:	Notification that set out of drainage system has been completed, and details of any design changes in locations and levels which are proposed by you.
Release of Hold Point:	The Principal will inspect the set out, including any proposed changes and, if necessary, amend the design to suit the actual site conditions prior to authorising the release of the Hold Point.

Payment for any amendments to the design directed by the Principal will be at scheduled rates or as determined by the Principal. Payment will not be made for any amendment made to suit your construction method.

Unless shown otherwise on the Drawings, locate catch drains at a distance of not closer than 2.5 m from the top of the batter in cuttings, or the toe of batter in embankments.

4.1.2 Erosion and Sedimentation Control

For each part of a drainage system, complete the required erosion and sedimentation control measures prior to commencement of the drainage works (except those parts of the drainage system forming part of the control measures).

4.2 CONSTRUCTION OF OPEN DRAINS

4.2.1 Excavation of Open Drains

Excavate open drains (including topsoil) to the dimensions shown on the Drawings.

Where dimensions are not shown, the open drain must have a minimum depth of 300 mm, a minimum waterway area of 0.2 m², with side batter slopes not steeper than 2H:1V.

Grade the open drains to a slope of not less than 0.5% to ensure a free flow of water. Where this is not feasible, notify the Principal.

HOLD POINT

Process Held: Construction of open drains with grade less than 0.5%.

Submission Details: Notification that 0.5% minimum grade cannot be achieved.

Release of Hold Point: The Principal will consider the matter, and will direct you further, prior to authorising the release of the Hold Point.

Extend open drains as necessary to natural drainage depressions or to a drainage system.

Trim open drains to produce a uniform surface free of irregularities. Compact the surfaces of drains to be lined to the requirements of Clause 4.9.2.

Deal with surplus materials from the construction of open drains in accordance with the requirements of Clause 4.9.3.

4.2.2 Embankments in Open Drains

Where construction of an embankment is required to form an open drain, clear, grub and strip of topsoil the affected area prior to placing the fill material. If inadequate foundation material is encountered, deal with the inadequate foundation material in accordance with the requirements of Clause 4.3.3.

Place fill material complying with Clause 3.3 in layers not exceeding 200 mm in depth, and compact to the requirements of Clause 4.9.2.

On completion of its construction, vegetate in accordance with Specification TfNSW R178.

4.2.3 Lining

Unless otherwise shown on the Drawings or directed by the Principal, line open drains with:

- (a) organic fibre mat and vegetation, where the longitudinal grade of the completed drain is between 1% and 5% inclusive; or
- (b) concrete where the longitudinal grade of the completed drain is less than 1% or greater than 5%.

Use rock mattresses only where shown on the Drawings. Rock mattresses must comply with Specification TfNSW R55.

Concrete lining must have a minimum compacted thickness of 100 mm measured at right angles to the surface of the lining, and must be colour matched with that of its surroundings, unless directed otherwise by the Principal.

Install the type of lining in accordance with the following Specifications:

Type of Lining	Specification
Cast-in-place concrete and sprayed concrete	TfNSW R53
Organic fibre mat	TfNSW R178
Wire mattresses	TfNSW R55

4.2.4 Movement Joints in Concrete Linings

Provide movement joints in concrete lining at intervals of not more than 3.0 m along the open drain to control cracking.

Movement joints must be straight narrow grooves, at 90° ($\pm 5^\circ$) to the line of the drain, 20 (± 5) mm deep. Install expansion joint material complying with TfNSW 3204 to the full depth of the concrete lining at every fifth movement joint.

4.3 EXCAVATION FOR DRAINAGE STRUCTURES

WITNESS POINT

Process to be Witnessed: Excavation for pipe installation and other drainage structures.

Submission Details: Notification to the Principal, not later than 24 hours but not earlier than 5 working days, of the anticipated date of completion of excavation and preparation of foundations.

4.3.1 Excavation for Pipe Installation

Excavate trenches for pipe installation to the widths shown in Standard Drawing R0240 – 01, or AS 3725, if not shown on the Drawings. Do not excavate more than 50 mm beyond the specified width of the trench for the part of the trench below the level of the top of the pipe, on either side of the trench, as this may affect the design pipe load class. (Refer to Standard Drawing R0240 - 01.)

