SPECIFICATION 404

CULVERTS

REVISION REGISTER			
Clause Number	**Description of Revision**	**Authorised By**	**Issue Date**
Clause 404B.08(1) & 404B.08(2) 404C.03(2)(a), 404C.03(5) 404C.07(4) 404C.07(7)(a) Guidance notes 9.1(a)	Clause reference update Drawing reference update Drawing reference update	PDE	24/11/2023
Guidance Notes	Change of Custodian	MRTE	06/08/2021
Clause 404C.05 & 404C.06	Updated subclause numbering.	PDE	11/12/2020
Clause 404.40.3	Update reference to AS 1597.2 Section 5	PDE	19/10/2020
Whole document	Removal of concrete requirements and replacement with reference to relevant concrete specification. Clause numbers for Contract Specific Requirements updated.	PDE	15/10/2020
References 404.87.03	Added AP-R575-18 Added design procedure requirements for plastic flexible pipe and fitting products.	PDE	25/03/2020
404.02	Added reference to Specification 203 and National Code of Practice for the Safe Removal of Asbestos	SRE	21/10/2019
404.03	Added new definition for Asbestos Containing Material	SRE	21/10/2019
404.41	Added requirements relating to Asbestos Containing Material (ACM)	SRE	21/10/2019
Guidance Note 17	Additional Guidance Note relating to Specification 203 Occupational Safety and Health	SRE	21/10/2019
Whole document	Reformatted	SCO	19/04/2017
Annexure 404A & 404B	Table 404A2, 404B1 and reference to AS/NZS 4058 amended	SRE	06/04/2016
404.40.01	Missing Horizontal & Vertical Tolerances introduced	SRE	29/05/2013
Clause 404.87	Discontinuation of the use of Polypropylene Pipes	SRE	12/11/2012
Whole document	Reference to AS 1597 amended	SRE	24/07/2012
References	Changed WS SP43 to ATIC SP43 throughout document	SRE	28/07/2011
References 404.10 404B.04.02 & 404C.05.02 404B.04.03 Annexure 404D	Added AS/NZS 2350 and WS SP43 Type GP Cement Major amendments for compliance for cement used and registration requirements Reference to WS SP43 Added Concrete Request for Registration form	SRE	29/05/2009

REVISION REGISTER			
Clause Number	**Description of Revision**	**Authorised By**	**Issue Date**
Whole document	Major amendments relate to approach for small box culverts installed in 'Aggressive' ground environment. New plastic culverts added. Multiple minor amendments made throughout document	SRE	26/06/2008
404C.07.03, 404C.07.04	Change minimum clear cover description.	CMPM	29/11/2006

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SPECIFICATION 404

CULVERTS

GENERAL

404.01 SCOPE

The work under this specification consists of the supply and installation of reinforced concrete pipes (RCPs) and reinforced concrete boxes (RCBs) culverts, corrugated steel pipe (CSP) and corrugated aluminium pipes (CAP) culverts, reinforced concrete end treatments for culverts and the supply and installation of RCP stormwater drains.

404.02 REFERENCES

1. Australian Standards, MAIN ROADS Western Australia Standards and MAIN ROADS Western Australia Test Methods are referred to in abbreviated form (e.g. AS 1234, MRS 67-08-43 or WA 123). For convenience, the full titles are given below:

Australian Standards

AS 1012	Methods of Testing Concrete
AS 1289.6.3.3	Methods of Testing Soils for Engineering Purposes – Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Perth Sand Penetrometer Test
AS 1379	Specification and Supply of Concrete
AS 1397	Steel Sheet and Strip – Hot Dipped Zinc Coated or Aluminium/Zinc Coated
AS 1478	Chemical Admixtures for Concrete, Mortar and Grout
AS 1597	Pre cast Reinforced Concrete Box Culverts
AS 1646	Elastomeric Seals for Waterworks Purposes
AS 1761	Helical Lock-Seam Corrugated Steel Pipes
AS 1762	Helical Lock-Seam Corrugated Steel Pipes – Design and Installation
AS 3610	Formwork for Concrete
AS 3972	Portland and Blended Cements
AS 5100.5	Bridge Design – Concrete

Australian/New Zealand Standards

AS/NZS 2041	Buried Corrugated Metal Structures
AS/NZS 2350	Methods of Testing Portland and blended cements
AS/NZS 2566.1	Buried Flexible Pipelines – Structural Design
AS/NZS 2566.2	Buried Flexible Pipelines – Installation
AS/NZS 3725	Design for Installation of Buried Concrete Pipes

AS/NZS 3750.9	Paints for Steel Structures – Organic Zinc-Rich Primer
AS/NZS 4058	Precast Concrete Pipes (Pressure and Non-Pressure)
AS/NZS 4130	Polyethylene (PE) Pipes for Pressure Applications
AS/NZS 4671	Steel Reinforcing Materials
AS/NZS 5065	Polyethylene and Polypropylene Pipes and Fittings for Drainage and Sewerage Applications

Other Standards

AASHTO M196-92 / ASTM B745	Corrugated Aluminium Pipe for Sewers and Drains
AASHTO M197-01 / ASTM B744	Aluminium Alloy Sheet for Corrugated Aluminium Pipe
AASHTO M246-05 / ASTM A742	Steel Sheet, Metallic-Coated and Polymer Pre-coated, for Corrugated Steel Pipe
NOHSC:2002	National Code of Practice for the Safe Removal of Asbestos

Austroads Research Report

AP-R575-18	Design of Buried Flexible Pipes

MAIN ROADS Test Methods

WA 115.2	Particle Size Distribution: Abbreviated Method for Coarse Soils
WA 133.1	Dry Density/Moisture Content Relationship: Modified Compaction – Fine and Medium Grained Soils
WA 133.2	Dry Density/Moisture Content Relationship: Modified Compaction – Course Grained Soils
WA 910.1	Chlorides and Total Soluble Salts in Soil and Water

MAIN ROADS Specifications

Specification 201	QUALITY MANAGEMENT
Specification 203	HEALTH AND SAFETY MANAGEMENT
Specification 204	ENVIRONMENTAL MANAGEMENT
Specification 302	EARTHWORKS
Specification 402	SURFACE DRAINS AND LEVEES
Specification 405	DRAINAGE STRUCTURES
Specification 406	ROCK PROTECTION
Specification 410	LOW STRENGTH INFILL
Specification 501	PAVEMENTS
Specification 503	BITUMINOUS SURFACING
Specification 504	ASPHALT WEARING COURSE
Specification 819	FALSEWORK
Specification 820	CONCRETE FOR STRUCTURES

Specification 821 FORMWORK
Specification 822 STEEL REINFORCEMENT
Specification 828 PRECAST CONCRETE MEMBERS
Specification 901 CONCRETE – GENERAL WORKS

404.03 DEFINITIONS

1. Culvert end treatments shall include endwalls or headwalls, wingwalls, cut-off walls and aprons. ***End Treatments***

2. Stormwater drains consist of reinforced concrete pipes connecting drainage structures such as inlets, manholes and catchpits as shown on the Drawings. ***Stormwater Drains***

3. Unless otherwise stated, Clauses within this specification, that reference RCP culverts are also applicable to RCPs installed to carry stormwater from drainage structures. ***RCP Stormwater Drains***

4. Where this specification refers to 'Aggressive' ground conditions, as defined in Annexure 404A, it includes environmental conditions where additional protective measures to culverts are required in accordance with Table 404A2. ***Aggressive Ground Conditions***

5. 'Culway' installations refer to culverts associated with traffic monitoring equipment. ***Culway***

6. Asbestos Containing Material (ACM) has the same meaning as detailed in the National Code of Practice for the Safe Removal of Asbestos ***Asbestos Containing Material***

404.04 – 404.05 NOT USED

PRODUCTS AND MATERIALS

404.06 REINFORCED CONCRETE PIPES

1. Concrete pipes for culverts shall be precast reinforced concrete pipes (RCPs) to the Classes shown on the Drawings. ***RCPs***

2. Concrete pipes shall be manufactured, tested and inspected in accordance with the requirements of Annexure 404B. ***Manufacture***

3. Concrete pipe shall be manufactured to suit the in-situ ground conditions as specified in Annexure 404A – Table 404A1, in accordance with the requirements of Table 404A2.

4. Joint types shall be as specified in Annexure 404A. ***Joint Types***

5. Rubber ring joints shall be provided for all spigot and socket pipes, unless otherwise shown on the Drawings. ***Rubber Ring Joints***

6. Rubber ring gaskets required for jointing spigot and socket concrete pipes shall conform to the requirements of AS 1646. ***Rubber Ring Gaskets***

404.07 CORRUGATED METAL PIPES

404.07.01 GENERAL

1. Corrugated metal pipes with diameter greater than 750 mm, or individual units that are to be joined to form a single barrel, shall be supplied with a unique identifying number for post installation shape measurement and reassembly purposes where applicable.

2. Corrugated metal pipes with diameter greater than 750 mm shall be supplied with indelible markings defining the internal diameter vertically (through the obvert and invert) and horizontally at intervals as specified in Specification 201 QUALITY MANAGEMENT. The manufacturer shall provide internal measurements taken at each set of indelible markings to an accuracy of ± 5 mm, cross referenced to the unique identifying number detailed in this clause.

3. Corrugated metal pipe shall be manufactured to suit the in-situ ground conditions as specified in Annexure 404A – Table 404A1, in accordance with the requirements of Table 404A2.

