TMS1731

CIVIL AND STRUCTURAL SPECIFICATION

Revision Table

Rev No.	Date	Document Status	Document Owner	Reviewer	Approver
4	27/11/2024	Issued for Use	Matt Foote RPEQ 10516	Mahesh Chandra	Daniel Wright

Revision History

Ver No.	Date	Version Details	Author
2	16/10/24	Issued for Use	Jon Hinde Miles Waller
2.1	20/11/24	Flood level correction, minor updates	Matt Foote
4	27/11/24	Update to revision number only to align with document system revision number, no changes to content	Matt Foote

DOCUMENT HISTORY

Doc No	Title	Revision	Date	Status
TMS1434	Technical Specification for Carbon Steel, Stainless Steel & Aluminium Structures	2	9/10/2019	Superseded
TMS1437	Technical Specification for Civil Works	2	9/10/2019	Superseded
TMS1439	Technical Specifications for Concrete Structures	3	6/4/2018	Superseded

Endorsement

Rev	Committee	Date
2	Technical Standards Committee	5/12/2022

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1. Purpose

This specification aims to provide suitable infrastructure to Urban Utilities in order to achieve its organisational policies including providing maximum value to its customers, providing a safe work environment to all persons and maximising benefit to the community through providing sustainable infrastructure and maximising economic value.

2. Objectives

This specification aims to achieve its purpose by providing the minimum technical requirements for the design, manufacture, fabrication, supply, installation and construction, maintenance, operation and demolition of Urban Utilities civil and structural works. This is to be achieved by:

- Providing a standardised approach to the design and construction of assets across the asset base leading to efficiencies of scale and reducing hazards to all persons including staff and contractors.
- Providing assets that achieve the desired design life with planned maintenance and avoiding failures and responsive maintenance work.
- Minimising safety impacts to staff, contractors and any other persons through compliance with all relevant standards and upholding best practice.
- Providing infrastructure which does not cause adverse or unexpected consequences to the general public and communities throughout the lifecycle.
- Utilising only proven technologies whilst being open to trialling emerging technologies to assess justification for long term adoption.
- Minimising environmental impact and enhancing the sustainability of infrastructure.

2.1 Scope

This specification applies to the design, manufacture, installation, testing, rehabilitation commissioning and demolition of Urban Utilities civil and structural infrastructure.

This specification is intended to complement any agreements between Urban Utilities and entities responsible for the delivery of required infrastructure, including but not limited to developers, delivery partners and successful tenderers.

This specification shall be read in conjunction with all relevant Urban Utilities technical specifications, industry codes, Australian and International standards, legislative and regulatory requirements, and any other relevant requirements.

The requirements of this document are subordinate to relevant legislation, regulations, Australian standards, and industry codes.

Table 2-1 outlines the applicability of this specification to water and wastewater infrastructure.

Table 2-1 Applicability Table

Asset area	Applicable (yes/no)
Dams and Earthen Storages	The *Treated Effluent Storage Lagoons Specification* TMS 1734 is applicable. Where TMS 1734 is silent with regards to the requirements for a particular application then the relevant sections of this specification shall apply.
Trunk Water Supply and Trunk Sewerage Mains	The *Trunk Water Main Code* TMS 1727 and *Sewerage Main Code* (under development at time of writing) are applicable for trunk services. Where TMS 1727 is silent with regards to the requirements for a particular design or

Asset area	Applicable (yes/no)
	construction element then the relevant sections of this specification shall apply.
Water and Sewage Treatment Plants	This specification is applicable.
Sewage Pumping Stations	The *SEQ Water Supply and Sewerage Design and Construction Code* amendment to the *Sewage Pump Station Code* WSA 04 is applicable. Where the *SEQ Water Supply and Sewerage Design and Construction Code* and WSA 04 is silent with regards to the requirements for a particular design or construction element then the relevant sections of this specification shall apply.
Drinking Water Reservoirs	The *Drinking Water Reservoirs Specification* TMS 1581 is applicable. Where TMS 1581 is silent with regards to the requirements for a particular design or construction element then the relevant sections of this specification shall apply.
Water Network **(Drinking water and non-drinking water reticulation)**	*SEQ Water Supply and Sewerage Design and Construction Code* amendment to WSA 03 is applicable. Where *SEQ Water Supply and Sewerage Design and Construction Code* and WSA 03 are silent with regards to the requirements for a particular design or construction element then the relevant sections of this specification shall apply.
Sewerage Network	*SEQ Water Supply and Sewerage Design and Construction Code* amendment to WSA 02 is applicable. Where *SEQ Water Supply and Sewerage Design and Construction Code* and WSA 02 are silent with regards to the requirements for a particular design or construction element then the relevant sections of this specification shall apply.
Recycled Effluent Water Systems **(recycled effluent water from treatment plants for irrigation and dual reticulation purposes)**	*SEQ Water Supply and Sewerage Design and Construction Code* amendment to WSA 02 is applicable. Where *SEQ Water Supply and Sewerage Design and Construction Code* is silent with regards to the requirements for a particular design or construction element then the relevant sections of this specification shall apply.

3. Definitions

Definitions of terms used in this document can be found in Table 3-1.

Table 3-1 Definitions

Item	Definition/description
Accountable Party	The entity identified as responsible for the respective check, authorisation, approval or acceptance of the particular associated work element as identified in the quality assurance documentation accepted by Urban Utilities. The Accountable Party may vary depending on the nature of the work element and may be Urban Utilities, an Urban Utilities representative, the Certifying Engineer or Contractor representative depending on the details of the quality assurance plan agreed for the works.
Buried Services	Consists of any underground services including pressure pipes, gravity pipes, conduits, cable pits, direct buried cables and cable trenches.
Contract	Any agreement between Urban Utilities and a Contractor.
Contractor	The entity responsible for the delivery, or part thereof, of the required infrastructure including design, manufacture, supply, installation, operation, maintenance and/or demolition. This may include, but is not limited to, a developer or the successful tenderer to a bid.
Certifying Engineer	The RPEQ engineer responsible for design and/or construction supervision verification of the associated infrastructure.
Fibre Reinforcement	Composite material of a polymer matrix reinforced with fibres.
Hardstand	A sealed (including concrete) or unsealed area used to store or park heavy vehicles or machinery.
Pre cast Concrete	Concrete members or products produced in advance at a factory or at a field production facility.
Project Documentation	Project Documentation is documentation that outlines the requirements of Urban Utilities infrastructure being established and may typically include a scope of works, design basis report, geotechnical reports, environmental reports, other technical reports, drawings, lists or schedules. This documentation will form part of the agreement between Urban Utilities and the entity responsible for the development of the relevant infrastructure.
Service	Infrastructure currently or previously used for the conveyance of service for public or private use, typically including telecommunications, electricity, sewerage, water, stormwater, gas and oil.
Structure	Road, embankment, tank, pipeline or other artefacts.

4. Abbreviations

Abbreviations used in this document can be found in Table 4-1.

Table 4-1 Abbreviations

Abbreviations	
ACM	Asbestos Containing Materials
AEP	Annual Exceedance Probability
AINDT	Australian Institute of Non-destructive Testing
AS	Australian Standard
AS/NZS	Australian and New Zealand Standard
ASTM	American Society for Testing and Materials
AWA	Australian Water Association
AWWA	American Water Works Association
BCC	Brisbane City Council
BS	British Standard
CBR	California Bearing Ratio
CIRIA	Construction Industry Research and Information Association
DTMR	Department of Transport and Main Roads
GITA	Geotechnical Inspection and Testing Authority
ISO	International Organisation for Standardisation
HDG	Hot dipped galvanised
IPAM	Infrastructure Products and Materials
ITP	Inspection and Test Plan
NACE	National Association of Corrosion Engineers
NATA	National Association of Testing Authorities
NDT	Non Destructive Testing
QUDM	Queensland Urban Drainage Manual
RPEQ	Registered Professional Engineer Queensland
RMS	Roads and Maritime Services
SEQ	South East Queensland
SP	Special Purpose
STP	Sewage Treatment Plant
WMS	Work Method Statement
WSA	Water Services Association of Australia
WSAA	Water Services Association of Australia

5. Standards, Codes and Regulations

All design, equipment and workmanship shall conform to the most recent requirements of the relevant statutory Local, State, and Commonwealth authorities and current applicable Australian Standards. Alternatively, where no Australian Standard exists, work shall conform to the most current and applicable International Standard or as agreed in the Project Documentation.

The below sections identify the standards, codes and regulations identified as most relevant to civil and structural works. This list may omit certain documents and accordingly the responsible Certifying Engineer, Contractor or other relevant entity shall undertake their own investigations to identify and ensure compliance with all relevant standards, codes and regulations.

5.1 Acts and Regulations

Current regulations and statutory requirements of the relevant Local, State and Commonwealth authorities shall be complied with, including those outlined in Table 5-1.

Table 5-1 Acts and Regulations

Act	Description
Work Health and Safety Act 2011 (Qld)	Provides a framework to ensure the health and safety of workers and workplaces
Work Health and Safety Regulation 2011 (Qld)	Prescribes specific requirements for hazards and risks to ensure the health and safety of workers and workplaces
Work Health and Safety Codes of Practice 2011 (Qld)	A practical guide to ensure the health and safety of workers and workplaces
Professional Engineers Act 2002 (Qld)	The act serves to protect the public by ensuring professional engineering services are provided by a registered professional engineer in a professional and competent way
Professional Engineers Regulation 2019 (Qld)	Prescribes specific requirements relating to the *Professional Engineers Act 2002* (Qld).
Environmental Protection Act 1994 (Qld)	Lists obligations and duties to prevent environmental harm, nuisances, and contamination along with setting the enforcement tools that can be used when offences or acts of non-compliance are identified
National Construction Code	A performance-based code that provides a minimum level required for safety, health, amenity, accessibility, and sustainability in relation to certain buildings
SEQ Water Supply and Sewerage Design and Construction Code	Provides a consolidation of design and construction standards for retail water supply and sewerage infrastructure for South East Queensland

5.2 WSAA and SEQ Codes

The Water Services Association of Australia (WSAA) codes of practice and the *SEQ Water Supply and Sewerage Design and Construction Code* (SEQ Code) shall be complied with for the applicable infrastructure as stated in this specification, including:

- *SEQ Water Supply and Sewerage Design and Construction Code.*
- *WSA Product Specifications for Products and Materials.*
- *WSA 201 Manual for Selection and Application of Protective Coatings.*
- *SEQ Code Infrastructure Products and Materials (IPAM) list*.

5.3 Urban Utilities Standards

Urban Utilities Procedures, Standards and Templates shall be adopted for the design and construction of civil and structural works. This includes the documents as outlined in the below tables. Refer to the Project Documentation for further identification of Urban Utilities Standards that are applicable to the scope of work.

Table 5-2 General Standards

Standard	Description
PRO84	Urban Utilities Risk Management Procedure
PRO307	Engineering Drawing and Document Management for Capital Project Delivery
PRO395	SEQ Water Supply and Sewerage - D&C Code Asset Information Urban Utilities Addendum
PRO662	Safety in Design Procedure
PRO752	Deviation From Technical Standards Procedure
STD117	Fall Protection and Safety Requirements for Liquid Retaining Structures - Design Standard Note
TEM183	Project Risk Assessments
TEM529	Template for Safety in Design Report (Appendix A)
TEM638	Template for Basis of Design Report
TEM641 Part B	Design and Construction Project Scope of Works Part B Standard General Specifications (This is a standard general specification to apply for infrastructure projects delivered under the Urban Utilities Program Management Approach)
TMS1654	Engineering Documentation Naming Requirements
TMS76	Supplement to the WSA 201 - Manual for Selection and Application of Protective Coatings

Table 5-3 Civil and Structural Standards

Standard	Description
TMS1734	Treated Effluent Storage Lagoons Specification
REF775	Trench Plate Design Quick Reference Guide
TMS1435	Technical Specification for Design and Construction of Water and Sewerage Main Systems

Standard	Description
TMS1581	Drinking Water Reservoirs and Tanks Specifications
TMS1582	Specification for Horizontal Directional Drilling (HDD)
TMS1583	Microtunnelling & Pipejacking Specification
TMS1719	Sewer Relining Technical Specification
TMS1720	Maintenance Hole Rehabilitation Specification
TMS1727	SEQ Water Supply and Sewerage - D&C Code - Urban Utilities Trunk Water Code Addendum
TMS176	Security Design Guidelines

Table 5-4 Mechanical Standards

Standard	Description
TEM688	Water Booster Pumping Station (BOD)
TEM687	Sewage Pumping Station (BOD)
TMS1636	Sodium Hypochlorite Storage and Dosing System (Standard Specification)

Table 5-5 Electrical and Instrumentation Standards

Standard	Description
TMS1200	Electrical Installation Specification
TMS1188	Transportable Switchroom Technical Specification

Table 5-6 Environmental Standards

Standard	Description
STD146	Air, Dust and Odour Environmental Standard

5.4 Other Relevant Specifications

Other relevant specifications not mentioned previously in this section are shown in Table 5-7.

Table 5-7 Other Relevant Standards

Standard	Description
Austroads Guide to Road Design	A guide providing road designers with a framework that promotes efficiency in design and construction to achieve economy and consistency.
BCC Urban Management Division, Subdivision and Development Guidelines Part B	Standards for Brisbane City Council (BCC) infrastructure including earthworks, roads, stormwater, streetscape, bridges and public utilities.

6. General Design Requirements

6.1 General

The design must achieve all performance requirements outlined in the Project Documentation and any other relevant requirements including those related to durability, safety, serviceability, restorability, maintenance, environment, landscape and economy. The design documentation must demonstrate the achievement of all Urban Utilities' requirements.

The design shall provide information necessary for construction, operation, maintenance and demolition, including construction methods, placement requirements, maintenance procedures and operational procedures.

6.2 Referenced Documents

The documents listed in Table 6-1 are either referenced, or shall be read in conjunction with, Section 6 of this specification.

Table 6-1 Referenced Documents

Reference	Description
Australian Standards	
AS/NZS 1170	Structural design actions
AS/NZS 3500.1	Plumbing and drainage Part 1: Water services
AS/NZS 3500.2	Plumbing and drainage Part 2: Sanitary plumbing and drainage
AS/NZS 3500.3	Plumbing and drainage Part 3: Stormwater drainage
AS/NZS 4020	Testing of products for use in contact with drinking water
Codes	
QUDM	Queensland Urban Drainage Manual
SEQ Code	SEQ Water Supply and Sewerage Design and Construction Code
Urban Utilities	
PRO84	Urban Utilities Risk Management Procedure
PRO662	Safety in Design Procedure
PRO752	Deviation Management Procedure
TEM641	Part B Standard General Specifications

Safety in Design processes shall be incorporated into the design in accordance with requirements of Urban Utilities procedures, relevant acts, regulations, Australian standards, and industry codes of practice.

The Urban Utilities *Safety in Design Procedure* (PRO662) provides guidance on Urban Utilities' minimum Safety in Design requirements, including:

- HAZID, HAZOP, and CHAIR workshops.
- Project risk assessments.

- Urban Utilities templates.
- Reporting.

6.3 Aesthetics

The design of Urban Utilities infrastructure which is within public spaces must minimise detrimental aesthetic impacts.

Where above-ground infrastructure within a streetscape or open space of community importance may be aesthetically detrimental to the extent of generating complaints or objection, the design activities must include a detailed aesthetic assessment. The assessment shall incorporate the advice of an experienced urban designer to assist with identifying the potential impacts and appropriate mitigating design features.

All infrastructure shall be aesthetically sympathetic to its zone. The Contractor must arrange with staff from the development services function of the relevant council for a pre-lodgement meeting and obtain written feedback for the proposed design.

Where planting is required, the Contractor shall engage a landscape architect to produce a landscaping detail and rehabilitation plan. The plan shall consider amenity, lifecycle establishment and maintenance. The plan must include detailed layouts suitable for construction including surface types, planting species and numbers.

6.4 Durability

6.4.1 Design Life

Where the design life is not specified in the Project Documentation then the applicable minimum design life stated in Table 6-2 shall apply.

Table 6-2 Minimum Design Life

Component	Minimum Design Life
Bitumen and asphalt surface treatments	10 years
Road pavements (where a surface treatment has been provided)	40 years
Concrete liquid retaining structures	100 years
Stormwater drainage	100 years
Concrete pavements	40 years
Other Concrete structures (e.g. valve chambers)	100 years
Metal reservoirs	50 years
Metal structures	50 years
Masonry blockwork	50 years
Buildings	50 years

Where brownfield site upgrades are required, Urban Utilities seeks to maximise the residual life of existing assets. The re-use and integration with new structures and equipment must be considered as part of the design. In such cases, a condition assessment is required to verify the

assets' suitability and that its residual life is adequate as determined by the project documentation.