For pipes under embankments:

- (a) where “Embankment Condition” installation is specified, construct first the embankment to a height of at least 0.7 times the external diameter of the pipe above the top of the bed zone, and for a minimum lateral distance past the boundary of the trench of 2.5 times the external diameter of the pipe;
- (b) where “Trench Condition” installation is specified, construct first the embankment to the level of the underside of the Selected Material Zone;

prior to excavating the trench and installation of the pipes.

Provide an alternative flow channel where appropriate.

4.3.2 Excavation for Drainage Structures Other Than Pipes

For drainage structures other than pipes, extend the excavation so that, for all points on the walls of the structure, the clear width between the structure wall and the face of the excavation is at least 300 mm.

When excavating for construction of box culverts and rock is encountered over part of the foundation, excavate the whole of the foundation area to a depth of 300 mm below the level of the bottom of the blinding layer and replace it with Type BH Select Fill, compacted to the requirements of Clause 4.9.2.

4.3.3 Inadequate Foundation Material

Notify the Principal of any area of the foundation which may contain material that is inadequate to support the proposed drainage structure. If the Principal agrees that the material is inadequate foundation material, or deems any areas of the foundations to be inadequate foundation material, the Principal may direct the removal and replacement of this material or some other foundation treatment. Dispose of the excavated material in accordance with Specification TfNSW R44.

Where the sides of trenches for drainage structures are composed of material which may require removal and replacement, notify the Principal of the presence of such material, for the Principal's direction.

HOLD POINT

Process Held:	Replacement of inadequate foundation material.
Submission Details:	Notification that inadequate foundation material has been excavated to the extent directed.
Release of Hold Point:	The Principal will inspect the excavation and may direct further excavation prior to authorising the release of the Hold Point.

Replace inadequate foundation material with materials from cuttings, or with other material acceptable to the Principal, and compact to the requirements of Clause 4.9.2 of this Specification.

4.4 INSTALLATION OF PRECAST CONCRETE AND FIBRE-REINFORCED CONCRETE PIPE

4.4.1 Pipe Support Type

Provide pipe support of Type HS3 complying with AS 3725 and Standard Drawing R0240 - 01.

Material for Bed and Haunch zones and Side and Overlay zones must be Type BH Select Fill (refer Clause 3.1.1) and Type SO Select Fill (refer Clause 3.1.2) respectively.

At pipe connections, material for Bed and Haunch zones must be controlled low strength flowable fill material complying with Appendix A in AS 3725. (Details of pipe connections are given in Standard Drawing R0220 - 49.)

4.4.2 Installation of Concrete Pipes

Handle, store and install the concrete pipes in accordance with the manufacturer's recommended practice.

When installing concrete drainage pipes, commence laying the pipes from the downstream end, with the socket end of the pipes pointed upstream.

After each length of pipe has been installed and before proceeding to install the next length of pipe, verify conformity of the assembled joint by checking that the position of the rubber ring on the spigot, and the clearance and overlap between the spigot and socket, are within the values specified by the manufacturer.

4.4.3 Anchor Blocks

Provide anchor blocks at a maximum spacing of 3 m and at bends or junctions for all stormwater pipes laid on a grade exceeding 20% and where shown on the Drawings. Construct anchor blocks as shown on the Drawings. Place insitu concrete directly against all faces of the keys in the sides and base of the trench.

4.4.4 Sealing of Lifting Holes and Joints

Seal all lifting holes in the pipes, and all flush or butt joints used to extend existing pipes, to prevent the ingress of materials.

4.4.5 Subsurface Drainage Pipe at Discharge End of Pipes

Install a subsurface drainage pipe, complying with Specification TfNSW 3552, at the discharge end of pipes at gully pits, junction boxes and headwalls unless the Drawings specifically direct the subsurface drainage be omitted.

Unless shown otherwise on the Drawings, the subsurface drainage pipe must be a 3 m length of 100 mm diameter subsoil pipe laid beside, and 100 mm above the invert level of the drainage pipe discharging through the wall of the pit or headwall. The subsoil pipe must be straight and discharge through the same wall as the drainage pipe. Seal the subsoil pipe at the upstream end and enclose it in a seamless tubular filter fabric complying with TfNSW 3553.

4.5 CONSTRUCTION OF REINFORCED CONCRETE BOX CULVERTS USING PRECAST UNITS

4.5.1 Base Slab, Headwalls and Wingwalls

Construct base slabs, headwalls and wingwalls for the precast concrete box culvert units to the details shown on the Drawings.