404.07.02 CORRUGATED STEEL PIPES

1. Corrugated steel pipe culverts shall be supplied to the corrugation size and steel thickness in accordance with this clause. ***CSPs***

2. The corrugated steel pipes shall be a spirally wound type. ***Spirally Wound***

3. Corrugated steel pipes shall conform to AS 1761.

4. The steel thickness shall be 2.0 mm for 450 mm diameter, 2.5 mm for 600 mm to 1500 mm diameter, and 3.0 mm for 1650 mm to 2100 mm diameter. ***Steel Thickness***

5. The corrugations shall be 68 mm x 13 mm for up to and including 1500 mm diameter, and 125 mm x 25 mm for 1650 mm to 2100 mm diameter. ***Corrugation***

6. All pipes shall be manufactured from Grade 250 steel plate to AS 1397.

7. All corrugated steel pipes cut during the manufacturing process for bevel or skew installations shall have their cut surfaces treated in accordance with Clause 404.36 ‘Damage’. ***Cut Surfaces***

404.07.03 CORRUGATED ALUMINIUM PIPES

1. Corrugated aluminium pipe shall be fabricated from Alclad 3004-H34 in accordance with AASHTO M197-01. Raw material coil width shall be 650 mm or greater to maximise lock seam spacing. ***CAP Base Material***

2. Manufacture shall be in accordance with AASHTO M196-92 to the tolerances shown in AS 1761, and shall incorporate a staked, double offset lock-seam joint. ***Manufacture***

3. The structural design procedure shall be in accordance with AS 1762, modified to suit the aluminium section properties of Alclad 3004-H34 with regard to metal strengths and flexibility, which are as follows: ***Design***

   (a) Modulus of Elasticity (E) = 69 000 MPa

   (b) Yield Stress = 165 MPa

   (c) Flexibility factor = 0.46 mm/N

4. The aluminium thickness shall be 2.0 mm for up to and including 450 mm diameter, 2.5 mm for 600 mm to 1500 mm diameter, and 3.0 mm for 1650 mm to 2400 mm diameter. ***Aluminium Thickness***

5. The corrugations shall be 68 mm x 13 mm for up to and including 1500 mm diameter, and 125 mm x 25 mm for 1650 mm to 2400 mm diameter. ***Corrugation***

6. Dissimilar metals shall not be permitted to be in direct contact with aluminium pipe. ***Dissimilar Metals***

404.08 REINFORCED CONCRETE BOXES

1. Reinforced concrete box culvert units with spans up to and equal to 1200 mm shall be manufactured, tested and inspected in accordance with Annexure 404C and AS 1597.1. ***RCBs (Spans ≤ 1200 mm)***

2. Reinforced concrete box culvert units with spans of 1500 mm and greater shall be manufactured, tested and inspected in accordance with Annexure 404C and AS 1597.2. ***RCBs (Spans ≥ 1500 mm)***

3. Reinforced concrete box culvert units shall be manufactured to suit the in-situ conditions as specified in Annexure 404A – Table 404A1, in accordance with the requirements of Table 404A2.

4. Joint sealant for masking external joints shall be a 150 mm wide joint sealant complying with this specification. ***Joint Sealant***

404.09 REINFORCEMENT AND IN-SITU CONCRETE

404.09.01 REINFORCEMENT

1. Reinforcing steel shall conform to the requirements of Specification 822 STEEL REINFORCEMENT.

404.09.02 IN-SITU CONCRETE

1. The supply of in-situ concrete for base slabs and end treatments shall conform to requirements of Annexure 404A – Table 404A3.

2. The supply and placement of all N Class concrete shall be in accordance with Specification 901 CONCRETE – GENERAL WORKS. ***N Class Concrete***

3. The supply and placement of all S Class concrete shall be in accordance with Specification 820 CONCRETE FOR STRUCTURES. ***S Class Concrete***

404.10 CEMENT STABILISED BACKFILL

1. Cement stabilised backfill material shall consist of basecourse material, or other suitable material approved by the Superintendent, stabilised in the proportion of 100 kg of Type GP Cement to one cubic metre of uncompacted backfill material. ***Mix Proportions***

2. Water for cement stabilisation shall be clean and potable. ***Water***

404.11 SELECT BEDDING MATERIAL

1. Select bedding material shall be basecourse material, or other suitable material approved by the Superintendent, containing less than 20% by mass of material retained on the 37.5 mm sieve as determined by MRWA Test Method WA 115.2.

404.12 JOINT SEALANT

1. Acceptable joint sealant for masking external joints are Flash Tac Scotch Wrap No. 50 and Rock Wrap 3000 or a suitable equivalent approved by the Superintendent.

404.13 – 404.30 NOT USED

INSTALLATION

404.31 GENERAL

1. The installation of pipes and box culverts shall include all trench excavations, construction and backfill to the details shown on the Drawings and as described in this specification.

404.32 TRENCH EXCAVATION

1. Trenches shall be excavated to the width shown in the Drawings with vertical sides throughout where the excavation is up to 1.5 m deep.

2. Where the excavation is greater than 1.5 m deep, the trench shall be excavated in accordance with the requirements of the Drawings. Any loose or disturbed material shall be removed from the walls of the trench. ***Trench > 1.5 m Deep***

3. All spoil material from excavations, including excavations for end treatments and rock protection, shall be disposed of as specified in Specification 302 EARTHWORKS. ***Spoil Material***

4. Excavations shall be kept free from water until work below ground level is sufficiently set or protected. Dewatering operations shall be undertaken in accordance with Specification 204 ENVIRONMENTAL MANAGEMENT , and water discharged from trenches shall in no circumstances be disposed of to sanitary sewers. ***Dewatering***

5. Trench excavations in rock, including excavation for end treatments, shall be carried out in accordance with Specification 302 EARTHWORKS. ***Rock***

404.33 BLASTING

1. Any requirement for blasting shall be carried out in accordance with Specification 302 EARTHWORKS. ***Blasting***

404.34 PROTECTION OF FOUNDATION SURFACES

1. The exposed surface at the bottom of the excavation shall be adequately protected from disturbance by the Contractor's operations or by the action of storm water or ground water. Where required, dewatering shall be undertaken in accordance with the requirements of Specification 204 ENVIRONMENTAL MANAGEMENT. Any disturbance shall be reinstated to the requirements of Clause 404.35 'Bedding' by the Contractor at no cost to the Principal. ***Exposed Surface***

404.35 BEDDING

1. Culverts shall be bedded as detailed on the Drawings.

2. Excavation for culverts, bedding and end treatments shall be undertaken to the extent shown on the Drawings. ***Extent of Excavation***

3. Unless shown otherwise on the Drawings, the culverts and end treatments shall be bedded on the in-situ foundation material that has been compacted to the requirements specified for 'Embankment Foundation' in Specification 302 EARTHWORKS, with a frequency of testing in accordance with Specification 201 QUALITY MANAGEMENT.

4. Select bedding material shall be constructed to the dimensions shown in the Drawings. Select bedding material shall be compacted to the Characteristic Dry Density Ratio specified for 'Embankment Construction' in Specification 302 EARTHWORKS, with a frequency of testing in accordance with Specification 201 QUALITY MANAGEMENT. ***Select Bedding Material***

5. Provisions shall be made to accommodate pipe socket/connections to ensure pipes are fully supported along the barrels.

404.36 DAMAGE

1. Precast concrete pipes and box culvert units shall be handled and installed in such a manner that no non-conforming cracking or other non-conforming defect occurs that is outside acceptable limits given in Annexure 404B and 404C as applicable. Damaged pipe and box culverts shall be assessed and repaired or replaced in accordance with Annexure 404B or Annexure 404C as applicable at no cost to the Principal. ***Damaged Concrete Units***

2. Corrugated steel pipe culvert units shall be handled and installed in such a manner as to prevent damage to the zinc coating. Areas on culvert units where zinc coating has been damaged shall be cleaned of rust and painted with two coats of zinc-rich organic priming paint complying with AS/NZS 3750.9. Where other coatings such as polymer pre-coats are used, then damage to those coats shall be repaired in accordance with the manufacturer's recommendations. Such surface repairs shall be undertaken at no cost to the Principal. Where damage occurs, other than to the surface coating then the damaged units shall be replaced at no cost to the Principal. ***Damaged CSPs***

3. Corrugated aluminium pipe culvert units shall be handled and installed with care to prevent damage to the pipe wall and seamed joints. Damaged pipe units shall be replaced at no cost to the Principal. ***Damaged Aluminium Pipes***

404.37 BACKFILL AND COMPACTION

404.37.01 GENERAL

1. **Prior to backfilling the Contractor shall certify to the Superintendent that compliance has been achieved with all specified requirements.** ***HOLD POINT***

2. The backfill requirements for all culverts shall be as detailed in the Drawings. Unless otherwise shown on the Drawings backfill material, other than cement stabilised backfill shall be embankment material placed and compacted to the requirements specified for 'Embankment Construction' in Specification 302 EARTHWORKS, with a frequency of testing in accordance with Specification 201 QUALITY MANAGEMENT. Backfill levels on each side of any conduit shall not differ by more than 150 mm. The Contractor shall ensure that the backfill placement does not damage the end treatments. ***Backfill***

3. The dimensional requirements relating to backfill shall be as shown on the Drawings. ***Extent***

4. All sheeting, struts, braces, and similar temporary supports shall be entirely removed from the trench prior to backfilling. Removal shall be effected in such a way so as not to disturb or displace the culvert. ***Removal of Bracing***

5. Appropriate precautions, such as the use of holding-down straps, shall be taken to ensure that corrugated metal pipe culvert barrels do not 'float' during the backfilling process, particularly during vibration of the backfill. ***Metal Culvert 'Float' Precautions***

6. The Contractor shall ensure that the equipment used during compaction of backfill does not damage the culvert. Limitations on the type of compaction equipment, and cover to be provided to the top of the culvert shall be determined in accordance with AS/NZS 3725 for reinforced concrete pipes, AS 1597 for reinforced box culverts or AS 1762 for corrugated steel pipes. ***Compaction Equipment***

7. No backfill shall be placed behind in-situ wingwalls or headwalls within seven days of concrete being placed in the wingwalls or headwalls. ***Concrete Strength***

404.37.02 CEMENT STABILISED BACKFILL

1. Cement stabilised backfill material to culverts shall be as specified in Clause 404.10 'Cement Stabilised Backfill' and shall be placed to the limits and dimensions as shown on the Drawings. ***Material***

2. Only sufficient water shall be mixed with the stabilised material to facilitate compaction. ***Water***

3. Cement stabilised backfill material shall be placed within 90 minutes of mixing the cement with water. The stabilised backfill shall be compacted during placement using pneumatic or mechanical rotary type immersion vibrators. The cement stabilised material shall be vibrated until all excess water and air are expelled. ***Placing***