6.4.2 Corrosive Environment

Corrosive environments occur where chemicals with a deleterious effect on materials are present. These include, but are not limited to:

- Areas within 2km of the sea shore (saltwater).
- High salinity, high groundwater environments (saltwater).
- Sewage treatment plants (H_2S gas).
- Sewage pumping station wet wells (H_SS gas).
- Corrosive chemical storage and dosing areas (various chemicals).
- High humidity, poorly ventilated rooms, chambers, dry wells etc.
- Maintenance holes in the circumstances described within the SEQ Code.

The Certifying Engineer shall consider the effect of these environments and implement any additional measures necessary to mitigate their effects.

6.5 Loads

6.5.1 General

The Certifying Engineer must identify all imposed loads required for the relevant structure, including but not limited to the following loads:

- Permanent, imposed, wind and other actions (AS/NZS 1170 *Structural Design Actions*).
- Temporary, occasional, cyclic and permanent loads.
- Hydrostatic Pressure Loading.
- Lateral soil loads.
- Vibration loads.
- Dynamic loads
- Thrust loads.
- Flotation.
- Earthquake.
- Surcharge loads.
- Thermal.

6.5.2 Stability

Structural stability checks must be carried out in accordance with the requirement of AS/NZS 1170.0.

Buoyancy checks must be carried out for all structures below ground level or that may be subject to water table variation or be potentially inundated by water. Buoyancy forces must be resisted by self-weight, the provision dead weight load or the soil on any toe in accordance with AS/NZS 1170, but not on soil adhesion. The provision of pressure relief or pop up valves may be considered in non sewerage applications in certain circumstances, subject to Urban Utilities acceptance.

6.5.3 Minimum Imposed Loads

Unless specified otherwise in the Project Documentation the minimum imposed loads for design must comply with Table 6-3.

Table 6-3 Minimum Imposed Loads

Location	Minimum Imposed Load
Storage Room	4 kPa
Control Room	5 kPa
Equipment Room	8 kPa
Platforms and Walkways	In accordance with AS 1657 and minimum of 4.0 kPa
Vehicle traffic	SM1600 to AS 5100.2
Metal Roof, not accessible except for maintenance	To AS/NZS 1170.1 with minimum of 0.5 kPa
Metal roof, designated areas for walkways and platforms.	2.5 kPa

In all other respects loads shall comply with the requirements of AS/NZS 1170.

6.5.4 Importance Level

Unless specified otherwise in the Project Documentation, the "Importance Level" as identified in AS 1170.0 and the *National Construction Code* must be in accordance with Table 6-4.

Table 6-4 Importance Level for Structures

Structure type	Importance level
Drinking water reservoirs and water supply infrastructure	3
Wastewater facilities	3

6.6 Design Investigations

The Certifying Engineer is responsible for the substantiation and verification of all design information used for their design.

Where applicable to the civil and structural works, refer to 8.3, 8.4, 8.5 and TEM 641 *Part B Standard General Specifications* Section 3.5 for requirements, including requirements for Dilapidation Survey, Design Review of Existing Structures, Geotechnical Investigation, Geospatial Engineering and Survey and Survey of Existing Services/Infrastructure.

The Certifying Engineer must identify and incorporate all existing underground services into the detailed design. The location of existing underground services shall be established using a variety of measures including, as a minimum, existing site layout drawings, *Dial Before You Dig* drawings and the use of underground services locating instruments operated by suitably qualified and experienced operators. Potholing must be undertaken for underground services which are critical to the detailed design, unless otherwise agreed by Urban Utilities. The

Certifying Engineer must consult with the affected service authorities for any special requirements and approvals.

6.7 Stormwater Drainage and Flooding

Where appropriate or required by the Project Documentation, the design shall include stormwater drainage including roof drainage, surface drainage and piped drainage in accordance with the provisions of the *Queensland Urban Drainage Manual* (QUDM) and the following:

- Estimated stormwater design flows using the methodologies described in the QUDM.
- Roof and allotment drainage for Urban Utilities sites designed to cater for the 5% AEP storm flows (Level IV QUDM).

Where QUDM requires any other specific provisions to be nominated by the user and they are not specified in the Project Documentation, the Contractor must refer them to Urban Utilities for agreement.

The stormwater drainage design must ensure that infrastructure is protected from inundation and the adverse effects of stormwater flows to the specified design standard. The stormwater system shall be designed to prevent nuisance, undue maintenance or damage to the environment due to stormwater. Refer to the local Council for advice on the lawful point of discharge to their stormwater system.

The stormwater drainage design shall consider the potential for overflows or spills from the associated site and incorporate mechanisms to minimise the impact of such events.

Stormwater drainage systems for roads shall be designed in accordance with the QUDM guidelines and as required by the responsible Council or DTMR, as applicable.

A post-construction CCTV camera survey and report shall be provided to Urban Utilities for all buried stormwater pipes unable to be internally inspected. The survey and report shall be provided prior to handover and clearly demonstrate that the stormwater system is compliant with the requirements.

6.7.1 Flooding

All buildings shall be positioned such that their floor levels are at least 300 mm above the currently-determined 1% AEP Event (i.e. 1 in 100 year flood level), or as required under Council planning provisions, whichever is higher.

Unless otherwise accepted by Urban Utilities, civil and structural provisions for all electrical, instrumentation and control equipment (except those which can sustain permanent inundation) must position this equipment at least 300 mm above the 1% AEP level.

Structures and process equipment including, pits, pumps, tanks, chambers and switchboards shall be positioned away from local stormwater flow paths, elevated at least 100 mm above the natural surface level.

The protection level for all infrastructure not identified above will be subject to acceptance by Urban Utilities.

While this specification establishes minimum elevation requirements based on current flood data, users must also consider potential changes in future flood levels due to climate change when determining the appropriate elevation for electrical and other inundation sensitive assets. As per the Urban Utilities' Climate Change Adaptation Strategy and Principles (in development), this includes consideration of the best available projected future 1% AEP flood levels under different climate change scenarios over the expected asset life, plus at least an additional 300mm freeboard as per the current specification. Users must make a best value decision based on the information available, balancing the cost of additional protection measures against the potential consequences of equipment failure during and after flood events. For further guidance on different climate change scenarios and adaptation options, see the Climate Change Adaptation Manual (in development).

6.7.2 Stormwater

Stormwater systems servicing surface runoff within Urban Utilities properties shall be designed in accordance with the *Brisbane City Council Standard Specification* S160 Drainage or as required by the relevant road authority, noting the following:

- Flexible pipes, polyethylene pipes and uPVC pipes are subject to prior approval by Urban Utilities.
- Stormwater entry directly into stormwater gully pits is not permitted, unless agreed by the relevant council.

Stormwater pipes shall be a minimum of 375 mm diameter and of pre-cast reinforced concrete construction.

6.7.3 Roof Drainage

Roof drainage systems for buildings and other structures (i.e. pits, chambers and other similar structures) shall be in accordance with AS/NZS 3500.3, unless otherwise directed by Urban Utilities.

Roof drainage pipes shall be:

- uPVC pipes with minimum 150 mm diameter DWV type with minimum stiffness rating SN8 but of an appropriate higher class where subject to vehicular loads.
- minimum cover of 600 mm but an appropriately greater depth and/or higher class where subject to vehicular loads.
- rubber ring joint type unless above ground.
- installed with a minimum of 1% fall with no low points.
- Designed with rocker pipes at all entry and exit points to rigid structures.

- designed with an access chamber or inspection point provided at all changes in direction. Each inspection points shall suitable, accessible and safe for cleaning using rodding equipment.
- of length no greater 40 m between access or inspection points.

6.8 Approvals

An Urban Utilities *Site Access, Tenure, Environment and Planning* (STEP) assessment (Urban Utilities Ref FOR325) or Urban Utilities *Quick Site Access, Tenure, Environment and Planning* (Quick STEP) assessment (Urban Utilities Ref FOR606), as appropriate, must be undertaken for all projects to identify the various planning and environmental considerations and statutory approvals before commencing construction.

This assessment will include identification of statutory approvals and mechanism for protection of significant cultural heritage and protected flora and fauna.

7. Masonry

7.1 Scope

This section applies to the requirements for masonry structures and supplements AS 3700 *Masonry Structures* and the *National Construction Code*.

All masonry structures must be temporarily supported where required during construction.

7.2 Referenced Documents

The documents listed in Table 7-1 are either referenced, or shall be read in conjunction with, this section.

Table 7-1 Referenced Documents

Reference	Description
Australian Standards	
AS 1170	Minimum design loads on structures
AS 1316	Masonry cement
AS 1672	Limes and limestones
AS/NZS 2699	Built-in components for masonry construction
AS 2870	Residential slabs and footings
AS/NZS 2904	Damp proof courses and flashings
AS 3700	Masonry structures
AS 3972	Portland and blended cements
AS/NZS 4455	Masonry units, pavers, flags and segmental retaining wall units
AS 4678	Earth Retaining Structures
AS 4773	Masonry in small buildings

7.3 Clay Masonry

Design and construction of clay masonry shall comply with the following additional requirements unless specified otherwise.

- Face fixed veneer ties to be screw fixed.
- Joints to be tooled.
- Control joints to be provided as detailed in the foundation design.
- Strength f'_{uc} = 12 MPa.
- Salt resistance grade.
- Mortar Type = M3.
- Mortar nominal thickness = 10 mm.
- Core filling grout to brick piers = 20 MPa.
- Wall ties = Medium duty.
- Durability classification = R4 (stainless steel).

- Fixing = Embedment in mortar 50 mm minimum.

7.4 Blockwork

Design and construction of blockwork shall comply with the following additional requirements unless specified otherwise in the Project Documentation.

- Blocks to AS/NZS 4455.
- Compressive strength 15 MPa.
- Grout compressive strength 20 MPa, aggregate 10 mm and slump 230 mm.
- Mortar admixtures to AS 3700 Clause 10.4.2.4.
- Lime to AS 1672.1.
- Portland cement to AS 3972 Type GP.
- Mortar mix M3 cement, lime, and sand ratios (by volume) 1:0:4.
- Block construction to AS 3700 Table 11.1.
- Joints thickness 10 mm.
- Provide purpose made cleanout blocks at the base of each grouted core. Locate cleanout blocks on side of wall to be concealed. Clean cores to dislodge mortar fins protruding from the blocks and mortar droppings from reinforcement. Remove through cleanout blocks.
- Grouting must not commence until grout spaces have been cleaned out and the mortar joints have attained sufficient strength to resist blow-outs. Wet down the hollow cores before grouting. Limit the height of individual lifts in any pour so the grout can be thoroughly compacted to fill all voids and confirm bond between grout and masonry. Compact grout by vibration. Top up the grout after 10 minutes to 30 minutes on completion of the last lift and vibrate to mix with the previous pour.
- Backfill behind the retaining wall to be controlled fill Class II in accordance with AS 4678.
- Backfilling not to commence until the retaining wall has achieved its full design strength.
- Backfilling and compaction to be completed without damaging the drainage system and the retaining wall.
- Drainage system behind the wall to be installed and to the manufacturer's specification. Filter layer to be stopped 200 mm below the finished ground level.
- Clean all cores after each day's laying.
- Control joints to be provided in accordance with Table 7-2 with a maximum of 6.0 m centres.

7.5 Articulated Masonry

Design and construction of articulated masonry shall comply with the following additional requirements unless specified otherwise.

- The design is based on masonry articulation joints being installed unless noted otherwise on the foundations and slabs.
- Articulation joints shall be located where new brickwork joins old brickwork.

- A slip joint around the lintel is required where an articulation joint is beside openings with brickwork above.
- The articulation joint is to continue between the window/door frame and the brickwork to the full height of the wall. The frames are to be fixed with fasteners that allow movement of the joint.
- The maximum spacing of joints and articulation joints to AS 4773 for unreinforced masonry unless noted otherwise. Refer AS 2870 for definitions. Use shorter spacing for HD sites.

Table 7-2 Articulated Masonry Joints

Site Classification	Construction and Surface Finish	Joint Spacing for Walls Less Than 4 m High (m)	Joint Spacing for Walls Greater Than 4 m High (m)
A & S	Not required	-	-
	External face finish	6.0	4.2
	External rendered/painted	5.5	3.9
M, M-D	Internal face finish	6.0	4.2
	Internal rendered/painted	5.5	3.9
	External face finish	5.0 to 5.5	3.5 to 3.9
H1, H2	External rendered/painted	4.5 to 5.5	3.2 to 3.5
H1-D	Internal face finish	5.0 to 5.5	3.5 to 3.9
H2-D	Internal rendered/painted	4.5 to 5.0	3.2 to 3.5
P, E, E-D	Refer to Engineer	-	-

8. Earthworks

8.1 Scope

This specification covers the minimum requirements for the materials, construction and acceptance testing of earthworks.

8.2 Referenced Documents

The documents listed in Table 8-1 are either referenced or shall be read in conjunction with this section of the specification. Where not otherwise specified, earthworks and the inspection and testing thereof shall be carried out in accordance with the requirements of AS 3798.

Table 8-1 Referenced Documents

Standard	Title
Australian Standards	
AS 1289	Methods for testing soils for engineering purposes
AS 1726	Geotechnical site investigations
AS 3706	Geotextiles
AS 3798	Guidelines on earthworks for commercial and residential developments
AS4133	Methods of testing rocks for engineering purposes – General requirements and list of methods
AS 4678	Earth-retaining structures
AS 5488	Classification of Subsurface Utility Information (SUI)
International Standards	
ISO/IEC 17020	Conformity assessment – requirements for the operation of various types of bodies performing inspection
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories
Brisbane City Council Specifications	
S 140	Earthworks
Codes	
SEQ Code	SEQ Water Supply and Sewerage Design and Construction Code
QDC MP 1.4	Queensland Development Code – Building over or near relevant infrastructure
Workplace Health and Safety Queensland	Excavation Work Code of Practice
WSA PS-355	Water Services Association of Australia- Product Specification - Geotextile filter fabric
Department of Transport and Main Roads	
MRTS04	General Earthworks

Standard	Title
MRTS16	Landscape and revegetation works
MRTS27	Geotextiles (separation and filtration)
MRTS100	High Strength Geosynthetic Reinforcement in Road Embankments
Urban Utilities	
FOR325	Standard Urban Utilities Site Access, Tenure, Environment and Planning (STEP) Assessment
FOR606	Standard Urban Utilities Quick Site Access, Tenure, Environment and Planning (STEP) Assessment
TEM641	Part B Standard General Technical Specification
TEM715	Geotechnical Investigation - Interpretive Report Template
TMS1435	Technical Specification for Design and Construction of Water and Sewerage Main Systems

8.3 Geotechnical Investigations

Where required by the Project Documentation, geotechnical investigations must be undertaken in accordance with AS 1726. The geotechnical investigation type, number and location are to be decided as recommended by the Certifying Engineer. The interpretive report associated with the investigation must meet the requirements set out in the TEM715 *Geotechnical Investigation - Interpretive Report Template*.

8.4 Geotechnical Inspection and Testing

An independent geotechnical inspection and testing authority (GITA) must undertake inspection and testing of earthworks on a Level 1 basis as described in AS 3798, Clauses 8.2 and 8.4.

The GITA shall be NATA accredited for all inspection (under ISO/IEC 17020) and testing (under ISO/IEC 17025) required.

The Contractor must submit a detailed report with the design deliverables, which includes all geotechnical data and its interpretation by the Certifying Engineer (RPEQ Geotechnical Engineer) to the extent necessary to form the basis of design. The Certifying Engineer is entirely responsible for identifying the need for; and performing all necessary or reasonable geotechnical and associated investigations, sampling, testing, reporting and consequential activities for the purposes of verifying the geotechnical assumptions applied for the works.

Detailed design must use the recommendations within the geotechnical report and the 'issued for construction' drawings must specifically tabulate the values adopted for the design. The detailed design must not be based on geotechnical assumptions not justified within the geotechnical report. The Certifying Engineer must verify the reliability, accuracy and adequacy of any existing information in relation to all ground conditions described in the report. The responsible Certifying Engineer must determine and obtain sufficient soil/rock samples to allow

for cross checking of the values obtained and suitability for use as a basis for detailed design. The Contractor must validate the adopted design values during construction of the works and should inconsistent values be identified, the Certifying Engineer must revise the design to the extent necessary and resubmit the revised design to Urban Utilities for consideration of design amendment.

8.5 Geospatial Engineering and Survey

The Contractor must identify the need for, and perform all necessary or reasonable engineering surveys required to, complete the works or as required by Urban Utilities.

Cadastral surveys must be carried out by a person licensed as a Cadastral Surveyor by the Surveyors' Board of Queensland. All survey data must be provided as a separate deliverable to Urban Utilities as part of the design deliverables.