Unless shown otherwise on the Drawings, base slabs of box culverts using precast units must be cast-in-place reinforced concrete, cast on a blinding layer of 50 mm thick plain concrete.

Concrete work, including reinforcing steel and other embedded items, for base slabs, headwalls and wingwalls must comply with TfNSW B80. Plain concrete for the blinding layer must comply with either TfNSW R53 or TfNSW B80.

4.5.2 Installation of Precast Units

Install precast concrete crown units in accordance with the details shown on the Drawings. Where not shown on the Drawings, install them in accordance with Clause 5.4 of AS 1597.2.

4.5.3 Sealing and Finishing

After installation of the precast crown units, seal the transverse joint between adjacent units all round with a 250 mm wide, self-adhering membrane of rubberised asphalt integrally bonded to polypropylene mesh (e.g. Bituthene or approved equivalent), of minimum 1.6 mm thickness, unless shown otherwise on the Drawings.

Seal lifting holes to prevent the ingress of materials. Cut off the protruding lifting hooks and coat the exposed steel with epoxy to prevent corrosion of the steel.

4.6 CONSTRUCTION OF CAST-IN-PLACE REINFORCED CONCRETE BOX CULVERTS

Construct cast-in-place reinforced box culverts in accordance with the Drawings.

Concrete work, including reinforcing steel and other embedded items, for cast-in-place box culverts including associated base slabs, headwalls and wingwalls, must comply with Specification TfNSW B80.

4.7 CONSTRUCTION OF “OTHER DRAINAGE STRUCTURES”

In Clause 4.7, references to “other drainage structures” means “drainage structures other than pipes and box culverts”, and include gully pits, junction boxes, drop structures, inlet and outlet structures, and energy dissipators.

4.7.1 General

Construct “other drainage structures” in accordance with the Drawings. Where precast units are used for the drainage structures, install the precast units in accordance with this Specification, TfNSW (RMS) Standard Drawings and the manufacturer’s recommended practice.

Construct the “other drainage structures” as soon as possible and not later than 14 days after the installation of associated pipes, box culverts or open drains.

Concrete work for cast-in-place “other drainage structures” must comply with Specification TfNSW R53, unless specified otherwise on the Drawings or in this Specification.

4.7.2 Foundations for “Other Drainage Structures”

For precast pits, install the precast pit on top of a minimum 50 mm thick Class 2 DGB bedding material, complying with Specification TfNSW 3051, or controlled low strength flowable fill material complying with Appendix A in AS 3725, to support the precast pit uniformly.

For drainage structures other than precast drainage pits, provide a foundation of unreinforced concrete complying with Specification TfNSW R53 not less than 50 mm thick, to uniformly support the structure unless shown otherwise on the Drawings.

WITNESS POINT

Process to be Witnessed: Construction of drainage structures other than pipes and box culverts.

Submission Details: Notify the Principal at least 7 days prior to the date of commencement of the work.

4.7.3 Precast Headwalls

For precast headwalls for pipes of 300 mm to 1200 mm diameter, provide a curtain wall at the outer edge of the apron in accordance with the TfNSW (RMS) Standard Drawings. Do not use precast headwalls for pipes greater than 1200 mm diameter unless approved otherwise by the Principal.

Do not use multi-piece modular precast headwalls unless approved otherwise by the Principal.

4.7.4 Ladder

For all pits, such as junction box, gully pit, drop structure, etc, which are deeper than 600 mm, install an individual-rung ladder (step irons) in accordance with AS 1657 on one internal wall for the full depth of the structure.

The top of the uppermost rung must not be more than 600 mm below the top of the pit. The top of the bottom rung must not be more than 500 mm or less than 300 mm above the invert of the pit. Rung spacings must be 300 mm \pm 50 mm.

4.7.5 Isolation Joint

Install an isolation joint where a drainage structure will abut a structure or concrete pavement. The isolation joint must be 10 mm wide using preformed jointing filler complying with TfNSW 3204.

4.8 WEEPHOLES

Where weepholes are provided in walls (whether retaining walls, headwalls, wingwalls or side wall of box culverts), place crushed stone or river gravel complying with Clause 3.2 in a continuous layer along the line of the weepholes and adjacent to the weepholes, on the fill side of the wall.