4. During placing of cement stabilised backfill the backfill levels on each side of any conduit shall not differ by more than 150 mm. Backfill placement shall not damage the culverts or end treatments. ***Placement***

5. Immersion vibrators shall be of the rotary out of balance type with a frequency of not less than 10 000 cycles per minute. Before the commencement of each backfill, sufficient vibrators and spares shall be available and tested. The number of vibrators required for a given rate of placing cement stabilised material shall be as specified in Table 404.01 and shall be continuously used during the process. ***Vibrators***

TABLE 404.01 NUMBER OF VIBRATORS

Rate of Placing Cement Stabilised Material m^3 per Hour	Working Vibrators Required	Standby Vibrators Required
Up to 4	1	1
4 to 8	2	1

404.38 PAVEMENT REINSTATEMENT

1. Where a culvert is constructed under an existing road pavement, the pavement on the existing road shall be reinstated by the construction of the appropriate pavement layers with thicknesses as shown on the Drawings. ***Reinstatement***

2. The edges of the excavation shall be saw cut straight and parallel to the line of the culvert or stormwater drain and the excavation backfilled to the requirements of clauses 404.31 'General' and 404.37 'Backfill and Compaction' respectively. The pavement layer(s) shall be constructed to the relevant requirements of Specification 501 PAVEMENTS. ***Edges & Pavement***

3. Bituminous surfacing and asphalt shall be applied in accordance with the requirements of Specification 503 BITUMINOUS SURFACING and Specification 504 ASPHALT WEARING COURSE respectively, with the top surface finished level with the surrounding existing sealed surface. ***Surfacing***

4. A waterproof seal shall be provided between the new and the old surfaces. ***Waterproof Seal***

404.39 TRAFFIC

1. The Contractor shall repair or replace any culvert damaged by construction backfill or Public Traffic in accordance with the requirements of Clause 404.36 'Damage', at no cost to the Principal. ***Damage***

2. Construction traffic with greater than legal wheel or axle loading, as defined by the Road Traffic (Vehicle Standards) Regulations 2002 shall not be permitted to travel over culverts.

404.40 CULVERTS

404.40.01 GENERAL

1. Batter slopes at culverts shall be evenly transitioned over a length of 10 m from the edge of the wingwall to match culvert wingwall slopes.

2. All culverts shall be constructed to the correct alignment and cross sectional shape and shall conform to dimensions, levels and other details specified or shown in the Drawings. ***Alignment***

3. Inlet and outlet invert levels shall be as shown in the Drawings plus or minus 10 mm. Inverts shall be smooth and of uniform gradient throughout each culvert length. ***Invert Levels Tolerance***

4. Any culvert which is not true to line, level or grade, or shows settlement after laying, or which is damaged during backfilling, compaction or subsequent operations, shall be removed by the Contractor and replaced at no cost to the Principal. ***Misalignment or Damage***

5. On completion of installation no diameter measured across the indelible markings on metal culverts shall differ from the supplied preinstalled dimension by more than 5 percent. Testing frequency shall be in accordance with Specification 201 QUALITY MANAGEMENT. ***Metal Culvert Diameter Tolerances***

6. Where shown on the Drawings, metal culverts shall be anchored to an in-situ concrete collar. ***Metal Culverts Anchorage***

7. All culverts shall be flushed clean from end to end on completion of the installation and maintained in proper working order for the duration of the Contract. ***Flushing***

8. Culverts shall be laid with the connections kept clean and shall be laid with the inverts true to the lines and levels shown on the Drawings and to the following tolerances:

   (a) Horizontal alignment ± 25 mm ± 25 mm

   (b) Vertical level ± 10 mm ± 10 mm

9. The Contractor shall seal the ends of the culverts with a temporary plug to exclude water, sand or other deleterious materials caused from work under the Contract unless otherwise approved by the Superintendent.

404.40.02 CONCRETE PIPE CULVERTS

1. Pipe laying shall proceed up-grade with the pipe sockets at the higher end of the pipes.

2. Rubber ring joints shall be lubricated in accordance with the manufacturer's recommendations. Pipe handling shall be carefully controlled to avoid disturbing the rubber ring and to ensure that it is free from dirt and other foreign materials. Any rubber ring so disturbed shall be removed, cleaned and re-lubricated before refitting. ***Rubber Rings***

3. Care shall be taken to properly align the pipe before the joint is forced home. During the jointing operation the pipe shall be partially supported in a suitable manner to minimise unequal lateral pressure on the rubber ring and to maintain concentricity until the rubber ring is properly seated. ***Jointing***

4. Flush jointed concrete pipes shall be installed in accordance with the manufacturer's recommendations, with the rubber jointing bands and pipe joints being kept free from dirt and foreign materials. ***Flush Joints***

5. The installation and jointing recommendations provided by the pipe manufacturer shall be followed at all times. Sufficient pressure shall be applied in making the joint to ensure proper seating and sufficient restraint shall be applied to ensure that the line does not creep until backfill material can be placed and thoroughly compacted around the pipe. At the end of the work day the last pipe shall be blocked in an effective manner to prevent creep. ***Manufacturer's Recommendations***

404.40.03 CONCRETE BOX CULVERTS

1. Unless otherwise detailed in the specification or Drawings, installation of all precast reinforced concrete boxes shall comply with the requirements of AS 1597.2 Section 5 – Installation. ***Concrete Boxes***

2. All box culverts shall be installed on a cast in-situ concrete base slab. Precast concrete bases shall not be used. ***In-situ Base Slabs***

3. Reinforced concrete box culvert units shall be placed in position on a mortar bed in accordance with the Drawings. Unless specified otherwise on the Drawings, cement mortar is to be 0.4 : 1, water : cement ratio by mass and 3 : 1, sand : cement ratio by mass.

4. **Cement stabilised backfill shall not be placed until the cement mortar used to seal culvert crown units has cured for 48 hours.** ***HOLD POINT***

5. The base slab construction for Box Culverts shall comply with the following requirements: ***Base Slab***

   (a) Dimensions shall be within 10 mm of those shown on the Drawings. Surface irregularities shall be less than 5 mm abrupt and 8 mm over a 3 metre straight edge. ***Tolerances***

   (b) No construction equipment or public traffic is permitted to travel or work on or over the concrete base slab within seven days of the placement of concrete in the base slabs. ***Traffic Use***

   (c) The Contractor shall not operate any plant directly on the concrete base slabs without prior approval from the Superintendent. ***Plant Use***

   (d) Reinforced concrete box culvert units shall not be placed on concrete base slabs within 24 hours of completing the concrete base slabs.

6. Box Culverts with a span of 1200 mm or greater shall have shear keys as shown on the Drawings and constructed in accordance with this specification. ***Shear Keys***

404.40.04 CORRUGATED STEEL PIPE CULVERTS

1. Installation of helical lock-seam corrugated steel pipes shall comply with the requirements of this specification, the Drawings, and AS 1762.

Helical Lock-Seam Corrugated Steel Pipes

2. Where corrugated steel pipes are to be cut in-situ to suit end treatments the cut surfaces shall be treated in accordance with Clause 404.36 'Damage' for damaged corrugated steel pipe.

404.40.05 CORRUGATED ALUMINIUM PIPE CULVERTS

1. Installation of corrugated aluminium pipes shall comply with the requirements of this specification, the Drawings and AS 1762.

Aluminium Pipes

404.41 EXISTING CULVERTS

404.41.01 REMOVAL AND BACKFILL

1. Where detailed on the Drawings, existing culverts shall be removed.

Redundant Culverts

2. Existing culverts nominated by the Principal as requiring demolition or removal that contain or potentially contain asbestos are nominated in Specification 203 HEALTH AND SAFETY MANAGEMENT. Management of these existing culverts shall be in accordance with Specification 203 HEALTH AND SAFETY MANAGEMENT.

Asbestos Containing Material

3. If an existing culvert does not contain Asbestos Containing Material and is deemed suitable for re-use by the Superintendent, it can be used for sidetracks. When the sidetrack is no longer in use, or if there is no sidetrack, removed culverts shall be stored or disposed of by the Contractor to the Contractor's disposal site, or an authorised waste disposal site or a site approved by the Local Government Authority.

Use of Existing Culverts for Sidetracks

4. Where damage to the concrete that exposes the reinforcement or any cracking which exceeds 0.1 mm wide occurs then those damaged culvert units shall be disposed of by the Contractor to the Contractor's disposal site, or an authorised waste disposal site or a site approved by the Local Government Authority. Minor chipping of the concrete may be repaired by the Contractor using an approved repair mortar and the culverts will be considered to be undamaged.

Damaged Fittings

5. If the removed culvert is not being replaced, the void remaining shall be filled and compacted with embankment material.

Backfilling

6. The embankment material shall be placed and compacted to the requirements for embankment construction in Specification 302 EARTHWORKS, with a frequency of testing in accordance with Specification 201 QUALITY MANAGEMENT.

404.41.02 LOW STRENGTH INFILL

1. Where indicated on the Drawings, redundant existing culverts and associated drainage structures located under roadways which are to be retained in their existing location shall be entirely filled in-situ in accordance with Specification 410 LOW STRENGTH INFILL. The open ends of any remaining pipe runs and apertures left in remaining drainage structures shall be permanently sealed off to exclude water, sand or other material. ***Low Strength Infill***

404.41.03 CULVERT EXTENSIONS

1. Construction of culvert extensions to existing culverts shall be in accordance with the relevant construction requirements for new culverts, except that extension of a culvert shall normally be completed before associated earthworks at the same location. ***Culvert Extensions***

2. Trench excavation for the culvert extension shall be carried out as required. Where the invert level of the culvert extension is lower than the existing ground level, the in-situ material shall be excavated to the width shown on the Drawings for new culverts.

3. Where the existing culvert is nominated in Specification 203 HEALTH AND SAFETY MANAGEMENT, prior to disturbing the existing culvert or endwall in any way, the Contractor shall adhere to the requirements of Specification 203 HEALTH AND SAFETY MANAGEMENT relating to Asbestos Containing Material. ***Asbestos Containing Material***

4. Where the existing culvert and culvert endwalls do not contain Asbestos Containing Material, the culvert endwalls shall be broken out as required and the old endwall material removed to spoil areas. Care shall be taken not to damage retained culvert conduit.