Before commencing construction, the Contractor must:

- verify the horizontal and vertical alignment of all underground services potentially affected by the works.
- liaise with the relevant service authorities to locate all buried services and obtain all necessary permits and clearances.

The location of existing underground services should draw upon a variety of measures, including as a minimum, existing site layout drawings, *Dial Before You Dig* drawings and the use of underground services locating instruments operated by suitably qualified and experienced operators. Potholing must be used for underground services which are critical to the works, unless agreed otherwise by Urban Utilities.

Except where the Project Documentation requires otherwise, the accuracy of all surveys must at least comply with the requirements of the SEQ Code *Asset Information Specification* and AS 5488.

The Contractor must not assume any geospatial values from GIS data provided by Urban Utilities unless otherwise stated in the Project Documentation.

8.6 Acid Sulphate Soils

The identification, testing and treatment of acid sulphate soils should be carried out in accordance with MRTS 04 Clause 10.

8.7 Existing Service Conflicts

The Contractor must establish whether any conflict exists between existing services and the intended location of any part of the works before commencing work. If the Contractor determines that the works shown within the Project Documentation will conflict with the existing services, the Contractor must immediately report such conflicts to Urban Utilities, the Certifying Engineer (or the RPEQ having responsibility for overseeing the works) and the owner of the service.

The Contractor must resolve the conflict in accordance with the requirements of the Certifying Engineer, Urban Utilities and the service owner.

A Network Access Permit (NAP) is required to conduct work on or near Urban Utilities assets.

8.8 Protection of Services

The Contractor must take every precaution that is necessary to secure the existing services and associated works. The Contractor must:

- Immediately advise the relevant authority and Urban Utilities of any damage to the service, infrastructure and associated works.
- Arrange for all damage to be repaired as soon as possible by the relevant authority or by the authority's approved repairers at no cost to Urban Utilities.

8.9 Dewatering

Keep earthworks free of surface water. Provide and maintain slopes, crowns and drains on excavations and embankments to ensure satisfactory drainage. Place construction including filling, paving, structures, and services, on ground from which surface water has been removed. Protect freshly laid work from water damage.

8.10 Adjacent Structures

The stability and protection of all structures must be maintained.

Where the proposed excavation works may potentially impact a structure, a suitably qualified RPEQ engineer must assess the potential for instability, movement or damage from the works, including the potential effect of adverse weather conditions. The above-mentioned RPEQ engineer shall design all necessary temporary and permanent works and provide related certification for appropriate support to protect all adjacent structures.

The details and engineering certification for all temporary and permanent support structures must be submitted to Urban Utilities before commencing relevant works.

8.11 Erosion and Sediment Control

Erosion and Sediment controls shall be implemented in accordance with the Urban Utilities standard specification TEM 641 Part B *Standard General Technical Specification.*

All earthworks shall be undertaken in accordance with legislative requirements and best industry practice.

8.12 Excavation

Excavation consists of excavation, removal, and satisfactory disposal of all materials from within the limits of work as outlined in the Project Documentation.

Excavate to extents required correct levels for construction, pavements, filling, and landscaping. Excavate for footings, pits, and shafts, to the required sizes and depths.

Material forming the foundation for any structure which has a performance less than that nominated in the Project Documentation or deemed unsuitable by the Certifying Engineer shall be removed.

Excavations that do not remain free draining during the work, or where material has become unsuitable to any depth, shall be re-excavated and replaced.

8.12.1 Clearing and Grubbing

Clearing and grubbing shall be undertaken in accordance with the Project Documentation and the following minimum requirements:

- Removal of all loose material and debris.
- Grubbing and removal of shrubs and roots.
- Removal of all vegetation and soil to a depth of 100 mm below natural surface.
- Stockpiling of good topsoil (as defined in Section 8.12.2) for future use.
- Carting away remainder of topsoil.
- Breaking up, removing, and carting away any existing obstruction, concrete paths, base, or foundations which affect excavation for the new work.
- Leaving site ready for excavation.

Clear only the site areas to be occupied by works such as buildings, paving, excavation, regrading, and landscaping. Clear generally to the extent necessary for the performance of the works and any other areas that are required to be cleared.

Clearing and grubbing shall consist of the removal and disposal of all trees, brush, stumps, logs, grass, weeds, roots and all decayed vegetable matter, pole stumps, refuse dumps, and all other objectionable matter resting on or protruding through the surface of the original ground from the specified area. Burning on site is not permitted.

Trees shall not be removed or trimmed without prior written approval and permits obtained from the relevant authority must be submitted to Urban Utilities for verification. Trees shall be felled within the area to be cleared in such a manner as to avoid damage to vegetation or any property outside this area. A qualified fauna spotter catcher must be present during any clearing works, as specified in the Urban Utilities standard specification TEM 641 Part B *Standard General Technical Specification*.

Suitable vegetation may be chip mulched and used for restoration and landscaping works. The maximum chip size of chip shall fit within a prism measuring 100 mm x 50 mm x 20 mm. Weeds identified within the environmental report shall not be chip mulched and shall be removed from site.

Clearing and grubbing shall also include the removal of concrete paving and foundations (to a depth of at least 1.5 m unless otherwise specified within the Project Documentation) from all areas, and the removal and proper disposal of all obstructions including kerbs, kerbs and channel, drainage pits, fences, and any old or incidental structures within the specified area which will conflict or interfere with construction. Unless otherwise specified, refill grub holes and the like with material similar to the surrounding soil.

The site and adjacent areas shall be left with a neat and tidy finished appearance free from unsightly debris. No accumulation of inflammable material shall be permitted to remain on or adjacent to the site.

Care shall be taken not to disturb any benchmarks, survey or level pegs during clearing and grubbing. Any damaged or lost survey pegs shall be replaced by a licenced surveyor.

8.12.2 Topsoil

Remove topsoil from areas to be affected by the works. The depth of removal of topsoil should be as per the Project Documentation or otherwise a minimum of 100 mm.

Stockpile topsoil separately from other excavated material and retain for reinstatement. In cut and fill areas, a sufficient quantity of the best topsoil available from the site shall be removed before commencing excavation.

Topsoil shall be fertile, dark coloured loam, friable soil, containing organic matter and shall be free from subsoil, refuse, tree roots, noxious weeds, clay lumps, and stones.

Remove excess topsoil once reinstatement and landscaping works have been completed.

8.12.3 Trench Excavation

Excavate for underground services, to required levels and grades. Make the trenches straight between inspection points and junctions, with vertical sides and uniform grades. Keep trench widths to the minimum required for laying and bedding of the relevant service and construction of pits. Trench width shall exclude trench supports. Shoring for trenches shall be designed by the Certifying Engineer or a suitably qualified RPEQ engineer.

Where the trenching is for installation of underground electrical services refer also to the requirements in TMS1200.

If excavation is necessary below the zone of influence of the underside of adjacent footings, seek advice from the Certifying Engineer on support for the footings in accordance with Section 9.11. The requirements of *Queensland Development Code* MP1.4 must at least be met.

Clear trenches of sharp projections. Remove other obstructions including roots, stumps and boulders which may interfere with services or bedding. Keep trenches free of water.

8.12.4 Surface Drainage

Provide, as early as possible during construction, surface drainage to divert water from work areas, prevent pooling and limit erosion. Coordinate temporary drainage structures with the construction of permanent drainage structures and other permanent control measures. Incorporate temporary drainage, erosion and sediment control measures into the Environmental Management Plan for the works.

8.12.5 Hand and Vacuum Excavation

Excavate using either vacuum excavation methods or by hand where the use of mechanical excavators may cause damage to property, trees, buried services, buildings, and other structures.

8.12.6 Excavation by Blasting

The use of explosives for excavation is not permitted.

8.12.7 Over-Excavation

Over-excavation is where excavation exceeds the required extent, whether resulting from poor ground, excess excavation, the presence of voids, fissures, etc.

Reinstate over-excavation to the correct depth in accordance with Section 8.15.

8.12.8 Excavation Support

Support for excavations shall be assessed in accordance with the *Workplace Heath and Safety Queensland Excavation Work Code of Practice 2021*.

8.12.9 Rock

For the purposes of measurement, unless otherwise specified in the Project Documentation, Non-rippable material or rock shall be as defined below.

8.12.9.1 Trenched Excavation

Non-rippable or Rock Material comprises any material which in the opinion of the Urban Utilities, cannot be excavated by a tracked 20 tonne or larger hydraulic excavator, having a manufacturer's rating for maximum break-out force of not less than 110 kN, using a 600mm nominal width bucket.

If in the opinion of Urban Utilities, the use of an excavator equal to that specified above is considered inappropriate for any reason other than the Contractor's chosen method of operation, "Rock" shall be as defined for trenchless excavation. Otherwise, "Rock" shall be defined as any material assessed by Urban Utilities as equivalent to that defined above.

8.12.9.2 Trenchless Excavation

Rock

Comprises any material with an unconfined compressive strength greater than 7 MPa as measured by the Point Load Test in accordance with the requirements of AS 1726 and AS 4133.4.1. A factor of 24 shall apply for conversion of the Point Load Strength Index to the approximate Unconfined Compressive Strength.

Cobbles

Comprises rock fragments with a minimum compressive strength of 7MPa and sized between 65 mm and 250 mm diameter, with no more than 40% by weight passing a 53 mm size sieve.

Gravel

Comprises rock fragments with a minimum compressive strength of 7MPa and sized between 2.6 mm and 65 mm diameter, with no more than 40% by weight passing a 2.36 mm size sieve.

Other than Rock

Comprises all other material encountered in the excavation.

8.12.10 Unsuitable Material

All unusable, surplus and contaminated soil or other similar material shall be excavated and removed from the work area. Unsuitable material is any material which is unsuitable for the work and includes:

- Excavated material with properties outside of the specified range represented in the Project Documentation or deemed unsuitable by the Certifying Engineer.
- Material from swamps, marshes, bogs or material contaminated with matter presenting a biosecurity risk including those containing noxious weeds and other matter which may adversely affect the local environment.
- Acid sulphate soils which cannot be treated or managed in accordance with the Project Documentation.
- Stripped topsoil deemed not suitable as planting media or other uses as part of the works.
- Material contaminated with building rubble including concrete, asphalt and other materials.
- Soil contaminated with hazardous materials or harmful substances, including hydrocarbons, asbestos, PFAS (Perfluoroalkyl and Polyfluoralkyl Substances) chemicals etc.

8.12.11 Stockpiling

All proposed stockpile areas shall be subject to acceptance by Urban Utilities and be located:

- Away from drainage lines, water courses or other areas which may mobilise sediment into the surrounding environment.
- Above the 5% AEP flood level.
- In an area which is safe and complies with relevant regulations.
- Such that the stockpile may be removed if required at any time.

Temporary erosion and sedimentation control measures must be installed and maintained in accordance with TEM641.

8.13 Materials

Non-cohesive materials for embedment of buried pipes shall be in accordance with the SEQ Code *Infrastructure Products and Materials* (IPAM) list, TMS1435 and TMS1727.

8.13.1 Fill

The use of all imported and borrowed fill materials shall be subject to the prior approval of the Certifying Engineer.

Fill material shall be inorganic, non-perishable material cohesive material free from roots, timber and other deleterious material.

8.13.1.1 General Fill

General fill shall be in accordance with MRTS04.

8.13.1.2 Select Fill

Unless a more onerous requirement is specified by the Certifying Engineer:

- Select fill shall be granular material with a particle size of 75mm maximum, proportion passing 0.075mm sieve at 25%. The plasticity index shall be between ≤ 2% and ≤ 15%. Soaked CBR shall be not less than 15.
- Fill within 0.5 m of concrete or masonry structures shall have with sulphur content not exceeding 0.5%, unless such elements are protected by impermeable membranes or by other suitable means approved by the Certifying Engineer.
- Emerson class shall be 4 or more for all fill material mentioned above. If the Emerson class is less than 3, special treatment must be undertaken in consultation with, and to the approval of, the Certifying Engineer.

8.13.2 Geotextile

All geotextile materials shall comply with MRTS27 and AS 3706. Filter type geofabric shall also comply with WSA PS-355. The Certifying Engineer must nominate the required geofabrics required for each separate application in the design deliverables.

Store geotextiles in accordance with MRTS27.

8.14 Placement

8.14.1 Placement Adjacent to Concrete Structures

Fill over and around pipes, culverts, bridges, and other structures shall be placed in such a manner that will avoid unbalanced loading and that will not cause movement or place undue strain on any structure. Any rocky material present in the fill for any layer shall be uniformly distributed within the layer and shall be compacted as specified.

Fill shall be placed in layers simultaneously on both sides of structures of pipelines to avoid uneven loading.

Do not place fill against a concrete structure until the design 28 days characteristic strength has been achieved, unless otherwise approved by the Certifying Engineer. Liquid retaining structures may not be backfilled until testing is completed in accordance with Section 10.13.

Fill not achieving these requirements must be re-excavated and re-compacted.

8.14.2 Foundations

Foundations shall be carried to good bearing undisturbed soil below any fill and to the minimum depth below finished surface level specified in the Project Documentation. Foundations must achieve the specified, design bearing capacity. If the required bearing capacity is not achieved at the indicated minimum depth, or should over-excavation occur, further preparation works shall be undertaken in accordance with the written advice of the Certifying Engineer.

Unless the footing may be poured within 24 hours, all foundations shall have a 50mm minimum thickness concrete blinding layer. The blinding concrete shall have a strength exceeding 15 MPa.

All foundation excavations shall be inspected and approved by the Certifying Engineer prior to filling or concrete placement.

8.14.3 Subgrade Preparation

"Subgrade" refers to the material below the subgrade level in cuttings and earth fillings.

Subgrade should be prepared in accordance with Brisbane City Council Specifications S140 Clause 9.0. *Subgrade Preparation*.

8.14.4 Geotextile

Before placing geotextile, trim the ground to a smooth surface, free from cavities and projecting rocks. Lay the material flat, but not stretched tight, and secure it with anchor pins. Overlap joints at 300mm minimum.

8.14.5 Soil reinforcement

Geosynthetic reinforcement in road embankments below Subgrade level should be carried out in accordance with MRTS100.

8.14.6 Fill Placement

All filling shall be inspected by Level 1 Geotechnical Inspection and Testing Authority (GITA) in accordance with AS 3768.

8.14.7 Compaction

The Certifying Engineer shall determine the density requirements for all foundations, subject to the minimum requirements outlined in Table 8-2.

8.14.8 Compaction Method

Fill shall have, during compaction, a moisture content within the range 70% to 100% of the optimum moisture content (determined by AS 1289.5.1.1) unless otherwise specified in the Project Documentation. The moisture content of the material in the layer shall be maintained within the range specified until the layer has been test rolled after completion of compaction.

Fill materials which have been satisfactorily compacted, but which become wet beyond 130% of optimum moisture content, shall be removed, dried, and re-compacted.

For general filling, place fill in uniform loose layers not exceeding 300mm thickness and so that the compacted fill surface is self-draining.

For service and pipeline trenches unless otherwise provided in Project Documentation, provide:

- Bedding and backfill in accordance with the SEQ Code, TMS1435 and local authorities' requirements for roads and pavement reinstatement.

8.15 Testing

8.15.1 Minimum Density Requirements

Compaction of all fill and backfill materials shall be in accordance with the minimum requirements set out in Table 8-2, unless otherwise detailed in the Project Documentation or approved by the Certifying Engineer.

Table 8-2 Minimum Density Schedule

Location	MINIMUM RELATIVE COMPACTION (STANDARD) Cohesive soils generally (see Notes 1, 2, 3, 4)	Minimum Density Index Cohesionless soils (see Notes 1, 5)
Allotment fill	95%	65%
Building pad	100%	80%
Commercial, industrial and multi unit residential developments		
Road and structural (other than building) formations including embankments, footpaths, paved areas and shoulders (see Note 6)		
> 0.3m below subgrade level	95%	65%
≤ 0.3m below subgrade level	100%	80%
All other areas e.g. parks		
> 0.3m below design level	90%	62%
≤ 0.3m below design level	95%	65%
Replacement of unsuitable or over-excavated subgrade material	100%	80%
Backfilling of grub holes	100%	80%
Backfill, under road pavement, cohesive and replacement of unsuitable or over-excavated subgrade material	95%	75%
Backfill in pipe trenches	**(As per the SEQ CODE)**	

Notes:

1) Field dry density to AS 1289.5.3.1, AS 1289.5.3.5 or AS 1289.5.8.1. If using AS 1289.5.8.1, calibrate the surface moisture-density gauge in accordance with AS 1289.5.8.4 before use on site.
2) Standard maximum dry density to AS 1289.5.1.1.