The gravel layer must extend to a height of not less than 450 mm vertically above the level of invert of the weepholes, and 300 mm horizontally into the fill.

Provide a geotextile complying with Specification TfNSW R63 as separation between the gravel layer and the adjacent fill, with the geotextile wrapped over the top of the gravel layer.

Alternatively, subject to the Principal's concurrence, you may substitute the gravel layer with a geocomposite membrane of equivalent drainage capacity, at no additional cost to the Principal.

4.9 BACKFILLING, COMPACTION AND DISPOSAL OF SURPLUS EXCAVATED MATERIAL

4.9.1 Backfilling

Backfill the Side and Overlay zones of box culverts with Type SO Select Fill. Refer to Figure 1.1 of AS 1597.2 for schematic details of these zones.

For pipes and box culverts located within a rock fill embankment, provide a minimum thickness of 1000 mm of Type SO Select Fill within the Side and Overlay zones, separated from the surrounding rock fill by a geotextile complying with Specification TfNSW R63.

Outside the Side and Overlay zones, backfill with general fill material excavated from cuttings or other material acceptable to the Principal.

Unless otherwise specified or directed by the Principal, place fill material for the foundations, bedding, support and general backfill in layers not exceeding 150 mm compacted thickness. Compact the fill material to the requirements of Clause 4.9.2 of this Specification.

Do not carry out backfilling against cast-in-place box culverts until the compressive strength of the concrete has reached at least 75% of the specified 28 day strength, and against other concrete drainage structures until at least 7 days has elapsed after placing the last concrete in the structure, unless authorised otherwise by the Principal.

When backfilling against box culverts, the difference in level of the backfill on opposing sides of the culvert must not exceed 500 mm, to minimise differential loading on the structure. Compact first the fill placed immediately next to the structure, and then progressively work outwards towards the face of the excavation, to prevent wedge action between the excavation and the walls of the structure.

4.9.2 Compaction

Provide, as part of the PROJECT QUALITY PLAN, procedures for achieving adequate compaction of the Select Fill in Bed, Haunch, Side and Overlay zones around pipes in trenches.

Compact the foundations and fill material placed to achieve the minimum characteristic value of relative compaction for the particular type of material, as shown in Table R11.2.

Table R11.2 – Minimum Characteristic Value of Relative Compaction

Description of Material	Min. Relative Compaction
Trimmed surface of excavated open drains to a depth of 150 mm, before placing lining or spreading topsoil for vegetation or fill material in embankments of open drains	95%
Material in trench base or foundation to a depth of 150 mm below the bottom of the Bed zone or blinding layer, and material replacing inadequate foundation material	95%
Select Fill in the Bed, Haunch, Side and Overlay zones adjacent to pipe culverts, and general backfill material	95%
Select Fill in the Side and Overlay zones of box culverts	98%
Backfill material within the Selected Material Zone of the adjoining earthworks (refer Specification TfNSW R44)	102%

Determine the field (insitu) density using either Test Methods TfNSW T173 using a nuclear gauge, TfNSW T119 using the sand replacement method, or TfNSW T165 using the fixed volume extractive method. The situations where these test methods are applicable are shown in Table R11.3.

Table R11.3 – Applicable Test Methods for Determining Field Density and Relative Compaction

Fill Material Properties	Test Method / Actions
≤ 20% by mass retained on 37.5 mm AS sieve	Either T173 (nuclear gauge) or T119 (sand replacement method)
> 20%, ≤ 40% by mass retained on 37.5 mm AS sieve	T119 (sand replacement method) ⁽¹⁾
> 40% by mass retained on 37.5 mm AS sieve	Report only % by mass of oversize material ⁽²⁾
Fine to medium grained cohesionless materials, including one size material or gap graded material	T165 (fixed volume extractive method)

Notes:

- ⁽¹⁾ If % by mass retained on 37.5 mm AS sieve is between 20% and 40%, do not use the nuclear gauge method.
- ⁽²⁾ If % by mass retained on 37.5 mm AS sieve is greater than 40%, do not report the relative compaction as the test result obtained is not valid.

Do not use TfNSW T173 (nuclear gauge) for insitu density tests if the layer thickness exceeds 300 mm.

Determine the characteristic value of relative compaction in accordance with Specification TfNSW Q. Round off the relative compaction value and the characteristic relative compaction value to the nearest 0.1%.