5. Unless shown otherwise on the Drawings, the existing culvert barrel shall be excavated back to a minimum of 500 mm from the end of the culvert. Prior to backfilling, the joint between the existing and the new conduit shall be masked with a suitable joint sealant in accordance with Clause 404.12 ‘Joint Sealant’.

6. The gradient of the culvert extension shall match the gradient of the retained portion of the existing culvert, or where required the extension shall be laid to a specified invert level. Culvert extensions shall be thoroughly jointed with the existing culvert so as to provide a continuous structure with no internal projections to impede the flow of water.

7. End treatments to extensions shall be constructed as for new culverts. ***End Treatments***

404.42 DAMAGE TO EXISTING STRUCTURES

1. Any damage to any culvert, end treatment or any other structure during the Contract shall be repaired by the Contractor at no cost to the Principal. ***Damage***

404.43 PEGGING OF CULVERTS

1. **Prior to any clearing at culvert locations, the Contractor shall peg the centreline of the culvert at the inlet and outlet inverts and peg the extent of the clearing required for associated Works for the Superintendents verification and adjustment as required.** ***HOLD POINT***

404.44 TRENCH EXCAVATION FOR CULVERTS

1. Except for culvert extensions, no culvert shall be laid until the embankment at the point of laying has been brought to a level 600 mm above all points along the top of the culvert, or to the subgrade level, whichever is the lesser, and compacted. Where pipes with spigot and socket joints are used then measurement shall be taken from the top of collar. ***Embankment Height***

404.45 END TREATMENTS

404.45.01 IN-SITU CONSTRUCTION

1. Unless otherwise shown on the Drawings, all culvert end treatments shall be constructed of cast in-situ concrete, or where applicable of mortared rock pitching in accordance with the Drawings. ***Construction***

2. The dimensions of the end treatments shall be within 10 mm of those shown on the Drawings when measured in accordance with AS 3610. ***Tolerances***

3. Surface irregularities of the concrete end walls, wing walls, cut off walls and aprons shall be less than 5 mm abrupt and 8 mm over a 3 metre straight edge. ***Surface Irregularities***

4. Unless otherwise shown on the Drawings, concrete shall be in accordance with Annexure 404A – Table 404A3 and shall conform to the requirements of Clause 404.09 ‘Reinforcement and In-situ Concrete’. ***Concrete***

5. Unless otherwise shown on the Drawings, mortar for mortared rock pitching shall comprise a 6 to 1 mix of builder’s sand and ordinary Portland cement, with all sand being from the same source. ***Mortar***

404.45.02 PRECAST CONCRETE END TREATMENTS

1. The use of commercially available precast end treatments shall not be permitted. ***Precast End Treatments***

404.46 FORMWORK

1. All formwork used to form and support the concrete shall conform to the requirements of Specification 821 FORMWORK. Associated requirements for false-work shall conform to the requirements of Specification 819 FALSEWORK.

2. The tolerances of formwork for concrete construction of all end treatments shall be as follows: ***Tolerances***

   (a) Variation in cross-sectional dimensions + 5 mm

   (b) Variation in overall dimensions + 10 mm

   (c) Variation in surface level + 5 mm

404.47 OUTLET DRAINS

1. Construction of culvert inlet and outlet drains shall be in accordance with the Drawings and Specification 402 SURFACE DRAINS AND LEVEES.

404.48 ROCK PROTECTION

1. Where shown on the Drawings, culverts shall have rock protection.

2. Unless otherwise shown on the Drawings, dimensions and class of rock for rock protection shall be as specified in the Culvert Schedule and shall be constructed in accordance with the requirements of Specification 406 ROCK PROTECTION. ***Rock Class***

404.49 DRAINAGE STRUCTURES

1. Supply and installation of drainage structures such as inlets, manholes and catchpits shall be in accordance with the Drawings and Specification 405 DRAINAGE STRUCTURES.

404.50 STORMWATER DRAINS

1. On completion of the entire system all pipes shall be flushed clean from end to end and left in proper working order. ***Flushing***

404.51 – 404.80 NOT USED

AS–BUILT AND HANDOVER REQUIREMENTS

404.81 AS-BUILT INFORMATION

1. As-Built Drawings shall include the following information for culverts:

   (a) Material type

   (b) Length

   (c) Culvert Skew Angle

   (d) Inlet and Outlet Invert Levels

   (e) Nominal diameter for pipes or span and height for RCBs

   (f) Number of barrels

404.82 – 404.90 NOT USED

CONTRACT SPECIFIC REQUIREMENTS

404.91 – 404.102 NOT USED

Refer to Guidance Notes

ANNEXURE 404A

CONSTRUCTION REQUIREMENTS

404A1 GROUND CONDITIONS (Clause 404.03)

1.1 In-situ ground conditions with respect to the manufacture and installation of culverts shall be classed in accordance with Table 404A1:

TABLE 404A1 IN-SITU GROUND CONDITIONS

Culvert Type and Material	Ground Condition / Exposure Class
Reinforced Concrete Pipe	Aggressive[1]
Reinforced Concrete Box	As per standard drawings for box culverts
Corrugated Steel Pipe	Aggressive
Corrugated Aluminium Pipe	Non-Aggressive
HDPE Pipe	Preferable for saline environments[2]

Delete the culvert types and conditions which are **not** applicable. **Refer also to Guidance Note 5**, and delete this note.

1.2 Requirements for culvert units installed in ground conditions identified as 'Aggressive' (refer to Table 404A1) shall be in accordance with Table 404A2:

TABLE 404A2 REQUIREMENTS FOR CULVERT UNITS INSTALLED IN AGGRESSIVE GROUND CONDITIONS

Culvert Type and Material	Requirements
Reinforced Concrete Pipe (all sizes)	Minimum cover to reinforcement shall be in accordance with AS/NZS 4058 for 'Marine' conditions
Reinforced Concrete Box (Span up to 1200mm)	(Refer to Guidance Note 5.2 for interim treatment options available to Project Managers. Insert the required treatment here and delete this note)
Reinforced Concrete Box (Span ≥ 1500mm)	(Refer to Guidance Note 5.2 for interim treatment options available to Project Managers. Insert the required treatment here and delete this note)
Corrugated Steel Pipe (all sizes)	(Refer to Guidance Note 5.3 for treatment options available to Project Managers. Insert the required treatment here and delete this note)

This table can be used for multiple types of culverts. Delete the culvert type which is **not** applicable and delete this note.

[1] Ground condition 'Aggressive' is described in clause 4.8 of AS 5100-2017.
[2] This will be subject to asset management/regional preference.

404A2 CONCRETE PIPE JOINTS (Clause 404.03)

2.1 The type of culvert joints to be supplied for Precast Reinforced Concrete Pipes shall be:

(a) Flush Joints

(b) Spigot and Socket Joint

Delete the joint type which is **not** applicable, and delete this note.

404A3 IN-SITU CONCRETE STRENGTH (Clause 404.09)

TABLE 404A3 IN-SITU CONCRETE STRENGTH FOR BASE SLABS AND END TREATMENTS

Culvert Type	Culvert Span / Diameter	Concrete Class[3]
Reinforced Concrete Box (RCB)	≤ 1200mm	N40
Reinforced Concrete Box (RCB)	> 1200mm	S50
Reinforced Concrete Pipe (RCP)	< 1500mm	N40
Reinforced Concrete Pipe (RCP)	≥ 1500mm	S50
Corrugated Steel Pipe (CSP)	< 1500mm	N40
Corrugated Steel Pipe (CSP)	≥ 1500mm	S50

Delete the type(s) and class(es) which is/are **not** applicable. **Refer also to Guidance Note 10**, and delete this note.

[3] Concrete class “N” or “S” type shall also depend on ground condition and exposure classification.

ANNEXURE 404B

PRECAST REINFORCED CONCRETE PIPES

GENERAL

404B.01 SCOPE

1. This Annexure is for the supply and delivery of precast reinforced concrete pipes. The Contractor must nominate the nominal effective length of the units with the tender.

404B.02 TERMINOLOGY AND STANDARDS

1. Unless otherwise specified, material and manufactured articles and workmanship shall conform to the relevant Australian Standards. Where conflict occurs between this Annexure and the relevant Australian Standard this Annexure shall take precedence.

PRODUCTS AND MATERIALS

404B.03 PRECAST UNITS

1. The pipes shall be manufactured, tested and accepted in accordance with the requirements of AS/NZS 4058, except where otherwise varied by this Annexure.

2. The pipes shall be manufactured to suit the in-situ ground conditions as specified in Annexure 404A – Table 404A1 in accordance with the requirements of Table 404A2. ***Ground Conditions***

3. The nominal internal pipe diameters to be supplied shall include those diameters between 300 mm and 4200 mm given in the Culvert Schedule and/or the Schedule of Rates. ***Pipe Diameter***

4. This Annexure applies to the following load classes as described in AS/NZS 4058: ***Load Classes***

   (a) Standard pipe classes 2, 3 and 4 are available as stock items.

   (b) Extra strength pipe classes 6, 8, 10 and 12 are also available from pipe manufacturers as required.

5. The Class of pipe shall be as shown on the Drawings.

6. The type of joints to be supplied shall be as specified in Clause 404A2. ***Joint Types***

7. Information to be supplied by the purchaser and the supplier shall be in accordance with AS/NZS 4058. ***Purchasing***

404B.04 REINFORCEMENT AND CONCRETE

404B.04.01 CONCRETE GENERAL

1. Concrete shall be cast and cured to produce a sound, dense and durable concrete.

2. Concrete shall have a surface finish equivalent to a steel trowel finish for internal surfaces. External surfaces shall have as a minimum a Class 3 finish in accordance with AS 3610. The internal and external surfaces of pipes shall not be coated unless otherwise specified. ***Surface Finish***

3. N-Class Concrete shall be produced in accordance with the requirements of Specification 901 and S-Class Concrete shall be produced in accordance with the requirements of Specification 820.