3) Relative compaction (% of maximum dry density) to AS 1289.5.4.1.
4) For plastic soils, compact soils designated under the unified classifications system as OH CH MH to not less than 92% nor greater than 96% of standard maximum dry density at moisture contents of between 90% and 120% of optimum moisture content.
5) Density index to AS 1289.5.6.1. Maximum and minimum dry densities to AS 1289.5.5.1.
6) In the context of this specification, road formation is deemed to include all the area within the designated road reserve. Structural formation is deemed to include the area under the paving plus a nominal 1m from the edge of the paved area.

8.15.2 Testing Requirements

Field density testing shall be undertaken at random locations selected by the Certifying Engineer. The minimum frequency of testing shall be as follows:

- General and select fill - One test per 300 m^2 of compacted fill for each compacted layer.
- Maintenance holes and other structures - two tests for each 1 m of compacted depth around the structure.
- Pipe embedment and trenchfill one test per 50 m length for each 300 mm of trench height.

However, minimum tests per Lot should not be less than 6.

The detailed testing and inspection plan must be reviewed and accepted by the Certifying Engineer prior to commencing the works.

The minimum density requirements are provided in Table 8-2. Where a compaction layer fails the field density test then that whole layer and any layers above shall be removed and replaced with correct fill and recompacted to meet the requirements in Table 8-2.

The cause of failed compaction test must be identified and resolved before compaction can resume.

8.16 Restoration

All restoration shall match the surrounding and adjacent surface types, be undertaken of a high standard and prevent undue ongoing maintenance. The rehabilitated site shall be left with an even grade and shall be free draining. Surface grades shall not exceed 1 in 3 and grassed areas requiring mowing shall not exceed 1 in 4 without the acceptance of Urban Utilities.

For general unpaved areas, topsoil shall be spread to a nominal thickness of 100 mm with density not less than adjacent natural material. Reinstatement of grassed areas must be reinstated with rolled turf, unless otherwise accepted by Urban Utilities. Ungrassed areas may be reinstated with hydromulch or grass seed with a seed mix accepted by Urban Utilities. Hydromulch standard shall be in accordance with MRTS16.

Restoration of trenches within roadways and trafficked areas must be undertaken in accordance with the SEQ Code drawing SEQ-WAT-1204-1 and as required by the relevant road authority, unless shown otherwise within the Project Documentation. The standard for restoration of asphalt or bituminous pavements shall be equal to or greater than the original pavement.

Landscaped areas must be maintained for a minimum period of twelve (12) weeks. Maintenance over this period shall include watering, mowing, erosion control, weed control and pest control.

9. Concrete Works

9.1 Scope

This section provides the general requirements for all Urban Utilities concrete components of structures including, but not limited to, slabs, buildings, chambers and retaining walls.

Sections 10, 11 and 12 of this specification provide supplementary information for Liquid Retaining Structures, Pre Stressed Concrete and Precast Concrete respectively.

9.2 Referenced Documents

The documents listed in Table 9-1 are either referenced, or shall be read in conjunction with, this section of the Specification.

Table 9-1 Referenced Documents

Standard	Title
Australian Standards	
AS 1012	Methods of testing concrete
AS 1141	Methods of sampling and testing aggregates
AS 1379	The specification and supply of concrete
AS 1478	Chemical admixtures for concrete, mortar and grout
AS 1672	Limes and limestones
AS/NZS 2425	Bar chairs in reinforced concrete
AS/NZS 2566.2	Buried flexible Pipelines Part 2: Installation
AS 2758	Aggregates and rock for engineering purposes
AS 2870	Residential slabs and footings
AS/NZS 2904	Damp proof courses and flashings
AS 3582	Supplementary cementitious materials, Part 1: Fly ash
AS 3735	Concrete structures for retaining liquids
AS 3600	Concrete structures
AS 3610	Formwork for concrete
AS 3799	Liquid membrane-forming curing compounds for concrete
AS 3972	General purpose and blended cements
AS/NZS 4671	Steel for the reinforcement of concrete
AS/NZS 4672	Steel prestressing materials General requirements
AS 5100	Bridge design
International Standards	
ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete

Standard	Title
EN 14889-1	Fibres for concrete - Part 1: Steel fibres - Definitions, specifications and conformity
EN 14889-2	Fibres for concrete - Part 2: Polymer fibres - Definitions, specifications and conformity
SA-HB79	Guidelines on Minimising the risk of Damage to Concrete Structures in Australia Alkali Aggregate Reaction
Codes	
SEQ Code	SEQ Water Supply and Sewerage Design and Construction Code
WSA PS-352	Water Services Association of Australia – Product specification for Controlled Low Strength Materials for Pipe Embedment
Urban Utilities	
TMS1435	Technical Specification for Design and Construction of Water and Sewerage Main Systems
TMS1727	SEQ Water Supply and Sewerage - D&C Code - Urban Utilities Trunk Water Code Addendum

9.3 Design Requirements

9.3.1 Durability

Concrete structures shall be designed in accordance with the design durability requirements of AS 3600 for structures with a 50 year design life and the design durability requirements of AS 5100 for structures with a 100 year design life, except where varied by this specification or as stated in the Project Documentation.

The minimum exposure classification for concrete structure shall be in accordance with the provisions of AS 3600 for structures with a 50 year design life and of AS 5100 for structures with a 100 year design life, unless otherwise stated in the Project Documentation.

9.3.2 Crack Control requirements for Serviceability

When in service, the crack control requirements must be in accordance with the provisions of AS 3600 for structures with a 50 year design life and of AS 5100 for structures with a 100 year design life, unless otherwise stated in the Project Documentation.

9.3.3 Minimum Compressive Strength

The minimum compressive strength for concrete structures, unless otherwise specified in the Project Documentation, must be in as follows:

- N15 for over excavation and blinding layers.
- N25 for pipeline thrust and anchor blocks, pipeline encasement, screeding and benching, kerbs, gutters.
- N32 for concrete pavements not subjected to solid wheel vehicles.
- N40 for concrete pavements to be subjected to solid wheel vehicles.

- S32 for reinforced concrete not mentioned above for exposure classification B1 or less as defined in AS 5100.
- S40 for reinforced concrete not mentioned above for exposure classification B2 as defined in AS 5100. Refer Section 9.5.3 for further details of 'S' type concrete mixes.
- S40 for pre-stressed concrete.

9.3.4 Penetrations

All penetrations must include compensatory reinforcement including additional trimmer bars to transfer loads and limit cracking.

Where rubber ring-jointed pipelines are connected to structures, two flexible joints must be provided in accordance with the SEQ Code, TMS1435 and TMS1727.

Water stops must be provided for all penetrations into structures. Refer Section 9.21.

9.4 Concrete Materials

9.4.1 General

Materials used in the manufacture of concrete shall comply with the requirements of AS 1379.

9.4.2 Cementitious Materials

Unless noted otherwise in the Project Documentation, or otherwise accepted by Urban Utilities, cement used shall be Type GB Blended Cement and shall comply with the requirements of AS 3972.

Where specified or required by the Certifying Engineer, sulphate resistant cement (Type SR), shrinkage limited cement (Type SL) or other types of special purpose cement must be used.

Blended cement shall be a hydraulic cement containing Portland cement and supplementary cementitious materials (fly ash or a combination of fly ash and ground granulated iron blast-furnace slag).

All concrete intended for a structural purpose (excluding blinding and the like) shall contain a minimum quantity of fly ash of 25% by mass of cementitious material.

9.4.3 Portland Cement

The details of Portland cement proposed to be used shall be checked and verified by the Certifying Engineer prior to commencement. All associated quality assurance records shall be compiled and included within quality documentation.

The maximum total alkali content of Portland cement shall not exceed 0.6% (Na2O equivalent).

9.4.4 Fly Ash

Fly ash shall comply with the requirements of AS 3582.1 – Grade 1.

Fly ash shall have a maximum total alkali content of 3% (Na2O equivalent).

A Test Certificate as defined by AS 3582.1 identifying the proposed source, compliance and reportable properties of fly ash shall be accepted by the Certifying Engineer and included within quality documentation.

Fly ash shall not be used as fine aggregate replacement.

9.4.5 Slag – Ground granulated blast furnace

Slag shall comply with AS 3582.2.

Slag shall have a maximum total alkali content of 1% and a maximum available alkali content of 0.5% (Na2O equivalent).

A Test Certificate as defined by AS 3582.2 identifying the proposed source, compliance and reportable properties of slag shall be accepted by the Certifying engineer and included within quality documentation.

9.4.6 Silica Fume

Unless accepted otherwise by Urban Utilities, silica fume or other forms of amorphous silica shall not be used as mixes with silica fume tend to have less bleed and are therefore more susceptible to early age cracking

9.4.7 Supplementary Cementitious Material Proportions

Unless accepted otherwise by Urban Utilities, the blend proportions shall be as per Table 9-2.

Table 9-2 Supplementary Cementitious Material Proportions

Blend	Exposure Class	GP Portland Cement	Fly Ash	Slag
Binary	B1 and B2	65 to 75%	25 to 35%	-
Tertiary	C1 and C2	50 to 55%	25 to 30%	20 to 25%

Note: The table refers to percent of total combined cementitious material by weight.

9.4.8 Aggregates

Fine and coarse aggregates used in concrete shall be normal weight (not lightweight) non slag aggregates and shall comply with the requirements of AS 2758.1.

Except where noted otherwise on the Project Documentation or in this specification, the maximum aggregate size shall be 20mm.

Coarse aggregate shall consist of crushed stone or gravels composed of clean, sound, hard and durable particles. Fine aggregates shall consist of sharp, coarse, clean siliceous sand. Aggregates shall be free from dust, clay, organic matter or other deleterious substances. Where testing of new sources of aggregate is required by the Project Documentation or the Certifying Engineer, coarse and fine aggregates shall be examined by petrographic analysis in accordance with ASTM C295. The petrographic analysis report shall include (but is not limited to) the following items:

- Types and content of deleterious substances including gypsum, pyrite, opaline materials, unstable silica minerals, and strained or microcrystalline quartz.
- An independent expert interpretation / opinion on the aggregate's suitability for use in the proposed concrete mix and exposure conditions at the site, and any precautions that should be taken.

Special requirements under AS 2758.1 shall be:

- Water absorption (Clause 7.3) shall not exceed 2.5%.
- Grading requirements (Clause 8.1) shall be based on 'submitted grading', which shall be supplied to the Certifying Engineer with the concrete mix design.
- Durability requirements (Clause 9) for aggregates shall be:
    - Exposure Classification B2 generally.
    - Exposure Classification C for specific structures nominated in the Project Documentation.
    - The permissible limit of light particles as listed in Clause 12 shall be 0%.

The sources, history of use, test data and reports of all proposed aggregates shall be submitted to Urban Utilities upon request.

9.4.9 Alkali-Silica Reaction

Aggregate used in concrete shall not be susceptible to adverse reaction with the alkali content of the cement and shall comply with the requirements of Clause 10 of AS 2758.1. In addition, the following information shall be included within quality control ITPs as mandatory requirements prior to placing of any concrete:

- A statement from a recognised authority that the aggregate is not susceptible to adverse reaction with the cement to be used.

Alternatively, concrete mixes containing a minimum of 25% of fly ash by total mass of cementitious material shall be deemed to comply with these additional requirements provided the potential alkali-silica / alkali-aggregate reactivity of the proposed aggregate is shown to be mild / slow (or less) when tested in accordance with:

- AS 1141.60.1 *Methods for sampling and testing aggregates*, Method 60.1: Potential alkali-silica reactivity - Accelerated mortar bar method.
- ASTM C295 – *Standard Guide for Petrographic Examination of Aggregates for Concrete*.

Aggregate test results and reports as necessary shall be included within quality control ITPs.

If the aggregate source or cement is changed, the above procedure shall be repeated.

9.4.10 Water

Water used in the manufacture of concrete must comply with AS 1379.

9.4.11 Chemical Admixtures

The use of admixtures shall be subject to acceptance of the Certifying Engineer. Under no circumstances shall materials containing calcium chloride, other salts or other deleterious chemicals be added to the concrete.

Admixtures shall comply with the requirements of AS 1478 and shall be used in accordance with the manufacturer's recommendations.

Unless otherwise accepted by Urban Utilities, the total alkali contribution of all admixtures used in the concrete mix shall not exceed 0.20 kg/m³ (Na_2O equivalent).

Approved admixtures and maximum dosage rates shall be as listed in *Registered Chemical Admixtures*, Queensland Transport and Main Roads, dated 22 June 2020.

Proposed admixtures and dosage rates together with technical data sheets and Manufacturer's printed recommendations shall be accepted by the Certifying Engineer prior to the placing of any concrete.

9.5 Concrete Characteristics

9.5.1 General

The characteristics required for each concrete element shall comply with the requirements of AS 3600 for structures with a 50 year design life and AS 5100 for structures with a 100 year design life with properties as defined in AS 1379.

9.5.2 Strength Grade

The strength grade for each concrete element shall comply with the requirements of AS 3600 for structures with a 50 year design life and AS 5100 for structures with a 100 year design life.

Minimum concrete strengths are given in Section 9.3.3 of this Specification.

9.5.3 Concrete Mix Proportions

The materials and concrete mix designs shall be approved by the Certifying Engineer before commencing concrete placement. The Certifying Engineer shall consider the results of drying shrinkage tests, if shrinkage limits are specified in the Project Documentation, and details of admixtures proposed for inclusion together with the Manufacturer's data sheets.

Once defined in the design documents then Concrete mix designs shall not be varied without acceptance by the Certifying Engineer.

Unless indicated otherwise, specific requirements for "S" type concrete mixes shall be in accordance with Table 4.4.1(A) of AS 5100.5.

9.5.4 Slump

The slump shall be 80mm, subject to tolerances as stated in AS 1379, at the point of delivery unless specified otherwise on the Project Documentation.

9.5.5 Drying Shrinkage

For S32 grade concrete the target average drying shrinkage at 56 days shall not exceed 900 microstrain, determined in accordance with AS 1012.13.

For S40 and S50 grade concrete, the maximum drying shrinkage at 56 days shall not exceed 600 microstrain, determined in accordance with AS 1012.13, with a tolerance range of ±50 microstrain.

9.6 Sampling and Testing

9.6.1 General

Concrete testing must be in accordance AS 1379, incorporating where applicable, requirements of AS 3600 for structures with a 50 year design life, and of AS 5100 for structures with a 100 year design life, unless otherwise stated in the Project Documentation.

The assessment method of testing in the Project Documentation shall be used.

Trial mixes must be designed and tested including undertake any additional testing required due to proposed changes in materials or proportions of the mix, as well as any additional testing occasioned by failure to meet the requirements of this Specification.

9.6.2 Testing Frequency

Minimum site sampling and testing shall be in accordance with Table 9-4.

Table 9-3 Minimum Site Sampling and Testing Requirements

Number of Batches per Day	Number of Samples
1	1
2 to 5	2
6 to 10	3
11 to 20	4

Note: A batch is defined as a quantity of concrete containing a fixed amount of ingredients and produced in a discrete operation.

For every 10 batches per day over 20, one additional sample shall be taken.

If early strength results are required, then additional cylinders shall be taken in the sample as required. Samples taken to determine stripping or prestressing times shall be stored so as to match the conditions of the concrete from which the test sample has been taken.

9.6.3 Testing Laboratory

Sampling and testing shall be carried out by a NATA certified laboratory. Sampling procedures shall be in accordance with AS 1012.

Concrete test reports shall be submitted to the Accountable Party as soon as practicable after completion of testing.

9.6.4 Records

The following information shall be recorded and incorporated into a cumulative weekly report which shall be included within quality assurance documentation and available for review by Urban Utilities at any time upon request:

- Date and time of taking the sample.
- Weather conditions at the time of concrete placement.
- Temperature of concrete at time of placement.
- Name of the supplier and location of plant.
- Number of delivery docket and number of the transport vehicle.
- Location of sampling.
- Method of identifying the test cylinders taken.
- Location of batch of concrete after its placement.
- Specified grade of concrete and source.
- Slump of sample.
- Date of tests.
- Test results.

The original delivery dockets of all concrete delivered shall be compiled into the quality assurance records for submission to Urban Utilities.

9.6.5 Compressive Strength

When the concrete compressive strength of any group of samples falls below the acceptance criteria specified in Section 17 of AS 3600, the concrete represented by the group of samples shall be regarded as not having attained the specified compressive strength required and shall be classed as defective concrete.

9.6.6 Drying Shrinkage

Where drying shrinkage limits are specified, drying shrinkage for each proposed concrete mix shall be measured in accordance with AS 1012.13.

