Department of Transport and Main Roads

Technical Specification

Transport and Main Roads Specifications
MRTS24 Manufacture of Precast Concrete Culverts

July 2025

Queensland Government

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1 Introduction

This Technical Specification applies to the manufacture of small and large precast reinforced concrete rectangular box culverts and other associated culvert components for the conveyance of stormwater, which does not place the culvert under internal pressure.

Culverts beyond 4200 mm in height or span are not within the scope of this Technical Specification. Culverts classified as Railway load class by AS 1597.1 *Precast reinforced concrete box culverts, Part 1: Small culverts (not exceeding 1200 mm span and 1200 mm height)* and 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)* are not within the scope of this Technical Specification.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

1.1 Registered products and suppliers

The requirements for the construction of concrete culvert elements include the use of registered products and suppliers. For information regarding these products and suppliers refer to the Transport and Main Roads website, https://www.tmr.qld.gov.au/business-industry/business-with-us/approved-products-and-suppliers, or email ET_Structures_ProductsAndSuppliers@tmr.qld.gov.au.

2 Definition of terms

The terms used in this Technical Specification shall be as defined in Clause 2.1 of MRTS01 *Introduction to Technical Specifications* and AS 1597 *Parts 1 and 2 Precast reinforced Concrete Box Culverts*.

In addition, terms listed in Table 2 are applicable to this Technical Specification.

Table 2 – Definition of terms

Term	Definition
Applied load per lifting anchor	The dead weight of the precast concrete culvert multiplied by the sling angle factor and the dynamic factor and divided by the number of effective lifting points used in the lift.
Culvert Component	Crown unit, integral unit, link slab, or precast base slab.
Designer	Registered Professional Engineer Queensland (RPEQ) responsible for the design of the precast concrete culvert component.
Dynamic Factor	A multiplying factor to account for dynamic effects during lifting.
Dynamic Load Allowance (DLA)	A multiplying factor to account for moving traffic loads.
Factor of Safety	The ultimate capacity (lower characteristic strength) of the lifting anchor divided by the applied load per lifting anchor.
f_{sy}	Yield strength of reinforcing steel, as per AS 5100.5
Large Box Culvert	Rectangular culvert exceeding 1200 mm span, or 1200 mm height, with span and height less than or equal to 4200 mm as per AS 1597.2.

Term	Definition
Lifting Anchor	A cast in, bolted on or otherwise attached device anchored to the precast culvert component at the lifting point, which is provided exclusively for lifting the precast concrete culvert component.
Lifting Attachment	Lifting device used to attach a lifting anchor to the hoisting equipment.
Lifting Point	The designed location of a lifting device to be used for lifting a precast concrete culvert component.
Link Slab	A single slab supported by adjacent culverts or structures.
Precast Base Slab	Precast concrete slab used for the base of the culverts.
Registered	Pre-qualified product or supplier in accordance with departmental registration schemes, including: • *Registration Scheme: Suppliers and Products for Bridges and Other Structures* • *Product Index for Bridges and Other Structures* • *Construction Materials Testing Supplier Registration Scheme* • *Quarry Registration System* (QRS) Registration for certain products and suppliers is a pre-requisite for Administrator approval, not a substitute.
Rigging Diagram	Diagram showing the method for attaching hoisting equipment to the precast concrete culvert, the required sling angles and load sharing requirements.
Small Box Culvert	Culverts with maximum 1200 mm span and maximum 1200 mm height as per AS 1597.1.
Sling Angle Factor	The factor by which the tension in a sling increases according to the included angle between the slings.
Working Load Limit	The maximum load which may be applied to a lifting anchor, device or attachment.

3 Referenced documents

Table 3 lists documents referenced in this Technical Specification.

Table 3 – Referenced documents

Reference	Title
AS 1379	*Specification and supply on concrete*
AS 1597.1 (2010)	*Precast reinforced concrete box culverts, Part 1: Small culverts (not exceeding 1200 mm span and 1200 mm height)*
AS 1597.2 (2013)	*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 3600 (2018)	*Concrete structures*
AS 3850	*Prefabricated concrete elements (Parts 1 and 3)*
AS/NZS 4680	*Hot dip galvanized (zinc) coatings on fabricated ferrous articles*
AS 5100 (2017)	*Bridge design (Parts 2 and 5)*
ATS 2230	*Supply of Small Box Culverts*
ISO 9001	*Quality management systems – Requirements*

Reference	Title
MRTS03	*Drainage Structures, Retaining Structures and Slope Protections*
MRTS70	*Concrete*
MRTS71	*Reinforcing Steel*
MRTS271	*Glass Fibre Reinforced Polymer (GFRP) Reinforcement*
MRTS274	*Repair of New Concrete Construction*
SCM-P-015	*Registration Scheme: Suppliers and Products for Bridges and Other Structures*
SD1250	*R C Box Culverts and Slab Link Box Culverts – Culverts Height > 600 (Drawing 1 of 3 to Drawing 3 of 3)*

This Technical Specification contains multiple references to specific clauses in Australian Standards. The versions listed above, with amendments up to 2024, are the ones referred to.