Control the moisture content of the foundations and fill material to prevent loss of density and strength in nearby earthworks through over wetting.

4.9.3 Disposal of Surplus Excavated Material

Dispose of as spoil any surplus excavated material in accordance with Specification TfNSW R44.

4.10 CONSTRUCTION TRAFFIC

Where you propose to move heavy construction plant and vehicles over pipe or box culvert structures, design and provide protective measures for each crossing in accordance with Specification TfNSW G2.

HOLD POINT

Process Held:	Moving heavy construction plant or vehicles over pipe or box culvert structures.
Submission Details:	Certificate and verification of protective measures.
Release of Hold Point:	The Principal may examine the submitted documents, prior to authorising the release of the Hold Point.

5 CONSTRUCTION TOLERANCES AND INSPECTION

5.1 CONSTRUCTION TOLERANCES

Construct the stormwater drainage system so that water flows through the system without unintended ponding, and within the construction tolerances in Table R11.4:

Table R11.4 - Maximum Construction Tolerances

Component	Attribute	Tolerance
Concrete pipes, box culverts, headwalls and wingwalls, energy dissipators, inlet and outlet structures	Location (plan)	Within 200 mm of the plan position shown on the Drawings or specified at any point
	Invert level	Within 20 mm of the design level at any point
Gully pits and junction boxes	Location (plan)	Within 200 mm longitudinally and 20 mm laterally of the plan position, with reference to the control line for the road shown on the Drawings
	Outlet invert level	Within 20 mm of the invert level shown on the Drawings
Lintels, covers and gratings	Line	The tolerances specified for the adjoining material; e.g. TfNSW R15 for kerbs and gutters, TfNSW R116 or TfNSW R119 for asphalt and TfNSW R83 for concrete base.
Precast concrete box culvert units	Step between units	On the internal faces of the walls and roof, no step between adjacent units must exceed 20 mm. Steps between 10 mm and 20 mm must be smoothed to a standard of durability equal to the rest of the culvert.
Open drains	Location	The tolerances specified for the adjoining material, including TfNSW R44 for berm drains and batter drains
	Level	Within 50 mm of the design level at any point provided that there is a continuous downgrade in the direction of flow not less than 0.5% at any point
	Waterway area	Not less than 95% of the design cross sectional area at any point
	Shape	Not more than a 50 mm departure from a 3 m straight edge placed on the bottom or a side of the open drain at any point
Trenches for precast concrete and fibre-reinforced concrete pipe drainage structures	When measured horizontally at any point within the trench at right angles to the line of the pipes:	
	Position of trench face:	Within 100 mm of the design location
	Excavation width:	Not less than the specified width; Not more than the specified width plus 100 mm

The tolerances in Table R11.4 apply to the amended set out directed by the Principal or proposed by you and accepted by the Principal.

5.2 INSPECTION

Carry out closed-circuit television (CCTV) inspections of all pipe and box culverts with dimensions that restrict human access, to verify that the works have been constructed within the specified tolerances, the flow of water is not obstructed by waste construction material left inside, and to check for visible signs of defects, at the following times:

- (a) on completion of the subject drainage structure and prior to commencement of the overlying pavement, and
- (b) no more than 14 days prior to Completion.

On completion of the inspections, submit to the Principal a report of these inspections and any nonconformity detected. Include any video recordings taken during the CCTV inspection.

The inspection and reporting must be accordance with WSA 05 – 2008.

ANNEXURE R11/A – PROJECT SPECIFIC REQUIREMENTS

NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising Annexure R11/A)

Where “Yes / No” option is shown below, delete whichever is not applicable.

A.1 FASTENING DEVICE FOR GRATES

Clause	Details	Requirement
2.4.4	Grates to be provided with a fastening device which prevents opening without the use of a tool	Yes / No

ANNEXURE R11/B – MEASUREMENT AND PAYMENT

Payment will be made for all costs associated with completing the work detailed in this Specification in accordance with the following Pay Items.

Where no specific pay items are provided for a particular item of work, the costs associated with that item of work are deemed to be included in the rates and prices generally for the Work Under the Contract.

Unless specified otherwise, a lump sum price for any of these items will not be accepted.

Payment for drainage and associated works covered by other specifications will be made under the appropriate Pay Items in the specifications listed in Table R11/B.1.