404B.04.02 REINFORCEMENT

1. Reinforcing steel shall conform with the requirements of Specification 822 STEEL REINFORCEMENT.

404B.05 JOINT MATERIALS

1. Where rubber joint rings are to be supplied by the Contractor, they shall comply with AS 1646. ***Rubber Joint Rings***

MANUFACTURE, HANDLING AND STORAGE

404B.06 COVER TO REINFORCEMENT

1. Unless otherwise stated in Annexure 404A – Table 404A2, the minimum concrete cover to reinforcement for precast pipes shall be in accordance with AS/NZS 4058 for ‘Normal’ environment.

2. Unless otherwise stated in Annexure 404A – Table 404A2, the minimum concrete cover to reinforcement for precast concrete box culvert and all other in-situ concrete element shall be in accordance with AS 5100.5 – 2017.

3. Nibs shall be supplied to all reinforcement spacers that intrude into the specified cover. Where pipes are spun or roller compacted then nibs shall be mild steel. Where pipes are wet cast then nibs shall be stainless steel. ***Nibs***

INSPECTION AND TESTING

404B.07 ROUTINE TESTING

1. The following specified tests are required in addition to those specified in AS/NZS 4058, Table 5.1:

   (a) Ultimate load

   (b) Water absorption

   (c) Cover

(d) Dimensional accuracy

(e) Joint assembly test (where appropriate)

2. Testing Procedures and Minimum Testing Frequencies shall be in accordance with Table 404B1.

3. Tests shall be carried out in accordance with AS/NZS 4058.

TABLE 404B1 MINIMUM TESTING FREQUENCY

The minimum testing frequency for materials used in concrete shall be in accordance with the requirement of Specification 201 QUALITY MANAGEMENT.

Process	Quality Verification Requirement	Minimum Testing Frequency
Precast Reinforced Concrete Drainage Pipes	Load Testing – as per AS/NZS 4058 and Clause 404B.07 of the specification	**In accordance with AS/NZS4058 Appendix A, Section A4.1 and A4.2**
	Cover to Reinforcement – as per AS/NZS 4058 and Clause 404B.06 of the specification	**In Accordance with AS/NZS 4058 Appendix A, Section A4.6**
	Inspection for Defects – as per AS/NZS 4058 and Clause 404B.08 of the specification	**Visual inspection all units**
	Absorption Testing – as per AS/NZS 4058 and Clause 404B.07 of the specification	**In accordance with AS/NZS 4058 Appendix A, Section A4.4**
	Dimensional Accuracy as per AS/NZS 4058	**In accordance with AS/NZS 4058 Appendix A, Section A4.7**
	Joint assembly Test as per AS/NZS 4058	**In accordance with AS/NZS 4058 Appendix A, Section A4.5**

404B.08 DEFECTS

1. Unless otherwise specified within this Clause, pipe defect types identified in AS/NZS 4058, Clause 3.4 ‘Workmanship and Finish’ shall not be acceptable. Selected Extracts from AS/NZS 4058, Table 3.6, are shown in the tables below.

2. Where specified below as Acceptable, finishing and repairs to defects shall be in accordance with AS/NZS 4058 Clause 3.4.

404B.08.01 PIPE WALL

1. The following Pipe Wall defects as defined in AS/NZS 4058, Clause 3.4 shall be deemed acceptable subject to the Acceptability of Defects shown below:

Defect	Acceptability
Type 1	Acceptable after repair
Type 2	Acceptable after repair
Type 4	Acceptable after repair
Type 5	Acceptable after repair

404B.08.02 JOINT SURFACE

1. The following Joint Surface defects as defined in AS/NZS 4058, Clause 3.4 shall be deemed acceptable subject to the Acceptability of Defects shown below:

Defect	Acceptability
Type 4	Acceptable after repair
Type 5	Acceptable after repair

404B.09 NON-CONFORMANCE

1. Pipes shall be deemed nonconforming when they fail to satisfy all the manufacturing and testing requirements of AS/NZS 4058 and this specification with modifications as specified in this Annexure. Non-conforming units shall be rejected and replaced at no cost to the Principal.

ANNEXURE 404C

PRECAST REINFORCED CONCRETE BOX CULVERTS

GENERAL

404C.01 SCOPE

1. This Annexure is for the supply and delivery of precast reinforced concrete box culvert sections. Nominal spans and heights of the precast units shall be as shown on the Drawings. The units shall be supplied in lengths of 1.2 m or 2.4 m. The Contractor must nominate the length of the units with the tender.

404C.02 TERMINOLOGY AND STANDARDS

1. The term ‘precast units’ where used in this Annexure shall include the precast reinforced concrete crown sections.

2. Unless otherwise specified material and manufactured articles and workmanship shall conform to the relevant Australian Standards. Where conflict occurs between this Annexure and the relevant Australian Standards this Annexure shall take precedence.

PRODUCTS AND MATERIALS

404C.03 PRECAST UNITS

1. For culvert units up to 1200 mm span the following shall apply:

   (a) Precast units have been designed by Main Roads and the minimum design requirements are detailed on Drawing Number 1930-0666.

   (b) Precast units shall be manufactured in accordance with the requirements of AS 1597.1, except where otherwise varied by this specification.

   (c) The recommended nominal internal dimensions for the 1200 x 1200 culvert units are:

      (i) 1200 mm width; and

      (ii) 1200 mm depth,

      in accordance with AS 1597.1, Figure 2.1. The effective waterways area shall not be less than 1.44 m^2.

   (d) The height of fill, including pavement, between the trafficable surface of the road and the top of the culvert unit, shall be in accordance with the Drawing Number 1930-0666.

2. For culvert units of 1500 mm span, the following shall apply:

   (a) Precast units have been designed by Main Roads and the minimum design requirements are detailed on Drawing Number 2030-2304.

   (b) Manufactured in accordance with AS 1597.2.

3. All precast concrete box units shall be manufactured to suit the in-situ ground conditions as specified in Annexure 404A – Table 404A1, in accordance with the requirements of Table 404A2.

4. The type of units required for the Contract are as listed in the Culvert Schedule or the Schedule of Rates/Bill of Quantities.

5. Tenderers shall submit with their Tender's full details of proposed concrete dimensions and reinforcement to meet the minimum design requirements as detailed on Drawing Number 2030-2304 (for spans 1500 mm and greater) and Drawing Number 1930-0666 (for spans up to 1200 mm).

6. Information to be supplied by the purchaser and the supplier shall be in accordance with AS 1597.2.

404C.04 FORMWORK

1. All formed concrete surfaces to the precast units shall have a smooth, dense and dust free concrete finish.

2. Form joint marks shall be unobtrusive and concrete surfaces shall be free from blowholes deeper than 5mm. The allowable extent of blowholes per unit area shall be as for Class 3 formwork in AS 3610. Maximum allowable surface irregularities shall be nil abrupt or 3mm over the width of the surface.

3. Form lubricants used shall be of the non-staining type and shall have no detrimental effects on the concrete.

4. The unformed surface of the precast units shall be wood floated to produce a uniform surface without surface pitting or cavities. Maximum allowable surface irregularities shall be nil abrupt or 5mm over the width of the surface.

5. For culvert units of 1500mm span and larger, the design of all formwork shall be in accordance with Specification 821 FORMWORK.

404C.05 REINFORCEMENT AND CONCRETE

404C.05.01 CONCRETE GENERAL

1. Concrete shall consist of a mixture of cement and water and coarse aggregate and fine aggregate. In its finished state concrete shall be sound and dense and durable and free from honeycombing and shall have the strength and other properties specified.

2. Precast reinforced concrete box culvert units shall be sampled and tested for water absorption in accordance with Appendix F of AS/NZS 4058. The calculated water absorption of each unit shall not exceed 6.5 percent.

3. All concrete shall be produced in accordance with the requirements of Specification 820 for S-Class or Specification 901 for N-Class based on the concrete class requirement.

404C.05.02 SECONDARY CEMENTITIOUS ADDITIVES

1. Cast in-situ structures including base slabs and end treatments, constructed in seawater or saline groundwater environments, shall use concrete containing 25% fly ash and at least 5% silica fume.

404C.05.03 ADMIXTURES

1. The use of admixtures in the concrete for the purpose of maintaining workability will be permitted. The use of admixtures for the purpose of reducing cement will not be permitted. If the Contractor proposes to use any admixtures in the concrete then details of these shall be submitted with the tender.

2. Any admixture to be used by the Contractor shall comply with the requirements of AS 1478.

3. Where specified in Annexure 404A – Table 404A2 the Contractor shall use culvert units containing an approved admixture in accordance with the following requirements:

   (a) Concrete shall contain a time-proven effective Hydrophobic Pore-blocking Ingredient (HPI) system, used strictly in accordance with the manufacturer's instructions and providing a hydrophobic cement matrix throughout, as well as dispersed polymer particles suitable for use as a pore- blocking agent.

4. The following hydrophobic pore-blocking ingredient system products are acceptable for use on MRWA projects: ***Approved HPIs***

   (a) Everdure Caltite (Cementaid) or similar approved product.

   (b) Admix C-5000 (Xypex) or similar approved product.

404C.05.04 REINFORCEMENT

1. Reinforcing steel shall conform to the requirements of Specification 822 STEEL REINFORCEMENT.

MANUFACTURE, HANDLING AND STORAGE

404C.06 CONCRETE

404C.06.01 MIX DESIGN

1. All S and N-Class concrete for the works shall be in accordance with the requirement of Specification 820 and Specification 901.

404C.06.02 TRIAL MIXES

1. If a Contractor has not previously supplied box culverts to Main Roads, or has changed the concrete mix design of any culverts, the Contractor shall submit details of the concrete mix design and shall, at the Contractor's own expense, prepare a trial mix for the required class of concrete using the plant to be used for concrete in the works.

404C.06.03 PLACING

1. Placing and compaction of concrete shall be in accordance with the requirement of Specifications 820 and 828.

404C.06.04 CURING AND PROTECTION

1. Curing of concrete shall be in accordance with the requirement of Specification 820 CONCRETE FOR STRUCTURES.

404C.07 REINFORCEMENT AND COVER

1. Reinforcement for the precast units shall be fabricated and fixed in accordance with the requirements of Specification 822 STEEL REINFORCEMENT.