4 Quality system requirements

4.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points, Witness Points and Milestones applicable to this Technical Specification are summarised in Table 4.1.

Milestones are defined in terms of calendar days.

Table 4.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
5.3	1. Approval of alternative dimensions		Submission of alternative dimensions (21 days)
8.8			Submission of design information (28 days)
9.4	2. Approval of manufacture of precast concrete culvert components		Submission of quality plan (14 days)
9.4.1	3. Approval of stock elements		Submission of quality plan (7 days)
12.2		1. Placement of concrete	
15		2. Inspection of products	
15	4. Acceptance of culverts		

4.2 Conformance requirements

The conformance requirements which apply to culvert components covered by this Technical Specification are summarised in Table 4.2.

Table 4.2 – Conformance requirements

Clause	Item
12	MRTS70 *Concrete*
12.8	Tolerances
13	Routine testing

4.3 Testing frequency

The minimum testing frequencies for work covered by this Technical Specification are described in Clause 13 and MRTS70 *Concrete*. Culvert components are accepted or rejected on an individual basis.

5 Culverts – types and dimensions

5.1 Types of culverts, link slabs and base slabs

Culvert components shall be as per AS 1597 Parts 1 and 2, being:

a) crown units: monolithic inverted U-shaped sections designed to be placed legs down

b) integral (one-piece, uniculvert) units: hollow rectangle sections forming base, 2 walls and crown

c) link slabs, and

d) base slabs.

A 'legs up' arrangement, where the U-shaped section forms the base, shall not be used.

> Note: There is currently no Standard Drawing for installation of integral units (uniculverts), so these would only be used with a detailed project-specific culvert design.

5.1.1 Link slab

Link slabs shall be simply supported on mortar seatings on the top of the culverts. Four bar anchors (dowels) per 1.2 m long slab section shall be provided to locate the assembly. The bar anchors shall pass through holes in the link slab and be grouted into holes provided in the legs of the culvert crowns. Bar anchors shall be reinforcing steel to MRTS71 *Reinforcing Steel* and be stainless steel for exposure classifications C1 and C2, or hot-dipped galvanised mild steel for exposure classification B2.

5.1.2 Precast base slab

Precast concrete base slab elements shall be designed by calculation and include full details and arrangements of joints, see Clause 8.7.

> Note: Precast base slabs require Administrator approval for use as a substitution for an insitu slab. See MRTS03 *Drainage Structures, Retaining Structures and Slope Protections*.

5.2 Sizes

The standard dimensions of box culverts components covered by this Technical Specification are as per Clause 2.8 of AS 1597.1 and Clause 2.8 of AS 1597.2, unless specified otherwise in the Contract documents.

Non-standard sizes may be available upon request from the manufacturer; this should be confirmed before finalising requirements. Availability of culverts components with a span of 450 mm or below should also be confirmed.

5.3 Design waterway area

The effective internal dimensions and total cross section of the waterway area in the culvert shall not be less than 95% of the nominal internal dimensions specified on the Drawings for all culverts. Where this requirement is not met, alternative dimensions may be submitted to the Administrator for approval. Drawings or tabulations showing the alternative dimensions shall be submitted not less than 21 days before supply of culverts is due to commence. **Milestone** No culverts of alternative dimensions shall be supplied until written approval is granted by the Administrator. **Hold Point 1**

The internal dimensions and effective cross sectional area of the waterway determines the hydraulic performance of the culverts. Consideration of alternative smaller effective cross sectional area of the waterway for culverts will need to take into consideration the reduction in hydraulic performance and should be referred to the Designer. Compatibility with existing infrastructure and other services may also need to be considered.

6 Design requirements – general

The design of precast concrete culvert components shall comply with the following requirements and shall apply to small and large box culverts.

6.1 Structural design

Structural design of precast concrete culvert components shall be in accordance with the following requirements.

6.1.1 Small box culverts and link slabs

Small box culverts and link slabs shall be designed by:

a) type testing in accordance with Clause 7, or

b) calculation in accordance with Clause 8.

Small box culverts components designed by type testing shall be limited to installations with heights of fill up to 2 m.

6.1.2 Large box culverts and link slabs

Large box culvert components shall be designed by calculation in accordance with Clause 8.

6.1.3 Precast base slabs

All precast base slabs shall be designed by calculation in accordance with Clauses 5.1.2 and 8.6.

6.2 Design life

The design life of all precast concrete box culvert components shall be 100 years.