After the concrete mix design has been accepted for use by the Certifying Engineer, three specimens of each concrete mix shall be tested and drying shrinkage readings shall be submitted after 14, 28, 56 and 90 days, for assessment of the drying shrinkage of the mix. During construction, three specimens shall be taken from the first pour of the mix. The concrete of each separate mix design shall be tested every three months and the results submitted to the Certifying Engineer.

9.7 Rejection of concrete

Concrete may be rejected after placement because of non-compliant finish, incorrect positioning or other failure to conform to the requirements of the Project Documentation. Where concrete already placed is classed as defective, the criteria for rejection shall be as set out in Section 17 of AS 3600.

Concrete classed as defective and rejected due to non-compliance to standards shall be removed, and together with any other work subsequently erected thereon, shall be replaced with concrete complying with this specification.

Should any concrete be liable to rejection, the Contractor may arrange for testing of specimens cut from the completed work. Coring and testing shall be in accordance with AS 1012.14.

The Certification Engineer must then consider the test results and other information and may, at its absolute discretion, determine whether the strength of the specimens cut from the work and adjusted for the age, diameter and height-to-diameter ratio of the specimens is to be taken as the actual strength of the concrete for acceptance purposes.

If specimens are cored from the completed work, holes shall be filled with concrete with a non-shrink additive and the surface finished to match the surrounding areas.

9.8 Supply and Delivery

9.8.1 General

Concrete shall be supplied in accordance with AS 1379 from a ready-mixed concrete supplier.

Mixing by hand will not be permitted.

Concrete shall be delivered in trucks of the revolving drum type. The use of non-agitating trucks will not be permitted.

9.8.2 Ready-mixed Concrete

Ready mixed concrete shall be supplied from a plant which qualifies for Production Assessment in compliance with AS 1379.

9.8.3 Rate of Concrete supply

Concrete shall be supplied at a rate and in sufficient quantity to ensure the uninterrupted placing of the concrete. Where, in the opinion of the Accountable Party, placement of concrete is sufficiently delayed such that initial set of the placed concrete has taken place, a construction joint shall be formed in the placed concrete in accordance with Section 9.20.2.

9.8.4 Elapsed Delivery time

The maximum time permitted for the delivery of the concrete, from the charging of the mixer to the completion of compaction in place, is specified in Table 9-5.

Table 9-4 Maximum Time Permitted for the Delivery of Concrete

Concrete Temperature at time of discharge	Maximum Permitted Time
Less than 5°C	Not permitted
5°C – 24°C	90 minutes
24°C – 27°C	75 minutes
27°C – 30°C	60 minutes
30°C – 35°C	45 minutes

Greater than 35°C	Not permitted

Where maximum permitted delivery times are not achievable, a departure may be requested. Requests for a departure must be accompanied by a detailed submission, including the following:

- Reasons for the proposed departure.
- Location of the concrete batching plant.
- Achievable delivery time.
- Details of proposed concrete mix design.
- Proposed admixtures and dosage rates. Refer Section 9.4.11 of this Specification.
- NATA endorsed test certificates demonstrating the proposed mix design satisfies the requirements of this specification.

Proposed departure submissions must be submitted to the Certifying Engineer for acceptance prior to concrete pour, submitted to Urban Utilities upon request and including in quality assurance documentation.

9.8.5 Delivery Docket

Each truck of concrete shall be accompanied by a delivery docket containing the information required by AS 1379.

The delivery docket shall include, but not be limited to, the following information:

- Name of supplier, project name and location.
- Delivery vehicle identification.
- Concrete mix design identification code.
- Concrete class and strength grade.
- Quantity.
- Time of discharge.
- Temperature of concrete at discharge.
- Details of any admixtures.
- Volume of water added on site.

All delivery certificates shall be compiled into the quality assurance records for submission to Urban Utilities.

9.8.6 Added water or other substances

Water and/or any other substances shall not be added to the concrete on site or at any time after the initial introduction of water to the cement without the acceptance of Urban Utilities.

9.9 Bedding Grout

Grouts used for bedding of base plates, mechanical plant, or other items placed in, or on, concrete shall comply with the following.

Grout shall be a non shrink, ready to use, fluid precision grout material, premixed and packaged at the manufacturer's factory and delivered to the job site requiring only the addition of water, mixing, forming, placing and curing.

The grout shall comply with Section 17 of AS 3600 and AS 1478 and shall have a characteristic compressive strength of not less than 50 MPa at 28 days.

Details of proposed grout types and curing compounds shall be accepted by the Certifying Engineer and Accountable Party prior to grouting operations being carried out.

Additives to promote fluidity and/or expansion of grout may be used subject to acceptance by the Certifying Engineer. Any such additives shall not reduce the strength of the grout. Additives containing aluminium powder, chlorides or nitrates shall not be used.

Grout shall be mixed and placed strictly in accordance with the manufacturer's written instructions.

Exposed areas shall be cured with a curing and sealing component complying with AS 3799 in accordance with the manufacturer's recommendations.

No grout shall be placed if the temperature of either the grout, baseplate, concrete base or other item in contact with the grout is above 35°C or below 5°C.

Precautions shall be taken to avoid the formation of air pockets and the edges shall be neatly bevelled off on completion.

When the grout has reached its full design strength, or otherwise specified in the Project Documentation, any steel wedges, packs or levelling devices used to hold the column in position shall be removed and the resultant cavities in the grout made good.

Grouts used to bed vibrating or dynamic plant or structures shall be checked and endorsed by the Certifying Engineer.

9.10 Cement Stabilised Sand

Stabilised sand shall be in accordance with AS/NZS 2566.2 Appendix K unless otherwise required by Project Documentation. Quality assurance for shall be in accordance with WSA PS-352.

9.11 No fines Concrete

No fines concrete shall consist of cement, water and 20mm nominal maximum coarse single-sized aggregate (not more than 5% by mass passing a 4.75mm sieve) with a cement: aggregate ratio by volume in the range 1:6 to 1:8 and a water-cement ratio of 0.4-0.5.

When no fines concrete is being placed, it shall be rodded sufficiently only to ensure the space is filled. It shall be screeded to the required surface level without tamping or vibrating.

No fines concrete shall be moist cured for at least four days by covering with wet hessian, polythene sheet or similar material. The use of wet sand or any other material which can enter the voids will not be permitted for curing purposes.

9.12 Reinforcement

9.12.1 General

Steel reinforcement and the placing and fixing of steel reinforcement shall comply with the requirements of AS 3600 and AS/NZS 4671.

Unless noted on the otherwise on the Project Documentation, steel bars and welded mesh reinforcement for concrete must be deformed ribbed bars Grade 500N to AS 4671.

9.12.2 Supply of reinforcement

The supply of reinforcement shall be deemed to include all tie wires, support bars, spacers, bar chairs, stools and the like necessary to complete the work.

The manufacturer / processor of the reinforcement shall hold a valid certificate of approval issued by the Australian Certification Authority for Reinforcing Steel (ACRS). Refer to https://www.acrs.net.au/.

Copies of test certificates for yield and ultimate strengths, elongation and cold bend performances carried out by the steel supplier confirming that the steel supplied conforms to the specified requirements shall be included within quality assurance documentation and submitted to the Urban Utilities upon request.

Reinforcement shall be furnished in the full lengths shown and laps and splices shall be made only in the positions and to the dimensions shown on the Project Documentation or otherwise accepted by the Certifying Engineer.

Unless shown otherwise on the Project Documentation, the reinforcement shall be cut, bent, and fabricated to the dimensional tolerances allowed by AS 3600.

9.12.3 Site bending

Reinforcement shall not be bent on site without the acceptance of Urban Utilities, unless specifically shown on the Project Documentation.

Bars specified to be cast into the concrete and subsequently bent out shall be quenched and self-tempered bar. Microalloy bars shall not be used for this application.

Notwithstanding the provisions of AS 3600, heating of reinforcement will not be permitted. Bends and hooks shall be cold bent and, where not dimensioned, cogs, hooks and bends shall be bent in accordance with the requirements of AS 3600.

9.12.4 Splicing

Splices shall comply with AS 3600 and the locations shown in the Project Documentation. Where not shown on the Project Documentation, splices may only be placed subject to the acceptance of the Certifying Engineer.

9.12.5 Welding

Welded joints of hot rolled high strength deformed bars other than those specifically detailed shall not be made without the acceptance of the Certifying Engineer. Any such acceptance shall be subject to the provisions of AS 1554.3.

Unless approved otherwise by the Certifying Engineer, welding shall not be permitted in locations less than 100mm from bent bars.

9.12.6 Mechanical splices

Proprietary mechanical/welded bar splices will only be permitted where specified and/or shown on the Project Documentation.

9.12.7 Surface condition

Reinforcement shall be free from loose mill scale, loose rust, mud, oil, grease and other coatings that would reduce the bond between the concrete and the reinforcement.

Any salts deposited on the steel surface shall be removed with high pressure fresh water jetting prior to the placing of concrete.

9.12.8 Placing and fixing of reinforcement

The concrete cover to the reinforcement shall be as shown on the Project Documentation or, where not shown, shall be in accordance with the requirements of AS 3600 for structures with a 50-year design life and AS 5100 for structures with a 100-year design life.

Reinforcement shall be securely tied and held in position within the tolerances specified in AS 3600. Reinforcement shall be rejected if placed so as the minimum concrete cover is not attained for 100% of its length.

Reinforcement shall be secured against displacement by tying at intersections with 1.6mm diameter mild steel wire or proprietary clips or ties. Ends of wire ties shall be bent away from the formed faces so that the wire does not project into the concrete cover.

Reinforcing steel shall be supported on spacers, stools, hangers and chairs spaced at not more than 1000mm centres. Details of proposed reinforcement supports shall be submitted to the Certifying Engineer for acceptance prior to being used in the Works. The supports must be strong enough to support construction activities and shall not compromise the integrity or durability of the reinforcing steel or concrete.

Where concrete strips or blocks are used to support reinforcement, the concrete strips shall be of the same strength and density as the concrete itself and shall be thoroughly compacted.

Supports made from brick, stone, aggregate, timber (or other porous or degradable materials), or metal (other than stainless steel) which extends into the concrete cover shall not be used.

For concrete cast against a membrane, bar chairs and other support legs shall be placed on plastic discs to prevent damage to the membrane and/or sinking into the ground.

Where surfaces are exposed to the weather or water, including those to receive applied finishes, only plastic or concrete spacers and chairs shall be used. If concrete spacers are used, then these shall be to the same mix as the section of work.

9.12.9 Inspection of reinforcement

The Contractor shall inspect the reinforcement and correct any defects prior to requesting an inspection by the Accountable Party.

9.12.10 Adjustment of reinforcement during concrete pouring

Damaged or displaced reinforcement shall be corrected prior to placing concrete and during concrete pour if necessary.

9.12.11 Fibre Reinforcement

Fibre reinforcement may be used only where specified in the Project Documentation and if accepted by Urban Utilities. Details of the proposed fibres, source and suppliers shall be submitted to Urban Utilities for acceptance prior to commencement.

9.13 Formwork

9.13.1 General

Formwork and falsework shall be designed and constructed in accordance with AS 3610.

Formwork shall be designed and constructed to produce concrete members which conform to the tolerances in shapes, lines, levels, dimensions and surface finishes required by the Project Documentation and this specification.

Certified formwork and falsework design calculations shall be submitted upon request. Formwork and falsework shall be certified by the Contractor's Certifying Engineer.

Sides of footings in other than rock material shall be formed rather than cast directly against the ground.

9.13.2 Dimensional tolerances

The dimensional tolerances for formwork shall be such as to permit the tolerances for formed surfaces (refer Section 9.16.3) to be achieved.

9.13.3 Formed surfaces

The surface finishes required from the formwork in the various concrete elements shall be in accordance with AS 3610 except where modified by the Project Documentation and this Specification.

The following classes of formwork to AS 3610 shall be used in the Works:

Table 9-5 Classes of Formwork

Concrete Element	Formwork Class to AS 3610
Internal walls and slab of a drinking water reservoir	Refer TMS1581
External walls of a drinking water reservoir	Refer TMS1581
All formed surfaces (except where permanently concealed by backfill)	2
All formed surfaces that are permanently concealed by backfill (other than footings)	3
Precast concrete elements	2
Buried footings	5

Other cast in-situ concrete	3

Except in the case of Class 5 formwork, formwork corners and angles unless otherwise specified, shall be formed with a bevel by chamfering or filleting the forms, the bevel in each case having a width as shown on the Project Documentation or, if not shown, of 20mm on each side with equal angles.

9.13.4 Formwork ties

Formwork ties used shall be consistent with the class of surface finish specified for the members as a whole.

Formwork ties shall be kept clear of the steel reinforcement and in no circumstances shall steel reinforcement be used to support the formwork. Tie wire passing through the concrete will not be permitted.

9.13.5 Embedded ties

Embedded ties for holding forms shall remain embedded. Concrete cover to embedded ties shall be not less than the concrete cover specified for adjacent reinforcing bars.

9.13.6 Removable ties

Removable ties which leave a through hole in the concrete element shall not be used for water retaining or underground structures.

9.13.7 Patching of recesses

No recesses shall be filled until they have been inspected by the Accountable Party.

Recesses resulting from the removal of formwork ties or cone spacers shall be cleaned and filled with mortar in the proportion of one part of cement to three parts of sand, well rodded, and floated flush.

Sample patching shall be carried out and accepted by the Accountable Party, before proceeding.

9.13.8 Types of formwork

The types of formwork required shall be chosen to achieve the surface finishes, shapes, lines, levels and dimensions of the concrete as required by the Project Documentation and this Specification.

Where it is not possible or practicable to remove formwork from formed surfaces, permanent or lost formwork shall be used. The type of permanent or lost formwork shall be subject to the acceptance of Urban Utilities.

The use of permanent steel formwork such as Bondek is not permitted.

Precast concrete permanent formwork shall not be used without the acceptance of Urban Utilities.

9.13.9 Treatment of forms

Form linings shall be coated with a suitable release agent, in compliance with AS 3610, prior to placing concrete or reinforcement. No part of the reinforcement or adjacent concrete faces shall be coated with release agent. The form release agent shall not adversely affect the concrete surface, colour, surface coatings, curing compounds or other specified requirements.

Rubbish shall be removed from the space to be occupied by the concrete and the work blown clean before the inspection by the Accountable Party.

9.13.10 Hot and cold conditions

When the ambient air temperature is greater than 32°C, the forms shall be sprayed with water and/or shaded to prevent the form faces exceeding 32°C prior to concrete placement.

When the ambient air temperature is less than 5°C, forms shall be warmed so that the form faces are above 5°C at the time of concrete placement.

9.13.11 Stripping and removal of formwork

Stripping and removal of formwork shall comply with AS 3610. In particular, back propping shall occur progressively as formwork is stripped. Under no circumstances shall whole spans be stripped before commencing back propping.

Forms to vertical surfaces shall not be removed until the recommended stripping times tabulated in AS 3610 have elapsed.

Concrete work that does not comply with the tolerances specified or has other defects due to the inadequacy of the formwork defect must be remediated to achieve compliant concrete.

No concrete shall be covered up, patched or repaired until it has been inspected and the proposed repair methodology accepted by the Accountable Party.

9.13.12 Permanent loading

No masonry walls or other permanent loading shall be imposed on the concrete member while it is supported on formwork or propped.

9.14 Blinding Layer

A blinding layer shall be placed below the underside of all concrete footings, slabs and other elements cast against the ground unless agreed otherwise with the Accountable Party, sufficient to protect the foundation material and to provide a clean, firm and level surface on which to work and support the reinforcement and formwork.

Unless shown otherwise on the Project Documentation, the blinding layer shall comprise a 50mm thick layer of Grade N15 blinding concrete.

The blinding layer shall be placed as soon as possible after the foundation material has been prepared and accepted by the Certifying Engineer. The surface shall be screeded or otherwise worked to an even finish level with the underside of the structural concrete to be placed over.

Internal slabs shall be poured on a 200 micron polyethylene vapour barrier where not otherwise shown on the Project Documentation.

9.15 Placing of Concrete

9.15.1 General

The placing of concrete shall be by normally accepted practices and in such a manner as to avoid segregation, loss of materials, contamination or adversely affect the final properties of the concrete.

Details of the proposed concrete placement activities must be approved by the Certifying Engineer before commencing and included in quality assurance documentation.

Notwithstanding the provisions of AS 1379, concrete shall be completely discharged, placed and compacted in its final position prior to initial set of the concrete.

9.15.2 Pre-pour activities

The Accountable Party shall be given not less than 24 hours notice of the proposed concrete pour to inspect the reinforcement and formwork.

Where slabs are cast on blinding without the use of a vapour barrier, the blinding shall be thoroughly wetted just prior to casting, to prevent excessive water loss from the concrete into the blinding.