2. Reinforcement in the areas of the haunches shall be well anchored to resist stresses which occur during manufacture, handling, transporting and installation of the precast units.

3. The minimum clear cover to the reinforcement for culvert units up to 1200mm span shall be as specified on Drawing Number 1930-0666.

4. The minimum clear cover to the reinforcement for culvert units 1500mm span and larger shall be as specified on Drawing Number 2030-2304.

5. Reinforcement shall be hard drawn steel wire or Grade 500N hot rolled deformed steel bars conforming to AS/NZS 4671. The minimum amount of main reinforcement shall be not less than 0.5% of the cross-sectional area of the walls or deck.

6. Where spacers or bar chairs are used to support reinforcement they shall be made of either plastic, concrete or stainless steel. No mild steel spacers shall be used.

7. For Culvert Units of 1500 mm span and larger with fill depths up to 4.5 metres the following additional requirements shall apply:

   (a) The Contractor shall detail the reinforcement to satisfy the requirements of this Annexure and Drawing Number 2030-2304.

   (b) The Contractor will be required to provide reinforcement to each face of the precast section. The minimum quantity of main reinforcement required at each face is given on the Drawings. The spacing between main reinforcing bars shall not exceed 200 mm.

   (c) Transverse distribution reinforcement is required to each face and shall not be less than 15 per cent of the main reinforcement taken over the same length. The spacing of the distribution reinforcement shall not

exceed 300 mm and the diameter of the bars shall not be smaller than 8 mm.

(d) Spot welding of the reinforcement for the sole purpose of cage fabrication will be allowed. The electrodes must be of the low hydrogen type.

(e) Where spacers or bar chairs are used to support reinforcement, they shall not be placed in zones of high stress in the corners and mid span regions.

404C.08 CASTING METHODS

1. The methods of manufacture shall be so designed to ensure that tolerances comply with AS 1597. The units shall be free from honeycombing and cracks and spalling. The ends of the units shall be free from any grout loss.

2. Moulds shall be designed to permit stripping without causing damage to the precast units.

3. Precast units shall not be removed from the casting mould until the concrete has attained compressive strength of not less than 15 MPa.

4. Each precast unit shall be suitably marked with a number and a date of casting and size dimensions. The concrete test specimens shall be marked with the date sampled and the batch they represent.

404C.09 HANDLING OF PRECAST UNITS

404C.09.01 LIFTING SYSTEM

1. The lifting system for the precast units shall be of the 'Swift-lift' type as marketed by Alan H Reid Pty Ltd, or Ramset ‘Pin Head Anchors’, or similar approved.

2. The number and size and location of the anchors to be cast into each precast unit shall be as specified by the manufacturer of the lifting system.

3. The Supplier shall provide a set of lifting slings with each truck load of units despatched from his Works for unloading the units at the specified delivery site. The lifting slings will remain the property of the Supplier and return with the delivery truck. Cranage for lifting the units at the site will be provided by the Supplier.

404C.09.02 HANDLING AND LOADING

1. The precast units shall be handled and loaded in such a manner so as not to cause damage to the units.

404C.10 DELIVERY AND STORAGE

1. Completed precast units shall not be transferred from the place of manufacture until:

   (a) For Culvert Units up to 1200 mm span – the 28 day minimum compressive strength of concrete has been achieved.

   (b) For Culvert Units 1500mm span or larger – the 28 day minimum compressive strength of concrete has been achieved. If an additional storage period has been specified then the units shall be stored at the Manufacturer's works for the nominated period and then delivered to site.

2. The Contractor shall be responsible for the supply and delivery of units to site and the condition of the precast units following delivery shall be in accordance with the requirements of this Annexure.

INSPECTION AND TESTING

404C.11 MINIMUM TESTING FREQUENCY

1. Testing Procedures and Minimum Testing Frequencies shall be in accordance with Table 404C3.

2. The minimum testing frequency for materials used in concrete shall be in accordance with the requirement of Specification 201 QUALITY MANAGEMENT.

TABLE 404C3 MINIMUM TESTING FREQUENCY

Process	Quality Verification Requirement	Minimum Testing Frequency
Precast Reinforced Concrete Boxes	Cover to Reinforcement - as per AS 1597 and Clause 404C.07	In accordance with AS 1597
	Inspection for Defects - as per AS 1597 and Clause 404C 12	Visual inspection all units
	Absorption Testing – methodology as per AS/NZS 4058, applied to RCBs	In accordance with AS/NZS 4058 Appendix A, paragraph A3.4
	Dimensional Accuracy as per AS 1597	In accordance with AS 1597

404C.12 DEFECTS

1. Defects in culvert units, links and base slabs shall be classified by type as identified in AS 1597.

2. The following defects shall be deemed acceptable subject to the Acceptability of defects shown below:

Defect	Acceptability
Type 1	Acceptable*
Type 4	Acceptable after repair

* For culvert spans 1500 mm and greater the acceptable crack width shall be no greater than 0.1 mm

3. No other defect types will be accepted.

4. Chipped sections shall be repaired to the equivalent of the original condition using an epoxy mortar approved by the Superintendent.

5. Surface cracks shall be measured using a feeler gauge.

404C.13 NON-CONFORMANCE

1. Culverts shall be deemed non-conforming if they do not meet the requirements of this Annexure and shall be rejected and replaced at no cost to the Principal.

GUIDANCE NOTES

FOR REFERENCE ONLY – DELETE GUIDANCE NOTES FROM FINAL DOCUMENT

1. All edits to this Specification are to be made using track changes, to clearly show added/ deleted text.

2. If **all** information relating to a clause is deleted, the clause number should be retained and the words **"NOT USED"** should be inserted.

3. The proposed document with tracked changes must be submitted to the Project Manager for review, prior to finalising the document.

4. Once the Project Manager's review is complete, accept all changes in the document, turn off track changes and refresh the Table of Contents.

5. The Custodian of this specification is Principal Design Engineer (Drainage).

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1. NON-HELICAL CORRUGATED STEEL PIPE (Clause 404.91)

1.1 Clause 404.91 shall be included under Contract Specific Requirements where non-helical corrugated steel pipe is to be used on a project.

2. PRECAST CONCRETE END TREATMENTS (Clause 404.92)

2.1 Clause 404.92 shall be included under Contract Specific Requirements where precast concrete end treatments are to be permitted on a project.

The Project Manager should be aware that precast concrete end treatments generally do not meet the geometric requirements shown on the Drawings. Advice should be sought from Main Roads' Structures Engineering Branch where, apron lengths, headwall heights, or wall thicknesses fall outside the dimensions shown on the Drawings.

3. CULWAYS (Clause 404.93)

3.1 Clause 404.93 shall be included under Contract Specific Requirements where Culways are to be installed.

4. STOCK AND FAUNA UNDERPASSES (Clause 404.94)

4.1 Clause 404.94 shall be included under Contract Specific Requirements where stock or fauna underpasses are to be installed.

5. GROUND CONDITIONS (Annexure 404A)

5.1 The ground conditions shall be classified as 'Aggressive' or' Non-Aggressive' to allow the correct culvert units to be supplied. Item 1 of Clause 404A1 should be completed accordingly (note that with the exception of Corrugated Aluminium Pipes the default ground condition is set as Aggressive). Aggressive ground conditions include environments where:

(a) for reinforced concrete pipes – the interior surface of the pipeline is subject to tidal flow, openly exposed to direct wave action or wind driven salt-spray, or where the

concentration limits applicable to some environmental constituents, detailed in AS/NZS 4058 Appendix E have been exceeded; or

(b) for reinforced concrete boxes – the exposure classification is defined as B2, C or U in accordance with AS 5100.5 Table 4.3; or

(c) for corrugated steel pipe – as detailed in AS/NZS 2041 Appendix C.

Where the chemical composition of the soil is unknown then guidance should be sought from Main Roads' Structures Engineering Branch. Where any doubt exists the default condition shall be set as 'Aggressive'.

5.2 On larger projects where it may be uneconomical to classify soil conditions along the entire length as 'Aggressive' then Clause 404A1 Item 1 should be amended as per the following example:

(a) The in-situ ground conditions with respect to the manufacture and installation of culverts shall be taken as 'Non-Aggressive' except for the following locations, which shall be taken as 'Aggressive'.

TABLE 404A1 LOCATIONS OF 'AGGRESSIVE' GROUND CONDITIONS

Chainage	Culvert Type and Material	Ground Conditions
12290-13000	RCP	Aggressive
13005-14130	CSP	Non-Aggressive

Additionally the above Table information should be provided on the Culvert Schedule under the column titled 'Ground Conditions'. This will assist in the management of the assets in the future. Note, it is intended to only include this information in one location and that should be in the Culvert Schedule. The existing Annexure Item 1 would therefore become:

(b) For details on ground conditions refer to Culvert Schedule.

5.3 Where culverts are to be used in 'Aggressive' ground conditions then direction on additional requirements should be inserted into Annexure 404A – Table 404A2 (under 'Requirements' column) as follows:

(a) For reinforced concrete pipes – default requirements has been inserted and is applicable only where the environment can be defined as 'marine' in accordance with AS/NZS 4058. Where the pipeline is openly exposed to wind driven salt-spray, or direct wave action, or where the environmental constituent limits as defined in AS/NZS 4058 Appendix E have been exceeded, then direction on minimum cover should be sought from the Concrete Pipe Association of Australia and inserted into Annexure 404A – Table 404A2 as applicable.

(b) For reinforced concrete boxes – the Project Manager has two options:

(i) Where the preferred method of protection is by concrete admixtures, add the following item to the Table:

'Culvert units shall contain an approved Hydrophobic Pore-blocking Ingredient (HPI) system in accordance with Clause 404C.05.05'.

Alternative products to those listed in Clause 404C.05.05 shall not be used. Manufacturers of alternative products shall make a submission to Main Roads' Structures Engineering Branch for acceptance and inclusion within the clause.