> This means that 95% of the culvert components should remain in a serviceable condition with negligible maintenance for 100 years.

6.3 Exposure classifications and cover to reinforcement

6.3.1 Exposure classifications

Exposure classifications shall be determined in accordance with AS 5100.5 *Bridge design*, with a minimum exposure classification of B2.

6.3.2 Cover to reinforcement

Cover to reinforcement shall be as per AS 1597.1 for small box culverts and AS 5100.5 for large box culverts, in conjunction with rigid formwork and intense vibration.

In the case where super-workable concrete is used, intense vibration is not mandatory.

6.4 Provision for lifting

Each precast concrete culvert component shall be provided with certified lifting points and these lifting points shall be shown on the Drawing. Lifting design shall be in accordance with AS 3850.3 *Prefabricated concrete elements* and the following requirements.

a) The Designer shall be responsible for certification of the lifting points. A rigging diagram shall be shown on the Drawing. The rigging diagram shall include details of the required load sharing to equalise loads between lifting points and the included angle between the slings.

b) For large box culvert components, a service lift factor (see AS 3850.3) of 1.8 shall be applied.

c) If holes are provided instead of cast in lifting anchors, the manufacturer shall supply tight fitting concrete or plastic plugs with each consignment to seal the holes. Alternatively, the holes can be filled with a registered cementitious repair mortar (see MRTS274 *Repair of New Concrete Construction*).

d) Cover to the lifting anchor is not required, provided any recess is filled with a registered cementitious repair material, and lifting anchors are hot dip galvanised to AS/NZS 4680 *Hot dip galvanized (zinc) coatings on fabricated ferrous articles*.

e) With the exception of small box culvert components with a mass less than 500 kg, a minimum of 4 lifting points shall be provided. No product shall be lifted with less than 2 points.

f) Lifting anchors which are damaged shall not be used without inspection and certification by a Registered Professional Engineer of Queensland (RPEQ).

In addition to the requirements of MRTS24, the following should also be considered:

a) AS 3850.3 includes guidance on design for lifting and installation but in detail is overridden by this technical specification.

b) Details of any temporary bracing or support requirements during transport or erection should also be detailed by the Designer.

c) For some products a generic lifting design may cover a range of variations to a product where there are only small variations in design such as minor changes which decrease product mass or inclusion of additional ferrules or cast in items.

d) For design purposes, it should be assumed that products are lifted 20 times.

7 Design of small box culverts and link slabs by type testing

Design of box culverts by type testing is limited to small box culverts and link slabs, with a maximum height of fill of 2 m (refer to Clause 1.2 of AS 1597.1).

Design of precast concrete small box culverts, and associated link slabs, will be accepted subject to testing of 1.2 m long units (in accordance with Appendix G of AS 1597.1), demonstrating compliance with Clause 3.3 of AS 1597.1 and the following requirements:

a) for culverts with a cover to reinforcement greater than 50 mm, the maximum allowable crack widths shall be as for culverts with 50 mm cover (Refer to Table G1 of AS 1597.1)

b) for ultimate load testing the coefficient of variation of the 5 recorded results shall not be greater than 0.15

c) testing of units shall occur at 28 ± 5 days from the date of manufacture

d) manufacture of the test units shall be in accordance with this Technical Specification, including all materials

e) for small culvert units with a nominal length of 2.4 m the design shall have the same concrete thickness and distribution of reinforcement as a 1.2 m long unit.

The design shall be certified by an RPEQ Engineer on the basis on the test results.

In addition to the provisions of AS 1597.1, any changes to the maximum nominal aggregate size in the concrete mix or to the manufacturing procedure (e.g. wet to dry casting) shall trigger restarting the type testing process.

Routine load testing of small box culverts and associated link slabs shall be in accordance with Clause 13.

8 Design of large box culverts and link slabs, and precast base slabs by calculation

Large precast concrete box culverts, associated link slabs, and all precast base slabs shall be designed in accordance with AS 1597.2 and the following additional requirements. Small box culverts with a height of fill above 2 m shall likewise be designed. Small box culverts with a height of fill under 2 m may be designed in accordance with this clause (instead of being type tested).

8.1 General

Culverts shall be designed for the worst combination of load effects. Culvert components design shall consider each variation of installation arrangement including:

a) fill heights of zero to either a nominated maximum fill height, or 2 m whichever is the greater

b) cell configuration (see Figure 3.1 of AS 1597.2):

   i. single cell unit

   ii. multi-cell unit placed side-by-side, and

   iii. multi-cell units in a link slab arrangement.

c) installation method:

   i. embankment, and

   ii. trench.

d) alignment to traffic direction from 0° to 90°.

Culverts may be designed for non-standard arrangement (see Clause 8.6). These arrangements shall be noted on the Drawing.