9.15.3 Weather conditions

The temperature at the time of placement shall be measured and recorded for each batch of concrete to demonstrate compliance with the following conditions:

Hot weather

- Concrete shall not be placed when the ambient temperature is likely to exceed 35°C at the time of placement.

Evaporation

- When the evaporation rate during placing and finishing operations is predicted to exceed 0.75 kg/m²/hr, aliphatic alcohol or other equivalent evaporation inhibitor accepted by Urban Utilities shall be applied to exposed concrete surfaces immediately after initial screeding.
- To compute the evaporation rate, the following information is required: air temperature, relative humidity, concrete temperature and wind velocity. Figure 9-1 can then be used to estimate the evaporation rate.

Table 1 Wind, Temperature and Humidity Combinations when the Evaporation Rate will Approximate 1 kg/m²/h

Wind conditions		Air temperature (°C)	Relative humidity* (%)	Concrete temperature (°C)
Speed (km/h)	Description			
10	Light	25	25	30
10	Light	30	52	35
		34	40	35
20	Moderate	20	50	25
20	Moderate	25	70	30
20	Moderate	30	91	35
		35	50	32
30	Fresh	15	40	20
30	Fresh	20	70	25
30	Fresh	29	100	33
40	Strong	10	45	15
40	Strong	15	70	20
40	Strong	20	90	25
40	Strong	23	110	28

*The lower the value of relative humidity, the worse the evaporation rate will be.

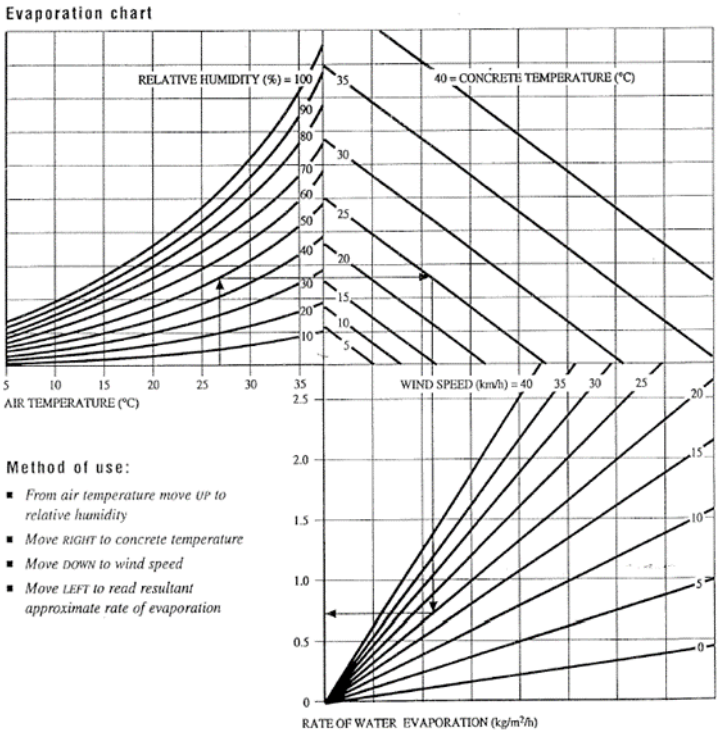

Figure 9-1 Evaporation Rate
Note: Courtesy of the Cement Concrete Aggregate Association.

Cold weather

- The temperature of concrete at the time of placement shall not be less than 10°C. Where ambient conditions are likely to result in concrete temperatures less than this limit, warming measures subject to acceptance by the Urban Utilities shall be undertaken.
- Concrete shall not be placed if the ambient temperature is likely to fall below 5°C at the time of placement.

Wet weather

- Adequate covers shall be retained on site for the protection of fresh concrete surfaces.

9.15.4 Layers

Concrete in deep members shall be deposited in continuous horizontal layers not exceeding 300 mm thick and each layer compacted before the preceding layer has taken initial set. Layers shall not be tapered off but shall be stopped against forms to produce square ends. The pour sequence shall be to limit the internal heat of hydration.

The free fall of concrete must be limited to a maximum of 1.5 m and to prevent segregation.

9.15.5 Wet conditions

Concrete shall not be placed in wet trenches or running water or whilst raining.

9.15.6 Pouring of concrete underwater

Unless accepted by the Accountable Party, no concrete shall be placed under water and permission to do so will only be given in the most exceptional circumstances.

9.15.7 Sequence of pours

Shrinkage effects shall be minimised by pouring the sections of the work between construction joints in the sequence specified in the Project Documentation.

9.15.8 Compaction

Concrete shall be in accordance with Section 17 of AS 3600 by using poker vibrators, vibrating screeds, and hand methods as appropriate and carefully worked into corners and around embedded fixtures and water stops, etc.

9.15.9 Plastic cracking

Appropriate measures shall be undertaken to avoid cracking of concrete in the plastic state – both plastic shrinkage cracking and plastic settlement cracking. Such cracking of the concrete may be cause for rejection.

9.15.10 Prevention of thermal cracking

The design and construction shall incorporate measures acceptable to the Certifying Engineer in order to prevent thermal cracking of any concrete elements that are 1 metre thick or greater. For liquid retaining structures specific assessment must be carried out in accordance with Section 10.

9.15.11 Vibrators

Concrete shall be compacted by means of high frequency mechanical vibrators of the immersion type to ensure complete compaction of all parts of the concrete sections.

The vibrators shall operate with a minimum frequency of 150 Hz and with sufficient energy output to visibly affect the concrete at a radius of 300 mm.

Vibrators shall be used in sufficient numbers (not less than one per 4 m^3 of concrete placed per hour) to keep pace with the rate of placing of the concrete and shall be handled by trained operators to ensure that the pattern of inserting the vibrators produces even and regular compaction. Vibrators shall be inserted vertically at successive positions not more than 450mm

apart and in a manner that ensures compaction of the concrete around the reinforcing steel and any other embedded fixtures, and into all parts of the forms.

Care shall be taken to ensure newly deposited concrete is vibrated into any fresh concrete adjacent to it to provide a homogenous concrete mass.

9.15.12 Pumping

The use of concrete pumps to place concrete shall be subject to acceptance by the Accountable Party. The application for acceptance shall include details of the type and capacity of the pumps, pipework and procedures to be adopted, and satisfactory evidence that any modifications to the concrete proportions and consistency to suit pumping procedures shall comply with the provisions and intent of this specification.

Delivery lines shall be of metallic type accepted by the Accountable Party. Under no circumstances shall aluminium alloy pipes or fittings be used nor shall concrete be permitted to come in contact with aluminium during its manufacture, transport or placing.

In the event of delay or breakdown in the equipment not exceeding 20 minutes during which time concrete cannot be placed, and the atmospheric (shade) temperature on the site does not exceed 18°C, the concrete in the receiving hopper and lines may be placed in the work on the resumption of pumping. Should the temperature exceed 35°C, the concrete in the receiving hopper and lines shall be discarded. Where the temperature lies between 18°C, and 35°C, the use or discarding of the concrete shall be reviewed by the Accountable Party.

If the delay exceeds twenty minutes an emergency construction joint shall be formed, where accepted by the Accountable Party, in accordance with Section 9.20.3 and concrete in the pipeline and receival hopper discarded.

In any case, if initial setting of the concrete has begun in the hopper or discharge lines, the concrete shall be discarded.

9.16 Finishing of concrete surfaces

9.16.1 Finishes to unformed surfaces

Slabs and other unformed surfaces shall be finished as described in the Project Documentation.

All operations associated with concrete finishing including screeding, floating, trowelling, jointing and edging of surfaces shall be done by specialist workmen experienced in such work.

Unless noted otherwise on the Project Documentation, the upper surface of slabs and concrete screeded to line and level shall be finished with a mechanical rotary trowel to a fine even dense surface and lightly broomed, leaving a surface without blemish.

Edges and corners shall be finished by hand to match the adjoining surfaces.

Concrete shall be kept as dry as possible to prevent bleeding and fines shall not be worked up to the surface. Excessive working shall be avoided. During trowelling, the surface shall not be dusted with cement, nor a mixture of sand and cement, nor other driers to absorb moisture or to facilitate trowelling.

9.16.2 Floor flatness

The finished surface of concrete shall not deviate by more than 10mm from the specified design level at any point.

The finished surface of floors and drainage channels shall not deviate by more than 6mm from the testing edge of a straight edge of 3m length laid in any direction and shall be free from discontinuities, except where shown in the Project Documentation.

Areas of floor or drainage structures surfaces which do not comply with the above shall be corrected by grinding or other means accepted by the Accountable Party.

Road slabs and other paved areas exposed to the weather shall be graded as shown on the Project Documentation, so that the surface will shed water to the drains.

9.16.3 Finishes to formed concrete surfaces

The surface finish of formed surfaces shall meet the requirements for the formwork category specified in Section 10.16.3 or shown in the Project Documentation and shall be in accordance with AS 3610.

Immediately after the formwork has been removed and while the concrete has still not fully hardened, all irregularities shall be rubbed or chipped off.

No concrete shall be covered up, patched, or repaired until it has been inspected and accepted by the Accountable Party.

9.16.4 Tolerances

The dimensional tolerances for formed surfaces shall be appropriate for the class of formwork specified and in accordance with AS 3610.

Notwithstanding the provisions of AS 3600 and AS 3610, the deviation of any point on the surface of a concrete element from its correct position in space shall not exceed 10mm.

The relative deviation of any two points on the surfaces of concrete elements from their correct positions in space shall not exceed 1/500 of the dimension between them except that in the case of cross-sectional dimensions of structural members such as, beams, slabs and walls, the tolerance shall be minus 0 plus 6mm. Nevertheless, this last concession shall not apply to the measurement of flatness of formed surfaces.

9.16.5 Defective work

Should any surface fail to meet the specified requirements, the surface shall be ground, or otherwise treated, to achieve the required standard of finish. Rendering will not be acceptable.

If, after stripping of the formwork, areas of segregation or honeycombing are found, these shall be cut out and made good in a manner accepted by the Certifying Engineer. Only cementitious products with performance characteristics similar to the concrete shall be used.

Repair procedures will depend on the extent of defective areas and may require the use of concrete or proprietary mortars.

9.16.6 Applied finishes

Floor screed and granolithic topping, epoxy and other special finishes shall be as shown in the Project Documentation or described in Section 13 of this Specification.

9.17 Curing of Concrete

9.17.1 General

Curing shall be carried out in accordance with AS 3600 and AS 5100 (as appropriate) and the provisions of this Specification.

Concrete shall be properly and adequately cured to ensure a dense, hardwearing surface free of shrinkage cracks. Details of the curing methods shall be documented and will be subject to acceptance by the Certifying Engineer, before any concrete is placed.

Freshly cast concrete shall be protected from premature drying due to hot temperatures and/or drying winds by the use of screens or by spraying the surface with aliphatic alcohol.

9.17.2 Initial curing

Initial curing of exposed concrete surfaces shall be commenced as soon as the surface of the concrete has hardened sufficiently to prevent damage and in any case the same day that the concrete is mixed and placed and shall continue for not less than twelve hours. The concrete surface shall be kept continuously moist, preferably by ponding but, where this method is impracticable, by the use of an absorbent cover kept continuously wet. Undisturbed formwork provides an acceptable means of curing.

9.17.3 Final curing

Final curing shall commence immediately following the initial curing period and shall continue for not less than 7 days, or 14 days where specified in AS 5100.5 for exposure classifications C1 and C2 and for marine environments. During this period, the curing shall be carried out either by continuing the method used during the initial curing period or by covering the moistened concrete surface with an impermeable sheet membrane, fixed and lapped so that no air can circulate.

Any damage to, or displacement of, the sheeting during construction shall be made good immediately and, should the concrete surface show signs of drying out during the final curing period, the sheeting shall be temporarily removed, the surface of the concrete wetted and the sheeting replaced.

9.17.4 Curing of formed surfaces

Curing of formed surfaces shall commence immediately following stripping of formwork and shall continue for not less than 7 days, or 14 days where specified in AS 5100.5 for exposure classifications C1 and C2, and for marine environments. Curing time shall be measured as the time after pouring of the concrete. Rapid drying out at the end of the curing period should be avoided.
Steel forms exposed to direct sunlight and all wood forms in contact with the concrete during the final curing shall be kept wet. If forms are removed during the curing period, one of the

previously described curing methods shall be employed and continued for the remainder of the period.

9.17.5 Curing compounds

Curing compounds conforming to the requirements of AS 3799 used subject to the acceptance of the Certifying Engineer.

Curing compounds may only be used upon acceptance of the Certifying Engineer prior to commencement of concrete works and subject to the consideration of the following:

- Details of the proposed curing compound.
- Certified test results demonstrating compliance with the requirements of AS 3799.
- Evidence that the proposed curing compound can be applied and maintained effectively.
- Evidence that an acceptable final surface colour will be obtained.
- Evidence of compatibility with any subsequent surface finish.
- The application rate of curing compounds shall be in accordance with the Manufacturer's instructions.

Curing compounds shall not be used on floors or paving that will be trafficable during the curing period unless the surface is suitably protected against scuffing or damage.

Wax emulsion membranes may not be used in any situation of exposed concrete because of their potential to hinder subsequent penetration of silane or siloxane coatings (whether application of such a coating is specified or not). PVA based curing compounds shall not be used.

9.18 Protection of concrete surfaces

9.18.1 General

Finished concrete shall be protected from damage from any cause including construction equipment, materials or methods of construction, rain, running water or wind.

9.18.2 Protection against staining

Completed concrete surfaces shall be protected from reinforcement, timber and other materials such as timber debris, nails, pop rivets and other metal to prevent staining.

9.18.3 Protection from overstress

Concrete structures and surfaces shall be protected from damage due to overstress. Where the completed concrete works are used to support construction loads, calculations certified by the Certifying Engineer shall be submitted to Urban Utilities, at least 14 days prior.

9.19 Cores, Penetrations and cast-in items

9.19.1 General

Only items shown in the Project Documentation (e.g. anchor bolts, holes, pockets and inserts, pipes, collars, sleeves, Unistrut fittings etc) shall be supplied and built into the concrete. Any

items proposed to be built into the concrete that are not shown in the Project Documentation must be accepted by the Accountable Party.

All metal cast in items shall be 316L stainless steel unless noted otherwise in the Project Documentation.

Items to be cast into concrete shall be free of loose rust, mill scale, dirt, paint, grease, or any other deleterious substances.

9.19.2 Submission of drawings

Drawings showing all penetrations and cast-in items shall be prepared and submitted to Urban Utilities prior to erecting formwork.

9.19.3 Inspection

Cast-in items and formwork for penetrations shall be in their intended position at least one working day prior to the proposed time of pour to allow inspection by the Accountable Party, if desired.

9.19.4 Formed holes

Formwork for holes to be formed in the concrete for holding down bolts shall have sound, rough surface.

No holes will be permitted in concrete members, other than for form bolts, unless shown on the drawings or specifically approved by the Certifying Engineer.

9.19.5 Cored holes

Where holes are to be cored/drilled in existing concrete, they must be located so as to avoid damage to existing reinforcement. A calibrated cover meter or similar must be used to locate existing reinforcement and clearly mark its locations on the face of the existing concrete. Holes must then be located to ensure a minimum of 20 mm clearance from the cored hole to any existing reinforcement and their proposed locations marked on the face of the concrete also.

Where design dimensions are such that the holes cannot be located with minimum clearance to existing reinforcement, they will be subject to the approval of the Certifying Engineer before any hole may be cored or drilled.

9.19.6 Anchor bolts

The anchor bolt grade and material shall be as shown on the Project Documentation.

Where Grade 8.8 anchor bolts are specified, under no circumstances shall they be welded to or heated in any way.

Where threaded high strength reinforcing bar is specified on the drawings, it shall be quenched and self-tempered bar with a minimum yield strength of 500 MPa.

Bolts shall be set truly vertical or horizontal as shown in the Project Documentation. Anchor bolts shall be positioned within the following tolerances unless noted otherwise in the Project Documentation:

- Location of centroid of a group of bolts +/-3mm.
- Location of bolts relative to each other +/-2mm.
- RL of top of holding down bolts + 12mm / -3mm.

The ITPs shall incorporate how cast-in bolt assemblies will be positioned, supported and measured by survey to ensure the required tolerances are satisfied.

The thread of anchor bolts shall be protected against damage during concreting operations by PVC tape or equivalent means accepted by the Accountable Party.

The Accountable Party must be notified immediately of any damaged/bent bolts with proposed repair method put forward for review and acceptance.

9.19.7 Electrical conduits

Electrical conduits shall be in accordance with Urban Utilities Technical Specification TMS1200.

The conduits shall be installed in the positions and to the dimensions and levels shown in the Project Documentation.