(ii) The Project Manager may choose to substitute reinforced concrete pipes or large span RCB units in place of small span RCB units. Where substituting with pipes the Project Manager should seek confirmation from the Designer that the pipe(s) have as a minimum the same hydraulic capacity as the box unit(s) they are replacing. Where any substitution is proposed there are no additional special requirements for Annexure 404A – Table 404A2.

(c) For corrugated steel pipes – the Project Manager has two options:

(i) Where the preferred method of protection is by means of a surface protection, details of the particular protection (i.e. brand name) should be added. Surface protection treatments shall be approved by Main Roads' Structures Engineering Branch prior to its use.

(ii) Where the preferred method of protection is by increasing the base metal thickness, then add the following Clause:

'All corrugated steel pipes shall have the base metal thickness increased to (…….) mm'. (insert base metal thickness here)

6. JOINT TYPE FOR RCPs (Annexure 404A, Item 2)

6.1 Select the required joint type for RCPs.

7. ANNEXURE 404C

8. BOX CULVERTS FOR STORMWATER DRAINS (Clause 404.95)

8.1 Clause 404.95 shall be included under Contract Specific Requirements where Reinforced Concrete Boxes (RCBs) are intended to be used for connecting stormwater drainage pits.

9. REINFORCEMENT DETAILS FOR BOX CULVERTS

9.1 Where box culverts are to be used then the following relevant Drawings must be included within the Contract documents:

(a) Where large culverts (Span ≥ 1500 mm) are used include Drawing No. 2030-2304.

10. IN-SITU CONCRETE CLASS FOR END TREATMENTS (Annexure 404A and Clause 404.96)

10.1 Where the Contract does not include any bridgeworks or there are not high numbers of culverts 1500 mm or greater then the requirement to use concrete class 'S50 to Specification 820 CONCRETE FOR STRUCTURES' for base slabs and end treatments of large pipes and box culverts may be relaxed. In this case Table 404A3 of Annexure 404A should be amended as follows:

TABLE 404A3 IN-SITU CONCRETE STRENGTH FOR BASE SLABS AND END TREATMENTS

Culvert Type	Culvert Span / Diameter	Concrete Class
RCBs and RCPs	All sizes	N40

10.2 Additionally, Clause 404.96 should be added to Contract Specific Requirements, which has the added benefit that the bulk of culvert contract documents may be reduced by not having to unnecessarily include Specifications 819 and 821.

11. PLASTIC FLEXIBLE CULVERTS (Clause 404.97)

11.1 Flexible pipes may be considered in remote locations where the cost of transport becomes prohibitive, due to their light weight, or where conditions are Aggressive, due to their inert nature to most naturally occurring chemicals.

11.2 Clause 404.97 should be added under Contract Specific Requirements where, the use of plastic flexible culverts, are permitted on a project.

11.3 Note that Section 2.0 'Minimum Testing Frequency' within Specification 201 QUALITY MANAGEMENT, will need to have the product/process 'Corrugated Metal Pipe' (under sub-section 2.3 'Drainage') amended to read 'Plastic Flexible Pipe'.

11.4 Unless otherwise recommended by the manufacturer, where plastic flexible culverts are to be used in ground conditions that would ordinarily be classified as 'Aggressive' for concrete culverts, Clause 404A1 (Annexure A) should be amended to "NOT USED". This is because the materials used in plastic flexible culverts are typically inert in such conditions.

11.5 Where in-situ concrete is proposed:

(a) N40 in-situ concrete used for pipe diameter with < 1500 mm.

(b) N50 in-situ concrete used for pipe diameter with ≥ 1500 mm

11.6 Alternative products to those listed in Clause 404.97.03 **shall not** be used. Manufacturers of alternative products shall make a submission to Main Roads' Structures Engineering Branch for acceptance and inclusion within the clause.

12. SUPPLY & DELIVERY OF RCPs (Annexure 404B and Clauses 404.98 and 404.99)

12.1 SUPPLY

Where the contract is for Supply & Delivery of Reinforced Concrete Pipes, Clause 404.98 should be added and Clause 404B.10 should be added to the end of Annexure 404B.

12.2 QUALITY SYSTEM REQUIREMENTS

Where Supply Contracts for RCPs incorporate Quality System requirements, Clause 404.99 should also be added and Clause 404B.11 should be added to the end of Annexure 404B.

13. SUPPLY & DELIVERY OF RCBs (Annexure 404C, and Clauses 404.100 and 404.101)

13.1 SUPPLY

Where the contract is for Supply and Delivery of Reinforced Concrete Boxes, Clause 404.100 should be added and Clause 404C.14 should be added to the end of Annexure 404C.

13.2 QUALITY SYSTEM REQUIREMENTS

Where, the Supply Contracts for RCB's incorporate Quality System requirements, Clause 404.101 should also be added and Clause 404C.15 should be added to the end of Annexure 404C.

14. DEWATERING (Clause 404.32.4)

14.1 Where the requirement for dewatering exists then Clause 204.94 in Specification 204 – ENVIRONMENTAL MANAGEMENT (Specification 204 Guidance Notes) shall be added to the Contract Specific Requirements of that document.

15. LOW STRENGTH INFILL (Clause 404.41.02 and Clause 404.92)

15.1 In certain situations such as road widening, redundant existing drainage located under the verge may ultimately become located under the roadway. If this occurs then Clause 404.102 shall be added to the Contract Specific Requirements of that document.

16. CONSTRUCTION TRAFFIC OVER CULVERTS (Clause 404.39)

16.1 The Superintendent may choose to allow construction traffic with greater than the legal wheel or axle loading to pass over culverts. Prior to approval the Contractor should provide suitable evidence stating that damage to the culvert unit(s) shall not occur, either in the form of:

(a) the culvert manufacturer's approval; or

(b) the outputs from the Concrete Pipe Association of Australia's 'Pipe Class' software.

17. SCHEDULE OF EXISTING CULVERTS THAT MAY CONTAIN ASBESTOS CONTAINING MATERIAL (ACM) IN SPECIFICATION 203 HEALTH AND SAFETY MANAGEMENT

17.1 In the schedule in Specification 203 HEALTH AND SAFETY MANAGEMENT include culverts that are being removed or substantially disturbed where the culvert is manufactured from a concrete (or similar) product (i.e. excluding circular steel pipes) and:

(a) there is reasonable grounds to believe that they were constructed in 2003 or earlier (refer to IRIS and/or As Constructed Drawings for further information); and

(b) testing of the culvert for ACM has not been conducted or testing has confirmed the presence of ACM.

17.2 For circular culverts, include diameters

17.3 For box culverts, include horizontal and vertical sizes.

17.4 In comments column, minimum detail should state whether testing for ACM has been conducted and if it has been conducted, confirm the presence of ACM, along with reference to further information.

CONTRACT SPECIFIC REQUIREMENTS

The following clauses are to be placed under the CONTRACT SPECIFIC REQUIREMENTS, as required. After inserting the clause, change the clause number and heading to style "H2 SP" so it appears in the Table of Contents.

404.91 NON-HELICAL CORRUGATED STEEL PIPE

1. Non-helical corrugated steel barrels shall either be a nestable or multi-plate bolted type.

2. Non-helical galvanised steel barrels shall conform to AS/NZS 2041.

3. Corrugation size for non-helical corrugated steel pipe shall be in accordance with Table 1.1 of AS/NZS 2041. ***Corrugations***

4. The Contractor shall ensure that the equipment used during compaction of backfill does not damage the culvert. Limitations on the type of compaction equipment, and cover to be provided to the top of the culvert shall be determined in accordance with AS/NZS 2041 for non-helical corrugated steel pipes. ***Compaction Equipment***

5. Installation of non-helical corrugated steel pipes shall comply with the requirements of this specification, the Drawings and AS/NZS 2041.

404.92 PRECAST CONCRETE END TREATMENTS

1. Where specified in the Culvert Schedule, the Contractor shall use precast concrete end treatments. The precast concrete end treatments shall comply with the following minimum requirements:

   (a) The end treatments shall be placed on a concrete bed consisting of Class N40 concrete, not less than 50 mm thick and be restrained against movement, including overturning.

   (b) Where not incorporated into the precast unit, the concrete bed shall be constructed with a 150 mm wide by 450 mm deep cut off wall unless otherwise specified in the Culvert Schedule.

404.93 CULWAYS

1. Backfill requirements for Culways shall consist of cement stabilised backfill as specified in Clause 404.10 – Cement Stabilised Backfill to the level of the top of box culvert. Where the cover to subgrade surface is less than 600mm then the backfill material over the culverts shall be basecourse quality. Where the cover to the subgrade surface is greater than 600 mm then the upper 600 mm layer of backfill material shall be basecourse quality and the remaining lower layer shall be sub base quality material to the required thickness. Basecourse and sub base quality material shall be in accordance with Specification 501 PAVEMENTS. Backfill over Culways shall be compacted in accordance with this specification.

404.94 STOCK AND FAUNA UNDERPASSES

1. Where reinforced concrete box culverts are to be used as underpasses for stock or native fauna then the approaches to both ends of the culvert shall consist of a 300 mm thick layer of embankment quality material to the dimensions and grades as shown on the Drawings.

404.95 BOX CULVERTS FOR STORMWATER DRAINS

1. The requirements of this specification applicable to Reinforced Concrete Boxes (RCBs) used as culverts also apply to RCBs installed to carry stormwater from drainage pits.

2. Stormwater drains consist of reinforced concrete pipes or reinforced concrete boxes connecting drainage structures such as inlets, manholes and catchpits as shown on the Drawings.

404.96 IN-SITU CONCRETE CLASS FOR END TREATMENTS

1. All formwork used to form and support the concrete shall conform to the requirements of AS 3610.

404.97 PLASTIC FLEXIBLE CULVERTS

404.97.01 GENERAL

Scope

1. The work to be executed under this specification consists of the supply and installation of plastic flexible pipes for use on Main Roads projects culverts only in accordance with AS/NZS 2566.2.