Consideration of the worst-case scenarios allows for variations in construction methodology, changes in culvert structure design and interchangeability of culvert components within the structure, and between different sections of the same construction site.

Sidesway considerations are only applicable for end units installed in marked ‘sawtooth’ configurations.

8.2 Design live loads

This clause modifies and clarifies Clause 3.3.5 of AS 1597.2.

Culverts shall be designed to resist vertical and horizontal forces and effects of road traffic and construction loads in accordance with the following:

a) Traffic load cases, as defined by AS 5100.2, to be considered are:

   i. W80 wheel load and A160 axle load

   ii. single lane of M1600 loading

   iii. two lanes of M1600 loading, with reduction for multiple lanes in accordance with AS 5100.2, and

   iv. HLP400 Load.

b) Construction traffic load cases shall be considered in accordance with Clause 3.3.5.4 of AS 1597.2.

c) Dynamic Load Allowance shall be calculated in accordance with AS 1597.2.

d) Braking loads are not required to be considered, unless culverts are to be installed on a skewed alignment where side-sway is a consideration (see Clause 8.6).

e) Fatigue loading shall be considered in accordance with AS 5100.2 and AS 1597.2.

f) Wheel contact areas and distribution of construction and traffic loads through fill shall be in accordance with AS 5100.2.

AS 5100.2 has been chosen for the definition of traffic loads and their effects, as permitted by AS 1597.2, to preserve consistency and clarity.

8.3 Handling and transport loads

In addition to the requirements of Clause 3.4.3 of AS 1597.2, the following requirements shall be met:

a) In addition to the self-weight, all culverts and link slabs shall be designed for a vertical dynamic allowance of 50% of the weight of the culvert or link slab at any stage of the lifting operation.

b) All culvert units shall be designed to be transported either legs down, legs up, or on edge, with this noted on the Drawings.

c) Culverts and link slabs shall be designed to resist handling and transport loads without producing a stress in the reinforcement in excess of 0.6 f_{sy}.

Where transport modes are limited by design, this should be indicated on the product.

8.4 Load effect analysis and design

In addition to the requirements of Clause 3.5 of AS 1597.2, the following design conditions shall be met:

a) Culverts shall be designed as portal frame structures pinned at the base, with horizontal movement prevented at the base of the culvert leg, as by a suitable restraint system.

b) Side sway considerations are only required for certain installation conditions.

c) Link slabs shall be designed as a simply supported slab with the effective span being the clear span plus the thickness of the link slab.

d) Design of 2.4 m long culvert units shall be as for a 1.2 m long culvert unit with the reinforcement being the appropriate multiple of the 1.2 m long culvert design.

8.5 Design for strength and detailing requirements

In addition to the requirements of Clauses 3.6 and 3.7 of AS 1597.2, the following design criteria shall apply:

a) Structural design shall be based on a characteristic concrete strength of at most 65 MPa.

b) Density of concrete shall be assumed to be 2500 kg/m³.

c) Consideration of the effect of reinforcement ductility class on capacity reduction factors shall be in accordance with AS 5100.5.

d) For design due to bending moment, the effect of the W80 wheel loading located at the edge of the culvert or link slab shall be considered. The effective width shall be determined in accordance with Clause 9.6(b) of AS 5100.5.

e) The shear capacity of recessed link slabs shall be calculated a distance ‘d’ (where ‘d’ is the effective depth of the recessed section) from the face of the support using ‘d’ in calculating the shear capacity.

f) Calculation of shear strength shall be in accordance with Clause 8.2.4 of AS 3600. The critical shear section shall be taken as shown in Figure 3.2 of AS 1597.2, with the load positioned in such a way that the maximum shear is produced at the critical sections.

g) The minimum flexural reinforcement shall be in accordance with Clause 3.7.2 of AS 1597.2.

h) Minimum transverse distribution reinforcement in the bottom face of the crown of culverts and of link slabs shall be the greater of 25% of the main bending reinforcement and 333 mm²/m with a bar spacing not exceeding 300 mm. This requirement shall also apply to precast concrete base slabs (refer to Clause 5.1.2).

The requirements of this sub clause are necessitated by uncertainty as to whether culverts are installed across or along the road.

i) Shrinkage reinforcement shall be a minimum of 150 mm²/m, with a maximum bar spacing of 300 mm.

j) The location of maximum negative moment is in accordance with Clause 6.2.2 of AS 5100.5.

k) Reinforcement shall be positioned on all faces of the culvert at nominal cover depth for large box culverts. Reinforcing may be placed centrally in small box culverts. Haunches shall be reinforced.

l) Minimum clear bar spacing shall be the greater of 1.5 times the bar diameter and 1.5 times the nominal aggregate size. Bar spacing shall be such to ensure concrete can be properly placed and compacted.