9.19.8 Pipe Penetrations

Pipe penetrations shall be in accordance with the SEQ Code requirements including SEQ-SPS-1301-3, SEQ-SPS-1400-1 and SEQ-SPS-1407-2, as appropriate.

All pipe penetrations shall have a hydrophilic seal to prevent water ingress.

For core drilled penetrations for pipe penetrations shall provide a minimum clearance of 50 mm clearance around the pipe for grouting. Core drilling of any concrete shall not occur unless shown on Project Documentation or otherwise accepted by Urban Utilities.

9.19.9 Integrity of concrete

Holes and openings shall be formed, and inserts cast in place at the time of concreting, unless specified otherwise in the Project Documentation.

In general, multiple penetrations, such as conduits through walls and slabs must have at least 100mm of reinforced concrete between the penetrations.

At the discretion of the Certifying Engineer and subject to the Project Documentation, bolts for minor members such as ladders and cable tray support brackets may later be epoxy-grouted, or chemical anchored into holes cored or drilled in the concrete. Expansive type masonry anchors shall not be used.

No part of the work shall be drilled or cut away without the approval of the Certifying Engineer.

9.19.10 Integrity of reinforcement

Reinforcement shall not be cut or left out to provide space for penetrations or embedments without the acceptance of the Accountable Party and the Certifying Engineer. Extra trimming bars shall be provided as shown in the Project Documentation.

As a minimum, the reinforcement truncated by penetrations must be compensated as follows:

- Additional reinforcement adjacent to the penetration in each direction must be provided within half the size of the penetration on all four sides. The amount of reinforcement provided on each side must be at least equal to one bar more than the half the number of bars truncated by the penetration. The compensating bars must extend past the other compensating bars in the orthogonal direction by amount at least equal to the anchorage length.
- Circular penetrations of 600mm diameter or more must incorporate 2 additional diagonal trimmers at each corner of the square formed by the compensating bars that run in each orthogonal direction. The trimmer bars at each corner must be spaced no more than 100mm centres and extend past the other trimmer bars in the orthogonal direction by an amount at least equal to the anchorage length.

Pipes, services or fitments shall at no place have less cover than the reinforcing bars.

9.20 Joints in Concrete

9.20.1 General

Construction joints shall comply with the requirements of AS 3600.

Joints shall be formed and constructed to the details and in the locations shown in the Project Documentation and shall not be varied unless accepted by Urban Utilities.

All joints in concrete shall be truly vertical or horizontal. Inclined or feathered joints will not be permitted.

9.20.2 Construction joints

Construction joints shall be provided at the locations shown in the Project Documentation.

Additional construction joints may be made to details and in locations accepted by Urban Utilities. Such joints shall, if possible, be planned and their number kept to a minimum. Additional construction joints shall be marked on the as constructed drawings.

Subject to acceptance by Urban Utilities, construction joints in suspended elements may be made within the middle third of the span. No joints will be permitted at the ends of the span or close to the point of application of heavy concentrated loads.

The face of the first poured concrete joint surface shall be finished to a uniformly rough surface having an amplitude of roughness of approximately 3mm by one of the following methods:

- Retarding the set of the surface concrete and water washing after an appropriate time interval.
- Thorough scabbling of the whole surface by the use of a tool that will not cause damage to the underlying concrete.
- The roughened surface shall be free of laitance and loose material and shall have an exposed aggregate finish.

9.20.3 Emergency construction joints

Whenever the work of placing concrete is delayed so that the initial set, as determined by the Urban Utilities, has taken place, the point of stopping shall be deemed a construction joint and formed accordingly.

Where such a point of stopping occurs at a location considered unsuitable by Urban Utilities, such concrete already placed shall be removed as will enable a satisfactory construction joint to be formed where directed by Urban Utilities.

9.20.3.1 Saw cutting

In slabs poured on the ground saw cuts shall be made only as described in the Project Documentation.

The elapsed time from final set to commencement of cutting shall be as soon as practicable without damage to the concrete. This will vary with concrete strength and ambient temperature and may require night-time work.

9.20.4 Jointing Fillers and Sealants

Joint fillers and sealants shall be in accordance with the requirements of Section 13.5 and as shown in the Project Documentation or otherwise approved by the Certifying Engineer.

The joint filler in tied or dowelled joints between adjacent independent slabs shall be bitumen impregnated fibre board.

The joint filler in expansion or rotation joints shall be closed cell polyethylene foam joint filler fixed to the concrete already cast using an adhesive.

Joint sealants shall be single component chemically resistant polyurethane elastomer applied in accordance with the Manufacturer's requirements. Sikaflex Tank N is preferred or a direct equivalent if accepted by Urban Utilities.

Details of proposed fillers and sealants with technical data sheets and Manufacturer’s printed recommendations shall be submitted to Urban Utilities for acceptance at least 14 days prior to proposed use in any joint.

The ITP shall incorporate quality control procedures recommended by the sealant manufacturer including quality control testing on site and acceptance criteria appropriate to confirm the acceptable application of the product.

9.21 Waterstops

9.21.1 General

Water stops shall be of the type and location as shown in the Project Documentation.

9.21.2 PVC waterstops

PVC waterstops shall have a minimum four flange internal ribs or bulbs (i.e. Parchem Fosroc Supercast or a direct equivalent if accepted by Urban Utilities).

Specific product details and a sample profile of each type or pattern of waterstop shall be submitted to Urban Utilities for acceptance with respect to compliance with the design intent prior to installation.

9.21.3 Hydrophilic waterstops

All hydrophilic water stops shall be either set in a groove or fixed so that they remain securely in their correct positions during concreting.

Hydrophilic waterstops shall be fixed in place as close as practicable to the time of placing the concrete and shall be protected from rain or other sources of water until placement of subsequent concrete pours.

9.21.4 Workmanship

Water stops shall be installed in accordance with the manufacturer's recommendations and be firmly located in position.

No holes shall be made through any waterstops, except where special webs are provided for this purpose.

9.21.5 Splicing

Splicing shall be carried out in accordance with the manufacturer's requirements.

10. Concrete Liquid Retaining Structures

10.1 Scope

This section of the Specification applies to the requirements for concrete liquid retaining structures. It provides additional and precedent requirements to those outlined in the remainder of this specification, including Section 9 Concrete Structures.

10.2 Referenced Documents

The documents listed in Table 10-1 are either referenced, or shall be read in conjunction with, this section of the Specification.

Table 10-1 Referenced Documents

Reference	Description
Australian Standards	
AS 1012	Methods of testing Concrete
AS 3735	Concrete structures for retaining liquids
AS/NZS 4020	Standard for Drinking Water Products
AS 5100	Bridge design
Codes and Guidelines	
CIA Z7/06	Concrete Institute of Australia - Concrete cracking and crack control
CIA Z7/07	Concrete Institute of Australia – Performance tests to assess durability
CIRIA guide C766	Construction Industry Research and Information Association - Control of cracking caused by restrained deformation in concrete
WSA 201	Water Services Association - Manual for selection and application of protective coatings
Urban Utilities	
TMS76	Urban Utilities Technical Standard - Supplement to the WSA 201 manual for selection and application of protective coatings

The following structures are deemed to be liquid retaining structure and shall be designed to the requirements of AS 3735.

- Structures used for the storage or conveyance of liquids including water, wastewater, recycled water and stormwater.
- Hardstand areas, floors, bunds and walls required for the spillage containment of chemicals.

10.3 Durability

Design shall be in accordance with the durability provisions of AS 5100, except where varied by this specification or as stated in the Project Documentation.

It should be noted that exposure classification U in AS 5100 is inclusive of exposure conditions for the surfaces of liquid retaining structures (Refer notes 12 and 13 of AS 5100.5 Table 4.3). AS 3735 and AS 3735 Supp 1 shall be used to assess the exposure classification of the surfaces of liquid retaining structures.

Notwithstanding the provisions of AS 5100, for sewage assets design to the exposure classification D is required to achieve a design life of 100 years. Alternatively, Urban Utilities may accept specification for exposure classification B2, provided a PE liner and calcareous aggregate are adopted.

Liquid retaining structures containing sewage and wastewater of Item 2 with exposure classification D in Table 4.1 of AS 3735 shall include a protective coating or lining which isolates the concrete surface from the attacking environment. The coating shall extend from 500 mm below the low water level and cover all areas above the water level, including cover slab soffit.

All protective coatings and linings shall be in accordance with TMS76 and WSA 201 unless otherwise accepted by Urban Utilities. For sewerage applications including wastewater maintenance holes, PE lining systems must be used wherever possible for new structures and calcium aluminate cement mortar lining systems for refurbishment of existing structures.

The design shall consider the durability of water stops and sealants in conjunction with that of the main structure. The design shall carefully assess durability and maintainability of these items to ensure the overall structure remains in alignment with Urban Utilities objectives and requirements. Water stops and sealants used in contact with potable water must comply with AS/NZS 4020.

Liquid retaining structures, including maintenance holes, may not be constructed using pre-cast concrete.

10.4 Concrete Characteristics

10.4.1 Strength Grade

Special type concrete shall be used for all concrete liquid retaining structures.

The strength grade for each concrete element shall comply with the requirements of AS 5100 unless otherwise stated in Project Documentation.

The minimum strength grade for liquid retaining structures for sewerage assets must meet the requirements of the SEQ Code.

The minimum strength grade for other liquid retaining structures shall be either:

- S40 for exposure classification B2 or lower.
- S50 exposure classification C1 or higher.

10.4.2 Concrete Mix Proportions

The materials and concrete mix designs shall be submitted for the approval of the Certifying Engineer before commencing concrete placement. The Certifying Engineer shall consider the results of drying shrinkage tests and details of admixtures proposed for inclusion together with

the manufacturer's data sheets. Full details on the materials and concrete mix designs shall be submitted to Urban Utilities.

Unless indicated otherwise in Project Documentation, the specific requirements for "S" type concrete mixes shall be in accordance with Table 4.4.1(A) of AS 5100.5. Concrete mix designs shall not be varied without approval of the Certifying Engineer.

Sufficient water only shall be used to produce a workable mixture that can be conveyed from the mixer to the forms without separation of the coarse aggregate from the mortar. In no case shall the quantity of water used be sufficient to cause the collection of a surplus in the forms.

10.4.3 Drying Shrinkage

For S40 and S50 grade concrete, the maximum drying shrinkage at 56 days shall not exceed 600 microstrain, determined in accordance with AS 1012.13, with a tolerance range of ±50 microstrain.

After the concrete mix design has been accepted for use by the Certifying Engineer, three specimens of each concrete mix shall be tested and drying shrinkage readings shall be submitted after 14, 28, 56 and 90 days, for assessment of the drying shrinkage of the mix. During construction, three specimens shall be taken from the first pour of the mix. The concrete of each separate mix design shall be tested every three months and the results submitted to the Certifying Engineer. Restrictions on Chemical Content in Concrete

Restrictions in chemical content shall be in accordance with AS 5100.5.

10.5 Crack Control Requirements at Serviceability

Liquid retaining structures shall be designed with a limitation on surface crack width due to early thermal and drying shrinkage strains to a value that will allow self-healing during the autogenous healing process. The limiting crack width for self-healing will depend upon the pressure gradient across the cross section of the element. CIRIA Guide C766 provides detailed assessment methods for the design checks required. Reference should also be made to CIA documents Z7/06 and Z7/07 for Australian-specific concretes and conditions so that appropriate assumptions can be made. Note that the minimum reinforcement ratios stipulated in AS 3735, may not limit crack-widths to values that will self-heal.

When in service, the minimum crack control requirements must be in accordance with AS 3735.

10.6 Reinforcement

The minimum reinforcement requirements shall be in accordance with Table 3.1 of AS 3735 and the CIRIA guide C766.

The minimum reinforcement must be proportioned for the full thickness of the member irrespective of whether one or both surfaces are designated as liquid retaining structures.

No reduction is permitted, irrespective of joint spacing or length.

Reinforcement must also follow for early-age thermal crack control if cracks are predicted using the CIRIA guide C766 or other accepted methods.

10.7 Constructions Joints

Construction joints for liquid retaining structures shall be in accordance with Section 7210.20 of this Specification with the following additional requirements:

- Vertical construction joints are not permitted in circular liquid retaining structures.
- Details of proposed construction joints and sealing shall be subject for acceptance by to the Certifying Engineer before commencing construction.

Where possible, the design shall minimise/eliminate the need for joints in the floor and wall. Furthermore, joint sealants shall not be relied upon as primary seals.

All sealants and waterproofing materials that would come in contact with water intended for human consumption shall comply with AS/NZS 4020 and have proven performance in contact with cleaning/disinfecting solutions.

10.8 Curing

Concrete for liquid retaining structures shall be cured in accordance with Section 9.17 of this Specification and AS 3735, in accordance with the following additional requirements:

- Final curing shall commence immediately following the initial curing period and shall continue for not less than 14 days or a longer period as Urban Utilities may direct.
- The concrete strength of the concrete shall not be less than 75% of the specified f'c.

10.9 Maximum Crack Widths

A scaled elevation of cracks exceeding 0.15 mm to be prepared and submitted to Urban Utilities. Cracks exceeding 0.15 mm are deemed non-compliant and must be monitored in accordance with this specification.

10.10 Formed Surfaces

Surface finishes shall be in accordance with Section 9.16.

10.11 In Ground Structures

Inspections shall be carried out by the Contractor and Certifying Engineer for all liquid retaining structures before back filling or covering up of the structure to identify defects that may lead to water penetration. Further inspections shall be jointly carried out after back filling.

10.12 Base Preparation

The prepared formation level for all liquid retaining structures is to have a minimum of 50mm thick blinding concrete with minimum 0.2 mm polyethylene sheet over, directly below the structural slab.

10.13 Hydrostatic Testing

All liquid retaining structures shall be hydrostatically tested.

Hydrostatic testing shall not commence until all structural elements have reached their required design strength as defined by the Certifying Engineer.

Testing shall be undertaken prior to the application of any linings or protective coatings and prior to the placement of any backfill, toppings or concrete benching.

The structure shall be cleaned prior to testing and the testing period shall not commence for a minimum of 7 days after initial filling to allow for absorption and autogenic healing.

The method for hydrostatic testing shall be as per AS 3735 clause 7.3 to the highest operating level and filled at a rate not exceeding 2m in a 24 hour period.

During the testing period the water level must be recorded every 24 hours for a period of 7 days. During this period the total permissible drop, after allowing for evaporation and rainfall, must not exceed 1/500th of the average depth of the full tank or 10 mm, whichever is the less.

All leaks and visible wet areas shall be rectified and retested if not previously passed. All repairs and rectifications shall not be commenced until the repair methodology has been accepted by Urban Utilities.

11. PRE STRESSED CONCRETE

11.1 Scope

This section is for the design and construction of concrete structures manufactured off site involving pre-stressing reinforcement techniques and shall be read in conjunction with Section 10.

11.2 Referenced Documents

The documents listed in Table 11-1 are either referenced, or shall be read in conjunction with this section.

Table 11-1 Referenced Documents

Standard	Title
Australian Standards	
AS 1314	Prestressing anchorages
AS 4672	Steel prestressing materials Testing requirements

11.3 Design

11.3.1 General

The designer of prestressed concrete structures must verify the requirements specific to prestressed concrete structures that the performance requirements related to safety, serviceability, etc. are met. It is necessary to perform modelling and taking into consideration factors such as anchoring locations of tendons and whether concrete members and tendons are bonded, so the prestressing induced in the concrete members can be allowed for appropriately.

The means of introducing permanent prestressing into concrete members is classified as follows:

- Pre-tensioning method.
- Post tensioning method.
- Internal tendon method.
- External tendon method.
- Combination use of both methods.

11.3.2 Prestressed Concrete Classification

Prestressed concrete is classified into:

- Prestressed concrete structures. These structures do not permit cracking in serviceability related verification and are structurally designed to control the edge stress in concrete by introducing prestress.
- Prestressed and reinforced concrete structures. These structures permit cracking in serviceability related verification and are structurally designed to control crack width by installing reinforcement and introducing prestress.

11.3.3 Loads

For precast concrete elements made using prestressing steel, the tensile forces initially applied to the prestressing steel and the methods of production and curing, shall be taken into consideration when determining the apparent relaxation ratio of prestressing steel for calculating the loss of prestressing.

11.3.4 Durability

The verification of durability should take into account the influence of using prestressing methodology. Assessment of steel corrosion is required for reinforcing steel and prestressing steel. Prestressing steel must be protected from corrosion for the design service life. When prestressed reinforced concrete structures are constructed in chloride environments, plastic sheaths must be used to protect the prestressing steel from corrosion. Assessment of the steel corrosion is required for the entire tendon system, including anchors and deviators when external tendons and un-bonded prestressing tendons are used.