Table R11/B.1 - Other Specifications Covering Drainage Works

Description of Work	Specification
Temporary drains which form part of the erosion and sedimentation control measures	TfNSW G38
Organic fibre mat and cover vegetation	TfNSW R178
Rock mattresses	TfNSW R55
Open drains which form part of the main earthworks (e.g. table drains) Topsoil removal and stockpiling as part of the main earthworks Excavation and backfilling which is necessary for construction of the drainage structure, but is carried out as part of the main earthworks	TfNSW R44
Contaminated material, including identification, classification in accordance with EPA Waste Classification Guidelines, treatment, haulage and disposal at sites legally authorised to accept the contaminated material	TfNSW R44
Cast-in-place reinforced concrete box culverts	TfNSW B80

Pay Item R11P1 Open Drains

Pay Item R11P1.1 Excavation for Open Drains

The unit of measurement is the “cubic metre” of bank volume of excavation after removal of the topsoil, measured in place.

The rate includes the cost of excavation in all types of material for the construction of the open drain, and disposal of any surplus excavated material. No additional payment for off Site disposal of surplus excavated material will be made under Pay Item R44P6.

Where removal and stockpiling of topsoil along the line of the drain is NOT carried out as part of the main earthworks and paid under Pay Item R44P1, the measured quantity of excavation for payment under Pay Item R11P1.1 includes the quantity of topsoil removed and stockpiled and the rate must allow for this work.

Pay Item R11P1.2 Embankment for Open Drains

The unit of measurement is the “cubic metre” of compacted volume of the embankment to form a diversion bank, measured in place.

The rate includes the costs of supply and haulage of fill material, placing and compaction in the embankment.

Any excavation necessary for the foundations of the embankment will be measured and paid under Pay Item R11P1.1.

Pay Item R11P2 Excavation for Stormwater Drainage Structures

The unit of measurement is the “cubic metre”, measured as bank volume of excavation, after removal of the topsoil.

No payment will be made for any additional material or work as a result of over-excavation.

The rate includes the cost of excavation in all types of material for construction of the stormwater drainage structures, and disposal of surplus excavated material in accordance with Clause 4.9.3.

No additional payment for off Site disposal will be made under Pay Item R44P6.

Where removal and stockpiling of topsoil along the line of the drain is not carried out as part of the main earthworks and paid under Pay Item R44P1, the measured quantity of excavation for payment under Pay Item R11P2 includes the quantity of topsoil removed and stockpiled and the rate must allow for this work.

(a) Excavation for Pipe Culverts

The width for payment is:

- (i) the excavation width shown on the Drawings; OR
- (ii) where the width is not shown on the Drawings,
for a single pipeline, the greater of:
 - 1.4 times the external diameter of the pipe barrel,
 - OR
 - the external diameter of the pipe barrel plus 0.6 m.

For multiple pipes installed side by side, the width for payment is the sum of the external diameters for each line, plus the side clearance between each pipe, plus the clearance between the outermost pipes and the trench wall, as shown on the Drawings. The sides of trenches are taken as vertical.

The length for payment is the actual excavation length.

The depth for payment is the average actual depth excavated except that it will not exceed the maximum depth for payment specified in Table R11/B.2.

Table R11/B.2 - Maximum Depth for Payment

Location	Installation Condition	Maximum Depth for Payment
Cuttings	Trench	The average difference in level between the Designed Floor Level ⁽¹⁾ of the cutting and the bottom of the Bed zone.
Embankments	Embankment	The average difference in level between: - the natural ground surface stripped of top soil ⁽²⁾ and the bottom of the Bed zone; OR - 0.3 m above the top of the pipe and the bottom of the Bed zone; whichever is the greater.
Embankments	Trench ⁽³⁾	The average difference in level between the underside of the Selected Material Zone ⁽¹⁾ and the bottom of the Bed zone.
Other areas	Trench	The average difference in level between the natural ground surface stripped of top soil ⁽²⁾ and the bottom of the Bed zone.

Notes:

- (1) Defined in TfNSW R44.
- (2) If removal and stockpiling of topsoil is carried out as part of main earthworks and payment for the work made under Pay Item R44P1.
- (3) For “trench” installation condition to be satisfied in an embankment, the embankment must first be completed to the underside of the Selected Material Zone prior to the commencement of the excavation for the pipe. Otherwise, the installation condition is an “embankment” condition.