8.6 Special cases

Under certain project conditions, the above clauses (8.2 to 8.5) may not be sufficient. The Drawings shall indicate whether the following scenarios have been considered.

8.6.1 Sawtooth configurations

Culverts units placed in skewed, multicell arrangements without adequate support from adjacent units shall be designed to withstand side sway and braking loads. ‘Adequate support’ is considered at least 0.5 m for 1.2 m long units and at least 1 m for 2.4 m long units.

8.6.2 Fish and fauna attachments

Provision of ferrules for fish baffles, fauna shelving or similar may be included in the design. The maximum associated loadings shall be nominated.

8.6.3 Innovative design

Innovative designs, such as those incorporating glass-fibre reinforced polymer bars (to MRTS271 *Glass Fibre Reinforced Polymer (GFRP) Reinforcement*) or higher strength (>500 MPa) reinforcing steel, shall be assessed by Transport and Main Roads on a case-by-case basis. Different or additional design criteria may apply.

> Designers should contact E&T Structures prior to embarking on these designs to ensure the design methodology is acceptable to all parties.

8.7 Precast concrete base slabs

In addition to the requirements of preceding clauses, precast culvert bases shall be designed such that:

a) For in service loads, the ultimate capacity of the precast base slab shall be at least equal to the structural capacity of cast insitu slabs in Standard Drawing 1250 *R C Box Culverts and Slab Link Box Culverts – Culverts Height > 600*.

b) For handling and transporting loads, the self-weight of the slab with a dynamic load allowance equivalent to 50% of the self-weight is supported during handling of the slabs and the steel stress in the reinforcing shall be less than 0.6 f_{sy}.

c) Joints between precast concrete culvert base slabs shall be designed to be filled with insitu concrete and be reinforced such that the joint is capable of resisting:

   i. 25% of the main bending capacity of the slab in the longitudinal direction (joint parallel to traffic)

   ii. 100% of the main bending capacity of the slab in the transverse direction (joint parallel to water flow), and

   iii. 100% of the shear capacity of the slab in all directions.

The joint shall also be designed to be durable with a design life of 100 years.

8.8 Design approval

Culvert component designs shall be provided to E&T Structures for acceptance via ET_Structures_ProductsAndSuppliers@tmr.qld.gov.au no later than 28 days before the proposed date of manufacture. **Milestone**

> Designs can be approved on a generic basis; they do not need to be separately approved by E&T Structures for each project.

8.8.1 Drawings

Drawings for culvert components shall contain the following information as a minimum:

a) concrete strength and nominal aggregate size

b) exposure classification and cover to reinforcement

c) fill height – zero and maximum height of fill

d) grade of reinforcing steel and steel schedule

e) number and nominal spacing of reinforcing bars and details of other reinforcement

f) tolerances on dimensions, cover and steel reinforcement

g) design loads in accordance with Clauses 8.2, and 8.3 of this Technical Specification

h) formwork and compaction type (that is, rigid formwork and intense vibration)

i) lifting details / assumptions and rigging diagram (see also Appendix A of AS 3850.3)

j) dimensions of haunch

k) calculated mass of individual units

l) proportion of nominal waterway area maintained

m) nomination of whether side-sway has been considered

n) unique Drawing identification (for example, plan number and revision number), and

o) reference to relevant TMR specifications

All Drawings are to be certified by an RPEQ Engineer.

(d) and (e) do not form part of the submission to the project under Clause 9.4.

8.8.2 Design report

A design report shall be included in the submission, detailing:

a) calculation report

b) ranges of sizes encompassed, and

c) range of variations included.

The intent is for most box culvert designs to be approved as a batch, with only outliers (e.g. penetrations, skews) requiring individual assessment.

8.8.3 Variations

Designs entailing minor variations, such as placement of ferrules for fish baffles, may be included under a single approval without submission of every said variation.

Updates to Drawings, not affecting the design (e.g. fixing errors), do not trigger the need for reapproval. These updates shall be submitted to E&T Structures for filing.

9 Conditions for manufacture of precast concrete culverts

9.1 Specification

All precast concrete culvert components shall be manufactured in accordance with the details shown on the Drawings, AS 1597 Part 1 or 2, and this Technical Specification.

Small box culvert components manufactured in accordance with ATS 2230 *Supply of Small Box Culverts* may not comply with this Technical Specification due to differing concrete requirements.

9.2 Manufacture by registered suppliers

Precast concrete culvert components shall be manufactured only by a Registered Supplier. Registered suppliers shall comply with the *Registration Scheme: Suppliers and Products for Bridges and Other Structures*.