404.97.02 DEFINITIONS

1. Culverts shall also include fittings as recommended by the manufacturer.

404.97.03 PLASTIC FLEXIBLE PIPES AND FITTINGS

1. Plastic flexible pipes and fittings for use on Main Roads projects culverts are limited to Polyethylene (PE) only.

2. Polyethylene (PE) plastic flexible pipes and fittings shall be manufactured, tested and inspected in accordance with AS/NZS 4130 and AS/NZS 5065.

3. The structural design procedure shall be in accordance with AS/NZS 2566.1 and the Austroads Research Report AP-R575-18 Design of Buried Flexible Pipes.

404.97.04 JOINT SEALANTS AND JOINT TYPES

1. Joint sealants used for coupling of pipe segments shall be in accordance with AS/NZS 2566.2 Appendix F ‘Methods of Jointing’.

404.97.05 TRENCH EXCAVATION

1. Except for culvert extensions, no culvert shall be laid until the embankment at the point of laying has been brought to a level 600 mm above all points along the top of the culvert conduit, or to the subgrade level, whichever is the lesser, and compacted. Measurement shall be taken from the top of collar or in the case of flexible pipes with ribs from the top of the rib. ***Embankment Height***

404.97.06 DAMAGE

1. Plastic reinforced pipes shall be handled and installed in such a manner so as to prevent damage to the pipes. Damage shall be assessed in accordance with the Acceptance Criteria detailed in AS 2566.2. Where approved by the Superintendent, damaged units shall be repaired in accordance with manufacturer's requirements. Where damaged units are unable to be repaired then they shall be replaced at no cost to the Principal. ***Damaged Plastic Units***

2. Where approved by the Superintendent, minor damage to culverts may be repaired in accordance with the manufacturer's recommendations. ***Minor Repair***

404.97.07 COMPACTION

1. The Contractor shall ensure that the equipment used during the compaction of backfill does not damage the culvert. Limitations on the type of compaction equipment, and cover to be provided to the top of the culvert shall be determined in accordance with Clause 5.5.2 'Protection of Pipeline' AS/NZS 2566.2 and satisfy the manufacturer's published requirements.

2. Appropriate precautions, such as the use of holding down straps shall be taken to ensure that plastic pipe culverts barrels do not 'float' during the backfilling process, particularly during vibration of the backfill. ***Plastic Culvert 'Float' Precautions***

404.97.08 PIPE SHAPE POST INSTALLATION

1. Variations allowed in the internal diameter of installed culverts shall be in accordance with AS/NZS 2566.2. Testing frequency shall be in accordance with Specification 201 QUALITY MANAGEMENT.

404.97.09 HANDLING

1. Plastic flexible pipes shall be loaded, carted, unloaded and stored in accordance with AS/NZS 2566.2 Section 2 'Transportation, Handling and Storage'. Damaged pipes shall be assessed and repaired or replaced in accordance with AS/NZS 2566.2 Section 3 'Pipeline Components Acceptance Criteria' and the manufacturer's requirements at no cost to the Principal.

404.98 SUPPLY AND DELIVERY OF RCPS – DELIVERY

Insert the following clauses at the end of Annexure 404B, and delete highlighted text.

404B.10 DELIVERY

1. Batches of pipes for delivery which comply with AS/NZS 4058 manufacturing and testing requirements and the Technical Specification shall be acceptable for delivery.

404B.10.01 SUPPLY ONLY CONTRACTS

1. The Principal will give the Contractor two weeks notice of when pipes for Non-Aggressive environments will be required for delivery. The Principal will give the Contractor six weeks' notice of when pipes for Aggressive environments or for extra strength load classes (i.e. Load Class 6 and higher) will be required for delivery. Completion of any order will depend on the size of pipe and the number required and shall be agreed with the Principal when the order is placed.

2. The Principal will be responsible for delivering the pipes to site. The Contractor shall be responsible for loading the precast pipes onto the truck supplied by the Principal.

404B.10.02 SUPPLY AND DELIVERY CONTRACTS

1. The Contractor shall supply and deliver to site, and offload the pipes at the site when delivery is included in the Price Schedule.

2. The Principal will provide the Contractor with a minimum of two weeks notice prior to the required delivery date.

404.99 SUPPLY AND DELIVERY OF RCPS – QUALITY

Insert the following clauses at the end of Annexure 404B, and delete highlighted text.

404B.11 QUALITY SYSTEM REQUIREMENTS

404B.11.01 QUALITY SYSTEM REQUIREMENTS FOR CRITICAL SUBCONTRACTS

1. The subcontracts listed below shall require the subcontractor to have a Certified Quality System in accordance with Specification 201 QUALITY MANAGEMENT.

   (a) Cement

   (b) Aggregate

   (c) Reinforcement

   (d) RCP Rubber Joint Rings

404B.11.02 TRACEABILITY

1. Traceability shall apply to the following processes:

   (a) Concrete – the trace shall start at the batching plant at the start of manufacture.

   (b) Precast concrete drainage pipes – batches shall have a unique identification.

404B.11.03 PROCESS CONTROL AND SPECIAL PROCESSES

1. A copy of the following process descriptions or procedures shall be submitted to the Superintendent at least one week prior to commencing each work process.

   (a) Reinforcement – measures that ensure strict adherence to the requirements for cover to reinforcement in accordance with Clause 5 of the specification for the Supply of RCPs (Annexure 404B).

   (b) Concrete Manufacture – manufacturing procedures that ensure the production of a uniform quality concrete with minimum variation in workability and strength. Testing of the moisture content of the aggregate as dictated by weather and variations in the material supplied will be necessary to achieve this.

   (c) Concrete Transport, Placing and Curing – procedures for handling, placing and compaction of concrete that ensure the production of a sound and durable product.

404.100 SUPPLY AND DELIVERY OF RCB - DELIVERY

Insert the following clauses at the end of Annexure 404C, and delete highlighted text.

404C.14 DELIVERY

1. Batches of RCBs for delivery which comply with AS 1597 manufacturing and testing requirements and the specification shall be acceptable for delivery.

404C.14.01 SUPPLY ONLY CONTRACTS

1. The Principal will give the Contractor two weeks notice of when RCBs will be required for delivery. Completion of any order will depend on the size of RCB and the number required and shall be agreed with the Principal when the order is placed.

2. The Principal will be responsible for delivering the RCBs to site. The Contractor shall be responsible for loading the precast RCBs onto the truck supplied by the Principal.

404C.14.02 SUPPLY AND DELIVERY CONTRACTS

1. The Contractor shall supply and deliver to site, and offload the RCBs at the site when delivery is included in the Price Schedule.

2. The Principal will provide the Contractor with a minimum of two weeks notice prior to the required delivery date.

404.101 SUPPLY AND DELIVERY OF RCB – QUALITY

Insert the following clauses at the end of Annexure 404C, and delete highlighted text.

404C.15 QUALITY SYSTEM REQUIREMENTS

404C.15.01 QUALITY SYSTEM REQUIREMENTS FOR CRITICAL SUBCONTRACTS

1. The subcontracts listed below shall require the subcontractor to have a Certified Quality System in accordance with Specification 201 QUALITY MANAGEMENT.

   (a) Cement

   (b) Aggregate

   (c) Reinforcement

404C.15.02 TRACEABILITY

1. Traceability shall apply to the following processes:

   (a) Concrete – the trace shall start at the batching plant at the start of manufacture.

   (b) Precast concrete box culverts – batches shall have a unique identification.

404C.15.03 PROCESS CONTROL AND SPECIAL PROCESSES

1. A copy of the following process descriptions or procedures shall be submitted to the Superintendent at least one week prior to commencing each work process.

   (a) Reinforcement - measures that ensure strict adherence to the requirements for cover to reinforcement in accordance with Clause 404C.07 of the specification for the Supply of RCBs (Annexure 404C).

   (b) Concrete Manufacture - manufacturing procedures that ensure the production of a uniform quality concrete with minimum variation in workability and strength. Testing of the moisture content of the aggregate as dictated by weather and variations in the material supplied will be necessary to achieve this.

   (c) Concrete Transport, Placing and Curing - procedures for handling, placing and compaction of concrete that ensure the production of a sound and durable product.

404.102 REDUNDANT CULVERTS

1. Where indicated on the Drawings, any redundant culvert and associated drainage structure which are to be retained in its existing location shall be entirely filled in in-situ, in accordance with Specification 410 LOW STRENGTH INFILL. The open ends of any remaining pipe runs and apertures left in drainage structures shall be permanently sealed off to exclude water, sand or other material.

AMENDMENT CHECKLIST

Specification No. **404** Title: **CULVERTS** Revision No: _____

Project Manager: _____ Signature: _____ Date: _____

Checked by: _____ Signature: _____ Date: _____

Contract No: _____ Contract Name: _____

ITEM	DESCRIPTION	SIGN OFF
Note: All changes/amendments must be shown in tracked changes until approved.		
2.	Project Manager has reviewed the Specification and identified additions and amendments.	
3.	Standard clauses amended? **MUST SEEK** approval from Manager Contracts and Commercial Management.	
4.	Any unlisted materials/products proposed and approved by the Project Manager? If "Yes" provide details at 16.	
5.	Deleted clauses shown as **"NOT USED"**.	
6.	Ensure appropriate **INSPECTION AND TESTING** parameters are included in Specification 201 (test methods, minimum testing frequencies verified).	
7.	**AS-BUILT AND HANDOVER** requirements addressed.	
8.	**CONTRACT SPECIFIC REQUIREMENTS** addressed? Contract specific materials, products, clauses added? (refer Specification Guidance Notes).	
9.	**ANNEXURES** completed (refer Specification Guidance Notes).	
10.	Estimates Manager has approved changes to **SMM**.	
11.	Project Manager certifies completed Specification reflects intent of the design.	
12.	Independent verification of completed Specification arranged by Project Manager.	
13.	Project Manager's review completed.	
14.	**SPECIFICATION GUIDANCE NOTES** deleted.	
15.	**TABLE OF CONTENTS** updated.	
16.	**FOOTER** updated with Document No., Contract No. and Contract Name.	
17.	Supporting information prepared and submitted to Project Manager.	
Additional information or further action:		

Signed: _____ *(Project Manager)* Date: _____