(b) Excavation for Box Culverts

The plan area for payment is the area calculated using the dimensions of the culvert base slab and wingwalls as shown on the Drawings.

The depth for payment is the average actual depth below ground surface stripped of topsoil to the bottom of the blinding layer.

(c) Excavation for Other Drainage Structures

The plan area for payment is the area calculated using the external dimensions of the structure as shown on the Drawings.

The depth for payment is determined by measurement of the distance from the existing surface at the time of excavation to the underside of the bedding layer.

Pay Item R11P3 Inadequate Foundation Material under Drainage Structures and Open Drains

The unit of measurement is the “cubic metre” of bank volume of material which is considered to be inadequate as foundation material and is directed by the Principal to be removed, disposed of and replaced.

The schedule quantity is a Provisional Quantity.

Where the sides of trenches are composed of material which the Principal determines must be removed, disposed of and replaced, the measured volume for payment includes the volume of that material.

No additional payment for offsite disposal will be made under Pay Item R44P6.

Pay Item R11P4 Concrete Lining of Open Drains

The unit of measurement is the “square metre” of concrete lining of the slope area, measured in place.

The rate includes surface preparation of the open drains, supply, placing, finishing and curing of concrete lining; forming of movement joints; and supply and installation of expansion joint materials.

Pay Item R11P5 Precast Concrete or Fibre-reinforced Concrete Pipes

The unit of measurement is the “lineal metre” of the actual the length laid, measured along the centreline of the pipe.

The rate includes:

- (a) supply of pipes, associated components and other materials;
- (b) preparation of foundation, and placing and compaction of bedding, support and general backfill material;
- (c) laying and jointing, including connection to new or existing gully pits;
- (d) provision of anchoring systems including anchor blocks;
- (e) supply and placing of subsurface drainage pipes and geotextile filter fabric at pits and headwalls;
- (f) CCTV inspection and reporting in accordance with Clause 5.2.

Separate rates must be given for each type, size and class of pipe.

Pay Item R11P6 Precast Concrete Box Culvert Structures (Excluding Inlet and Outlet Structures)

The unit of measurement is “each” box culvert constructed, as scheduled.

The rate includes the supply of all materials, preparation of foundation, blinding layer in plain concrete, reinforced concrete base slab, installation of precast crown units (including mortar pads, temporary bracing and other protective measures), link slabs (if applicable), jointing (including connections and transverse sealing membrane), backfilling with Select Fill and general fill, inspection and reporting.

The rate excludes the inlet and outlet structures.

Separate rates must be given for each box culvert.

Pay Item R11P7 Drainage Structures Other Than Pipes and Box Culverts

The unit of measurement is “each” drainage structures constructed as scheduled, including any associated elements. For example, a headwall unit includes also the wingwalls, apron and cut off walls; and a gully pit includes also the lintel (or similar), lid, grating, and any channel (gutter) in front of the lintel or over the pit, but excludes the kerb and channel transition to the lintel. The kerb and channel transition to the lintel is paid under TfNSW R15.

The rate includes the supply of all materials, all necessary excavations (unless there is a separate pay item for excavation), preparation of foundations, plain concrete, bedding, construction, installation, jointing (including connections), backfilling, compaction, inspecting and reporting.

Separate rates must be given for each drainage structure.

ANNEXURE R11/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.3.

C1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS

Clause	Type	Description
2.4.1	Hold	Submission of certified product drawings and details of methods for manufacture, testing and installation, prior to the supply of precast concrete members subject to traffic and/or earth pressure loading, or water retaining structures with capacity greater than 25,000 litres
2.6	Hold	Submission of certificate of conformity prior to incorporation into the Works of any supplied manufactured drainage product
4.1.1	Hold	Notification of set out of drainage system and any proposed design changes in locations and levels
4.2.1	Hold	Notification that 0.5% minimum grade cannot be achieved for section of open drains
4.3	Witness	Excavation for pipe installation and other drainage structures
4.3.3	Hold	Replacement of inadequate foundation material
4.7.2	Witness	Construction of drainage structures other than pipes and box culverts
4.10	Hold	Protective measures for pipes and box culvert structures from heavy construction plant or vehicles

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW Q Annexure Q/E.