9.3 New or innovative manufacturing procedure or design

Where a new or innovative procedure is proposed to design or manufacture precast culvert components, this shall be submitted to E&T Structures for assessment and approval through the Registration Scheme. All details of materials and processes shall be provided.

Where innovative design or manufacturing processes are proposed, it should be noted that the department has a strategy document on engineering innovation, which can be found on the department's Engineering innovation website.

With respect to intellectual property, the department has and always will respect manufacturers' intellectual property. However, it is considered necessary for all details of products and processes purchased by the department to be provided. These details shall not be provided to any third party.

Note: Any confidentiality document or formal agreement required would need to be negotiated between Transport and Main Roads' Legal Services and the manufacturer.

Dry casting is considered an innovative procedure. Use of alternate concrete or reinforcement materials would be considered a design innovation.

9.4 Manufacture of precast concrete culverts

At least 14 days before manufacture is due to commence, the Contractor shall provide to the Administrator the following information: **Milestone**

a) Drawings, incorporating the list in Clause 8.8.1, excluding reinforcement design (d) and (e)

The purposes of these submitted drawings include confirming that the culverts are appropriate for / match the project design, acting as a benchmark for quality assurance, and informing the Contractor to plan and set out installation.

b) the calculated mass of element

c) nominated precast supplier, the precast supplier registration certificate and the place of manufacture

d) casting program

e) a quality plan, consisting at a minimum of:

   i. an Inspection and Test Plan (ITP)

ii. nominated acceptance testing laboratory

iii. nominated method of concrete delivery, placement and compaction

iv. nominated method of concrete curing, and

v. method of product identification and marking.

f) where applicable (e.g. large box culverts) a copy of the design approval, and

g) any pre-production submissions required by other Technical Specifications (e.g. MRTS70 *Concrete*, MRTS71 *Reinforcing Steel*).

> Other pre-production submissions include, for example, the nomination of a concrete mix design and submission of its approval certificate (MRTS70 *Concrete*), and nomination of reinforcing steel supplier (MRTS71 *Reinforcing Steel*). These would form part of the quality plan.
>
> The submitted quality plan is not the "quality manual" of ISO 9001 *Quality management systems – Requirements*, nor full work instructions. It may be a brief statement with some attachments.

Manufacture of precast concrete products shall not commence until the above submission has been approved by the Administrator. **Hold Point 2**

> In accordance with Clause 9.4.1, Hold Point 2 may be replaced by Hold Point 3.

9.4.1 Stock items

Where small box culvert components have been manufactured (prior to Contract) in accordance with this Technical Specification they may be accepted at the sole discretion of the Administrator subject to:

a) Submission (7 days prior to delivery) and approval of:

i. documentation listed in Clause 9.4

ii. conformance report (see Clause 15.1) **Milestone**, and

b) inspection of the product before delivery to site.

Components shall not be delivered to site until approval of documentation has been granted by the Administrator. **Hold Point 3**

10 Materials

Steel reinforcing shall comply with the requirements of MRTS71 *Reinforcing Steel*.

Cast in items shall comply with Clause 11 of this Technical Specification.

Concrete shall comply with the requirements of MRTS70 *Concrete*, except as amended by this Technical Specification (refer to Clause 12).

11 Cast-in items

Cast in items including, but not limited to, ferrules and lifting devices, shall be proprietary items as specified in the Drawings or approved equivalent. Proprietary cast in items shall be a registered product.

Cast in ferrules and lifting anchors shall comply with AS 3850.1.

12 Additions to MRTS70 *Concrete*

12.1 General

In addition to the requirements of MRTS70 *Concrete*, Clauses 12.2 to 12.10 shall apply to the manufacture of precast concrete culvert components.

Concrete shall be designated special class.

12.2 Placing concrete

Placing of concrete shall be a mandatory Hold Point in the manufacturer's Quality Management System. The manufacturer shall also advise the Administrator of the intention to place concrete. **Witness Point 1** For small box culverts, refer to alternative requirements in Clause 9.4.1.

12.3 Formwork

Culverts shall be cast legs down or on end.

12.4 Fillets and chamfers

Internal corners and external edges of all precast concrete culverts shall be finished with curved or straight fillets appropriate to the application.

> Specified cover also includes cover to fillets and chamfers.

12.5 Installation of lifting devices

Lifting anchors shall be fixed securely in place before placement and compaction of concrete.

> Puddling in of lifting anchors into wet concrete is not permitted. Regarding cover to anchors see Clause 6.4.

12.6 Removal of formwork

Formwork shall not be removed from the concrete, nor the product lifted until the concrete has attained a strength of 20 MPa. Curing in accordance with MRTS70 *Concrete* shall continue as soon as practical, but no later than 1 hour after removal of formwork.

Where a minimum concrete lifting strength is shown on the Drawings which is higher than this requirement, the Drawing requirements shall apply.

12.7 Heat-accelerated curing

Curing shall be deemed complete when either 420 °Ch or 35 MPa is achieved. Further membrane curing is required if neither target is met.

35 MPa is listed here as 70% of f'c (nominally 50 MPa).

12.8 Finish

12.8.1 Surface condition

The concrete shall be dense, hard and substantially free from chipped edges, fins, protrusions and surface roughness. A Class 2 finish in accordance with AS 3610.1 shall be achieved for off-form surfaces. Unformed surfaces shall achieve at least a Class 3 finish.

After installation of the product, lifting recesses shall be filled with a registered cementitious repair grout or mortar (see MRTS274 *Repair of New Concrete Construction*) to achieve the required surface finish in accordance with AS 3610.1. Lifting ferrules shall be kept clean and fitted with a removeable cap.

Elements shall not be coated with cement wash or any other preparation not specified or otherwise approved by the Administrator.

12.8.2 Defects

Defects shall be assessed and managed in accordance with Table 12.7.2. All defects shall be recorded.

Acceptability of defects shall be as per Table 12.7.2

Table 12.7.2 – Surface defects

Defect type	Criteria	Acceptability	Action
Crack	≤ 0.15 mm	Acceptable	Record
Crack	0.15-0.3 mm (width) OR > 300 mm (length)	Unacceptable	Repair to MRTS274
Crack	> 0.3 mm (width) OR > 500 mm/m² (density) OR Full thickness	Unacceptable	Reject
Dents, bulges, chips, spalls	> 3 mm (depth/height) OR > 200 mm (across)	Unacceptable	Repair to MRTS274
Surface imperfections	Not meeting Class 2	Unacceptable	Fill to MRTS70
Air holes	> 3 mm (depth) OR > 20 mm (across)	Unacceptable	Repair to MRTS274
Bony patches	> 3 mm (depth) OR > 100 mm (across)	Unacceptable	Repair to MRTS274
Foreign material	> 100 mm²	Unacceptable	Reject

Crack width shall be measured at the surface of the crack and not with the feeler gauge method.

This table is a variation on AS 1597 defect classification and acceptability.

The intention of MRTS24 is that precast units are produced crack free and with very few air holes.

The use of feeler gauges to measure crack width (see AS 1597) is not considered accurate enough due to variability in crack shape and operator technique.

12.9 Tolerances

Tolerances on measured dimensions for both small and large box culverts and associated link and base slabs shall comply with AS 1597.1 and AS 1597.2 as appropriate and the following requirements.

12.9.1 Straightness

When the inner surface of a culvert is tested with a 1 m long straight-edge, the deviation from straightness at any point shall not exceed 6 mm.

12.9.2 Ends

When tested with a tri square, the end faces of the culvert unit, link slab or base slab at any location shall be square within ± 4 mm when measured across the unit section thickness.

12.9.3 Verticality

With the base of the culvert unit horizontal, the vertical side faces of the legs and the end faces shall not deviate from the vertical at any location by more than ± 20 mm for the entire height of the culvert unit.

12.9.4 Fillets

The internal corners of culverts shall be finished with curved or straight fillets appropriate to the size of the culverts. Fillets shall not reduce the waterway area beyond the requirements outlined in Clause 5.3.

13 Routine testing

Routine testing shall be conducted in accordance with AS 1597.1 or AS 1597.2 and the following clauses.

A 'lot' shall consist of a single batch.

In AS 1597.1 and AS 1597.2, a 'batch' consists of components of the same class and design whereas a 'lot' can contain multiple sizes / designs.

The testing machine used for load testing shall meet the requirements of AS 2193 Class B and shall be calibrated by NATA accredited laboratory. A jack and pressure gauge system may be used provided that calibration is carried out at not more than 12 monthly intervals.

13.1.1 Proof load testing

A batch for proof load testing is defined as a maximum of 50 units of the same size, and cover to reinforcement and manufactured and cured at the same casting yard within one calendar month.

Proof load testing is not required for small box culvert components designed in accordance with Clause 8 of this technical specification.

The sampling provisions of Appendix F of AS 1597.1 continue to apply, therefore 2 culverts or link slabs are tested per lot.

13.1.2 Ultimate load testing

Ultimate load testing is required for small box culverts and link slabs, unless design has been conducted in accordance with Clause 8.

A batch for ultimate load testing is defined as a maximum of 150 units of the same size, and cover to reinforcement and manufactured and cured at the same casting yard within 3 calendar months.

13.1.3 Concrete cover and dimensional accuracy

The concrete cover to the steel reinforcement shall be measured with a calibrated cover meter. The cover meter device shall be capable of detecting the presence of reinforcement and indicating the depth from the concrete surface to the nearest point on the surface of the reinforcement with an accuracy of ± 2 mm at a depth of 25 mm.