Clause	Description of the Identified Record
2.4.1	Product drawings and methods for manufacture, testing and installation of precast drainage structures other than pipes and box culverts
2.6	Certificate of conformity, stating that the supplied manufactured product conform to the requirements of this Specification
5.2	Report on CCTV inspections of drainage structures

ANNEXURE R11/D – PLANNING DOCUMENTS

Refer to Clause 1.2.4.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. The requirements of this Specification and others included in the Contract must be reviewed to determine additional documentation requirements.

Clause	Description
2.4	Detailed drawings and methods for manufacture, testing and installation of precast drainage structures other than pipes and box culverts.
2.6	Certificate of conformity that pipes, culverts, precast concrete units, access covers, road grates and frames, comply with the requirements of this Specification.
4.9.2	Procedures for achieving adequate compaction of Select Fill in Bed, Haunch, Side and Overlay zones around pipes in trenches.

ANNEXURES R11/E TO R11/K – (NOT USED)

ANNEXURE R11/L – MINIMUM FREQUENCY OF TESTING

Refer to Clause 1.2.5.

Clause	Characteristic Analysed	Test Method	Minimum Frequency of Testing
2.1	Precast concrete pipes:	AS 4058	As specified in Clause 2.1 and AS 4058
2.2	Fibre reinforced concrete pipes:	AS 4139	As specified in Clause 2.2 and AS 4139
3.1	Type BH Select Fill:		
	particle size distribution	TfNSW T201	- One per 50 m ³ or part thereof prior to placement
	plasticity	TfNSW T109	- One per 100 m ³ or part thereof prior to placement
3.1	Type SO Select Fill:		
	particle size distribution	TfNSW T201	- One per 100 m ³ or part thereof prior to placement
	plasticity	TfNSW T109	- One per 200 m ³ or part thereof prior to placement
4.9.2	Compaction: Surface of excavated open drains Foundations and trench bases Select Fill General fill Selected Material Zone	TfNSW T166	- In accordance with the requirements of Specification TfNSW Q

ANNEXURE R11/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.6.

TfNSW Specifications

TfNSW G2	General Requirements
TfNSW G38	Soil and Water Management
TfNSW Q	Quality Management System
TfNSW B80	Concrete Work for Bridges
TfNSW B115	Precast Concrete Members (Not Pretensioned)
TfNSW R15	Kerbs and Channels (Gutters)
TfNSW R16	Precast Reinforced Concrete Box Culverts
TfNSW R44	Earthworks
TfNSW R53	Concrete for General Works
TfNSW R55	Rock Filled Gabions and Mattresses
TfNSW R63	Geotextiles (Separation and Filtration)
TfNSW R83	Concrete Pavement Base
TfNSW R116	Heavy Duty Dense Graded Asphalt
TfNSW R119	Open Graded Asphalt
TfNSW R178	Vegetation
TfNSW 3051	Granular Pavement Base and Subbase Materials
TfNSW 3204	Preformed Joint Fillers for Concrete Road Pavements and Structures
TfNSW 3552	Subsurface Drainage Pipe (Corrugated Perforated and Non-perforated Plastic)
TfNSW 3553	Seamless Tubular Filter Fabric

TfNSW Test Methods

TfNSW T107	Fine Particle Size Distribution of Road Construction Materials
TfNSW T109	Plastic Limit and Plasticity Index of Road Construction Materials
TfNSW T119	Field Density of Road Construction Materials (Sand Replacement Method)
TfNSW T166	Relative Compaction of Road Construction Materials
TfNSW T173	Field Wet Density of Road Construction Materials (Nuclear Gauge in Direct Transmission Method)
TfNSW T201	Particle Distribution of Aggregates (by Washing)

Australian Standards

AS 1012.20	Methods of testing concrete
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AS 1597.2	Precast reinforced concrete box culverts - Part 2: Large culverts (exceeding 1200 mm span or 1200 mm height and up to and including 4200 mm span and 4200 mm height)
AS 1646	Elastomeric seals for waterworks purposes
AS 1657	Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS 3600	Concrete structures
AS 3725	Design for installation of buried concrete pipes
AS 3735	Concrete structures retaining liquids
AS 3996	Access covers and grates
AS/NZS 4058	Precast concrete pipes (pressure and non-pressure)
AS 4139	Fibre-reinforced concrete pipes and fittings
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS 5100	Bridge design
AS/NZS ISO 9001	Quality management systems – Requirements

Other Documents

WSA 05 – 2008	Conduit Inspection Reporting Code of Australia
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