For small box culverts and link slabs, a batch is defined as a maximum of 100 units manufactured within 3 calendar months.

For large box culverts and link slabs, a batch is defined as a maximum of 25 units manufactured within one calendar month.

13.1.4 Tightened testing frequencies

For small box culverts and link slabs, if any sample element fails the respective test, that element shall be rejected and the sampling regime specified in Table 13.1.4 implemented. Secondary samples will not be permitted during this time. The sampling frequencies specified in Table 13.1.4 shall be in place for a minimum of 6 months, after which, if no further failures have occurred, a normal sampling frequency may be resumed.

Table 13.1.4 – Tightened testing frequencies

Test	Test Frequency (whichever gives the greater number of tests)
Proof Load	1 in 10 or weekly
Ultimate Load	1 in 50 or monthly
Cover and dimensions	1 in 50 or weekly

14 Handling, storage, and transportation

14.1 Marking

The following information shall be clearly and permanently marked on each culvert component from time of manufacture:

a) the date of manufacture and unique identification number

b) the manufacturer's name or registered mark:

   i. if the manufacturer runs multiple sites, the site of manufacture shall be indicated.

c) the size of the culvert component

d) the maximum mass of the culvert component, and

e) the Technical Specification number and version to which the culvert component has been manufactured.

14.2 Handling

Culvert components shall be handled in a manner which will avoid damage to the components and shall be lifted using the lifting points provided as shown on the Drawings and Rigging Diagram (refer Clause 6.4).

Where culverts are lifted in the legs up position, a lifting beam shall be used in order to avoid inducing excessive bending moments in the legs.

14.3 Transportation

The legs of all culverts shall be adequately braced to prevent whipping and bending.

Precast base slabs and link slabs shall be transported in the as laid position.

Components shall not be transported from the precast yard until the greater of 7 days or the time when concrete has attained 70% of the specified 28-day characteristic strength.

14.4 Storage

Culvert components to be stored shall be placed on an even surface, stacked and supported in a manner that will avoid damage, tipping and overturning. Culvert components may be stored in more than one layer. Timber or other suitable material which does not damage, mark or stain the culverts shall be used as supports between the ground and the culvert components and separating each layer. For culvert components, stack height shall be no greater than either 6 m or 6 culverts. The manufacturer shall be responsible for any damage that occurs during storage.

For precast base slabs and link slabs, supports shall be placed near the ends of the slab and directly above the supports of any lower layer and the maximum number of slabs in any one stack shall be 6 components.

15 Acceptance

Precast culvert components shall remain available for inspection for a minimum of 7 days from the date of manufacture. **Witness Point 2**

The acceptability of precast concrete elements in accordance with this Technical Specification shall be determined by inspection on the basis of visual inspection, geometric measurement, measurement of clear cover to reinforcement, reinforcement spacing and location, load test results and specified 28-day concrete strength. **Hold Point 4**

Precast culvert components shall be rejected if the components fail to meet any of the requirements of this Technical Specification.

Any damage to the product during handling or transportation to site shall be assessed in accordance with Clause 12.7.2 of this Technical Specification.

This Technical Specification states that 'Precast concrete culvert components may be rejected should the components fail to meet any of the requirements of this Technical Specification'. It should be noted that manufacture of defect free product in accordance with MRTS24 is always the preferred outcome. However, where issues exist early submission of non-conformances in accordance with the Contract to the Administrator may assist with resolving issues. Acceptance of non-conforming or defective product is always at the discretion of the Administrator.

15.1 Records to be submitted

With each batch of culverts delivered to the site, a delivery docket shall be supplied that provides traceability to a conformance report for the batch. The delivery docket shall also state that the culverts supplied conform to the requirements of this Technical Specification.

For release of **Hold Point 4**, a conformance report with the following records shall be submitted:

a) definition of the batch(es) that the report covers including:
   i. design (size, exposure classification, product code / drawing number)
   ii. date range of manufacture
   iii. individual unit identifiers
   iv. batch size

b) a statement of whether the culvert components are defect free, have acceptable defects or have been repaired / tested in accordance with Clause 12.7.2

c) for large box culvert components:
   i. concrete strength test reports and summary (as per MRTS70 *Concrete*)
   ii. heat-accelerated curing charts (as per MRTS70 *Concrete*), if applicable

d) for small box culvert components
   i. reports on the load testing of small box culverts and link slabs in accordance with AS 1597.1 Clause G9.2 (unless designed by calculation), and
   ii. a summary concrete strength report covering culvert batch(es) supplied, by month.

Full quality records, including individual concrete test reports shall be made available for audit if requested.

The summary concrete strength report is akin to the 'production assessment report' of AS 1379 *Specification and supply on concrete*.