11.3.5 Safety

Verification of the influence of prestressing on safety is required. Safety verification must include investigation of cross-sectional failure and fatigue failure.

11.3.6 Serviceability

Verification related to serviceability requirements must separately address prestressed concrete and prestressed reinforced concrete structural classes. Verification related to appearance, vibration, displacement, deformation, watertightness, etc. must be completed.

11.4 Products

11.4.1 Grout

Proposed grout, shall be assessed for suitability for the intended purpose in advance of the grouting operation, to enable adjustments to be made to the materials plant.

Grout shall consist of pre-bagged materials requiring only the addition of a measured amount of water and shall comply with the Australian Standards.

11.4.2 Strands

Strands shall comply with the requirements of Australian Standards. The grade and diameter shall be specified with the relaxation class. Strands shall be supplied by suppliers with valid Certificates of Approval for the supply of strands.

The coating material to un-bonded strands shall be 1mm polypropylene unless otherwise specified.

11.4.3 Anchorage

Anchorages for post tensioning systems shall comply with the minimum performance requirements of Australian Standards. Documentary evidence of compliance shall be supplied with the anchors.

11.4.4 Ducts and Vents

Ducts, vents and connection material shall be sufficiently robust to resist damage during construction. They shall be smooth galvanised steel with a minimum wall thickness of 0.35mm or corrugated galvanised steel with a minimum wall thickness or 0.3mm. Where plastic ducts are used, they shall comply with the requirements Corrugated Plastic Ducts for Internal Bonded Post-tensioning.

Ducting shall prevent the entrance of paste from concrete and shall not cause harmful electrolytic action or deterioration of the tendons or tendon components. The internal cross-sectional area shall be at least twice the net area of the tendons' prestressing steel. The ducting shall be capable of transferring forces from the grout to the surround concrete.

11.5 Construction

All prestressing tendons must be fully bonded. Hand-placed or mechanically-placed mortar is not permitted.

Verification during construction shall include:

- Ensuring that the tensile stresses in tendons during and immediately after tensioning are not exceeded by the design values of tensile strength and yield strength of the tendons.
- Concrete cracking has not occurred and the tensile stress in concrete does not exceed the design flexural strength.
- Tension reinforcement has been provided in concrete in regions where tensile stresses exist.
- Diagonal tensile stress in concrete due to shear and torsional moment does not exceed the design tensile strength of concrete.
- The maximum values of flexural and axial comprehensive stress due to flexural moments, axial forces and prestressing forces immediately after prestressing are less than the design compressive strength of concrete.
- Verification of safety requirements.

12. PRE CAST CONCRETE

12.1 Scope

Concrete members or products produced in advance at a factory or at a field production facility shall be considered as precast concrete. This section shall be read in conjunction with Section 10.

Pre-cast concrete maintenance holes and liquid retaining structures are prohibited.

12.2 Referenced Documents

The documents listed in Table 12-1 are either referenced, or shall be read in conjunction with, this section.

Table 12-1 Referenced Documents

Standard	Title
Australian Standards	
AS 1597.1	Precast reinforced concrete box culverts- small box culverts
AS 1597.2	Precast reinforced concrete box culverts- large box culverts

12.3 Design

12.3.1 General

Concrete members or products produced in advance at a factory or at a field production facility shall be considered as precast concrete.

The precast concrete shall be designed to confirm it meets the required criteria for performance, safety and economy when used as a single unit or as part of a structure. Both each single item and the whole assembly of precast concrete must be safe for handling, transport and installation during construction and during the service period for the design life.

12.3.2 Loads

The design loads shall include storage, transportation, fabrication, joining, and others in addition to the normal design loads.

12.3.3 Connections

The connections designs for the precast members used in part or whole of the structure shall confirm the load transfer capacity of the connections with consideration of the connection method. It shall be confirmed that the connection will secure the required strength and durability based on the connection method.

12.4 Construction

12.4.1 Lifting

Precast elements shall not be lifted from the base on which they have been cast before the concrete has attained its design demounting strength and is strong enough to prevent the

precast element from being damaged, overstressed or distorted giving regard to demounting equipment to be used.

12.4.2 Reinforcement and Fixings

The manufacturer shall determine the need for any additional reinforcement or fittings necessary for handling the precast element or other provisions required for temporary structural purposes until the precast elements are incorporated into the structure, including details for making good of any provision made for lifting etc.

Any inserts of fixings required to be cast into the concrete and permanently exposed either externally or within the building cavity envelope shall be stainless steel.

12.4.3 Handling and Storage

Precast components shall be clearly marked before delivery in accordance with the erection specification to indicate their weight, location and orientation in the works in order to facilitate concrete erection. Where delivery cannot be timed for direct final positioning, arrangements shall be made for suitable storage to prevent deterioration or damage. Storage shall be on firm supports clear of the ground.

Precast component faces shall be protected from mechanical damage, dirt, staining, rust marks and other disfiguration.

12.4.4 Temporary Stability

Confirm that any precast concrete components to be incorporated into the structure shall be kept stable in its erected position until such time as the component can safely carry the construction loads without distress. The overall stability of the structure shall be maintained at all times during the erection process.

13. Concrete Rehabilitation

13.1 Scope

The repair of concrete and provision of coatings on concrete substrate must comply with the requirements of this specification. Rehabilitation of concrete maintenance holes must be in accordance with Urban Utilities standard TMS1720.

13.2 Referenced Documents

The documents listed in Table 13-1 are either referenced, or shall be read in conjunction with, Section 10 of this specification.

Table 13-1 Referenced Documents

Standard	Title
Australian Standards	
AS 1012	Methods of testing concrete
AS 1554	Structural steel welding
AS 1627.4	Abrasive blast cleaning of steel
AS 2350	Methods of testing Portland, blended and masonry cements
AS/NZS 2717.1	Welding Electrodes Gas Metal Arc
AS/NZS 4020	Standard for Drinking Water Products
AS/NZS 4671	Steel for the reinforcement of concrete
International Standards	
EN 1542:1999	Products and systems for the protection and repair of concrete structures
Codes	
WSA 201	Water Services Association - Manual for selection and application of protective coatings
Urban Utilities	
TMS76	Urban Utilities Technical Standard - Supplement to the WSA 201 manual for selection and application of protective coatings
TMS1720	Maintenance hole rehabilitation

13.3 Concrete Repairs

13.3.1 Breakout and Removal of Deteriorated Concrete

Unless otherwise required by the manufacturer of the proposed concrete repair products or accepted by the Certifying Engineer, breakout of existing failed concrete repairs shall be undertaken as follows:

- Saw cut the perimeter of each repair as a series of straight lines at right angles to the surface to a nominal depth of 20mm to prevent feathering of edges. Reinforcement is not to be damaged during this process.

- Remove defective concrete within marked out areas using a portable jack hammer or equivalent, to expose the sound concrete substrate.
- After initial removal of defective concrete, the Certifying Engineer shall be informed to inspect the breakout. Where the Certifying Engineer decides that any of the surrounding concrete is still not sound, the repair area shall be enlarged, until such time as the Certifying Engineer agrees all defective concrete has been removed.
- Where reinforcement is exposed, the breakout shall extend 25mm beyond the depth of the reinforcement.
- The repair perimeter shall extend until a minimum 130mm length of sound reinforcement (i.e. there is no section loss of the reinforcement) is achieved.
- Feathered edges will not be accepted and where necessary, fresh saw cuts are to be made to eliminate featheredges at the completion of the breakout.
- Record the exact locations and size of the breakout on relevant drawings and submit them to the Certifying Engineer for approval. The drawings shall be used for the purposes of recording and measuring the work.

13.3.2 Treatment of Exposed Reinforcement

To inhibit further corrosion any exposed reinforcement is to be cleaned prior to the reinstatement of concrete, as follows:

- Reinforcement shall be cleaned to remove any loose scale and/or corrosion products to achieve a surface finish equivalent to Sa 2.5 AS 1627.4.
- Abrasive blasting or the use of power tools are acceptable methods to achieve this class of finish.
- Where a loss of section greater than 30% is identified, an equivalent bar diameter in accordance with AS/NZS 4671 shall be welded to the existing sound bar. The weld shall be a double-lap splice (bars vertical) in accordance with Appendix F, Table F4 of AS/NZS 1554.3, Joint Type L-c. The minimum length of weld is 80mm and weld consumable are W50X in accordance with AS/NZS 2717.1 (ISO 14341). Welding within 50mm of bends in any bar is not permitted.
- The additional reinforcement shall be lapped in a manner such that the depth of cover is not reduced from the existing value.
- Welding of additional reinforcement shall be performed by experienced personnel with qualifications in accordance with AS 1554.
- Precautions shall be taken to prevent excessive heating and resultant damage to surrounding concrete during welding. The reinforcement welded joint configuration shall be double-lap splice as shown in Appendix F, Table F4 of AS/NZS 1554.3, Joint Type L-c.
- All reinforcement shall be primed with the preferred primer Nitoprime Zincrich (or a suitably approved equivalent). Application of the priming agent is to be in accordance with manufacturer's recommendations.

13.3.3 Concrete Substrate Preparation

The concrete substrate must be prepared prior to reinstatement of the concrete patch repair mortar. Except where otherwise required by the manufacturer of the repair product, an acceptable methodology is as follows:

- The substrate shall be lightly scabbled with a hand-held power tool such as a pneumatic hammer drill or jack hammer to ensure good adhesion (and mechanical key) with the repair mortar.
- Following the scabbling, thoroughly wash the substrate surface to ensure that the substrate is free from dust, loose particles, and other contaminants.
- Prepare the substrate prior to reinstatement of repair concrete by soaking with potable water for a minimum period of 2 hours.
- The substrate shall be primed with a compatible polymer emulsion-bonding agent (eg Nitobond HAR for Renderoc HB40). Application of the priming agent must be in accordance with the manufacturer's recommendations.
- The Accountable Party shall witness the concrete substrate preparation prior to concrete reinstatement.

13.3.4 Concrete Repair Materials

The concrete repair materials used shall be suitable for hand application. The concrete repair mortar shall have, as a minimum, an equivalent strength to the parent concrete. Unless otherwise approved by the Certifying Engineer, the concrete patch repair mortar shall be a single component polymer-modified cementitious repair mortar exhibiting the following characteristics:

- A minimum rated characteristic compressive strength of 40 MPa at 28 days.
- Drying shrinkage at 28 days age of less than 600 microstrain when tested in accordance with AS 2350: Part 13.
- The repair material shall not crack excessively due to thermal and/or shrinkage effects. Excessive cracking shall be defined as cracks with width in excess of 0.10mm in the repair, crazing/cracking covering significant areas of the repair, or any cracking at interfaces between old concrete and the repair material.
- The total chloride ion content of the repair material shall not exceed 0.1% by weight of cement.
- The total alkali content of the repair material (as Na_2O equivalent) shall be limited to 3.0 kg/m3 of repair material.
- Seven-day bond strength to substrate (by direct pull-off) with no single result less than 1 MPa and mean result exceeding 1.2 MPa.

The preferred repair mortar is Renderoc HB40 or similar equivalent approved by the Certifying Engineer. All materials in contact with potable water shall be in accordance with AS/NZS 4020 requirements.

13.3.5 Mixing

Unless otherwise required by the product manufacturer of the repair product, the mixing of the repair mortar shall be undertaken as follows:

- Mixing of the repair mortar shall be undertaken in accordance with the manufacturer's recommendations.
- Whole bags of dry component material shall be used. Split bags shall not be used. Materials that have passed the manufacturer's "best before" or "use by" dates or have otherwise deteriorated in any way in the opinion of the Certifying Engineer shall not be used.
- Potable water only is to be used during mixing, provided it also meets all requirements of the manufacturer of the repair product.
- The volume of mix ingredients shall be measured and added in accordance with the mix proportions and procedures recommended by the manufacturer.

13.3.6 Reinstatement

Unless otherwise required by the manufacturer of the repair product, reinstatement of the concrete using the repair mortar shall be undertaken as follows:

- The repair mortar must be applied prior to the drying of the priming agent.
- Placement of material on the prepared substrate shall be either by gloved hand or trowel application.
- The repair mortar must be thoroughly compacted onto the primed substrate and carefully packed around reinforcement to confirm there are no voids.
- Reinstate prepared area with proprietary high performance and low shrinkage repair mortar, compatible with existing concrete Renderoc HB40 preferred or similar equivalent approved by the Certifying Engineer in accordance with the manufacturer's requirements.
- If applying in layers, the manufacturer's recommended minimum and maximum thickness of application shall be adhered to and each previous layer must be scratched to provide a mechanical key to subsequent layers.
- Confirm that fresh material does not contaminate the tank by providing adequate containment to the work area. Dispose of trapped materials off-site in accordance with statutory authority regulations.

13.3.7 Surface Finishing

Finishing of the repair surface shall be flush with the surrounding areas within a tolerance of 2mm.

13.3.8 Curing

Curing shall be undertaken immediately after reinstatement. The curing compound shall have a minimum curing efficiency of 90%. A proprietary curing agent that is compatible with the repair mortar shall be used (Concure A99). Application of the curing compounds shall be in accordance with the manufacturer's requirements.

13.3.9 Repair of Surface Defects

Following the reinstatement and curing of the repair mortar, a visual inspection of the repairs shall be undertaken. Any surface defects identified shall be repaired as follows:

- Remove and dispose of all applied materials that lack uniformity, exhibit segregation, honeycombing, delamination, cracking, or which contain dry patches, voids, or sand pockets.
- Repair such areas immediately after cleaning and surface preparation of the substrate and the interface with the existing repairs.

13.3.10 Inspection and Testing

Inspection and testing of the repair areas must include compressive strength testing of repair mortar, visual inspection of all repairs and soundness survey of concrete repairs.

Where the manufacturers specify that additional testing is to be undertaken to adhere to their warranty schemes, then this additional testing must be undertaken. If destructive testing is involved, then these test areas are to be repaired as indicated in this specification.

All testing records and associated documentation must be included in quality assurance documentation to be submitted at handover.

13.3.11 Visual Inspection

Visual inspection must be undertaken on the surface of all repair areas. Any defects identified in this visual inspection, such as voids, honeycombing, cracking, crazing, or any cracking at interfaces between old concrete and the repair, shall be deemed unacceptable and must be satisfactorily repaired.

13.3.12 Soundness of Repair (Hammer Sounding)

After 7 days' and 28 days' curing, soundness surveys of all repair areas must be undertaken. Any hollow sounding shall be deemed unacceptable and must be removed and satisfactorily repaired, following the procedures outlined in this specification.

13.3.13 Compressive Strength Testing

Compressive strength testing of the repair mortar must be undertaken on the same batch of repair mortar to be used in the repair works as per AS 1012.9. The results of the compressive strength testing must be submitted to the Certifying Engineer for their approval.

13.3.14 Bond Testing

The bond strength of the applied materials shall be tested at a minimum of 3 locations after 7 days' curing. The testing shall be undertaken in accordance with EN 1542: 1999 *Products and systems for the protection and repair of concrete structures – Test Methods – Measurement of bond strength by pull off*. Areas of repair with bond strength below the performance criteria shall be deemed unacceptable and are to be removed and satisfactorily repaired, following the procedures outlined in this specification.

13.3.15 Exposed Reinforcement and Anchor Repair at Concrete Surface

Unless otherwise required by the manufacturer of the repair product, all exposed reinforcement and mild steel anchors at the concrete surface must be repaired as follows:

- Chisel cut concrete, perpendicular to concrete surface, 10mm deep around reinforcement/anchor.
- Breakout concrete around reinforcement/anchor to a depth of 60mm.
- Cut exposed reinforcement/anchor at a minimum depth of 50mm from concrete surface.
- Clean concrete surface and remove all loose material.
- Abrasive blast clean exposed reinforcement/anchor. Apply “Nitoprime” zinc rich primer.
- Thoroughly soak substrate with clean water. Apply “Nitobond HAR” primer.
- Apply “Renderoc HB40” to fill opening.

13.3.16 Exposed Reinforcement and Concrete Repair Around New Pipe Penetration in Existing Concrete

Unless otherwise required by the manufacturer of the repair product, exposed reinforcement and concrete around new pipe penetrations in existing concrete must be repaired as follows:

- Core holes on each corner of area to be cut.
- Saw cut concrete, perpendicular to concrete surface, 15 to 20mm deep around permitter of the opening.
- Breakout remaining concrete around the opening without damaging reinforcement.
- Cut exposed reinforcement so that it is 30mm clear of the pipe.
- Clean concrete surface and remove all loose material.
- Abrasive blast clean exposed reinforcement if it is corroded and apply “Notoprime” zinc rich primer.
- Thoroughly soak substrate with clean water for a minimum of two hours.
- Place N12 circular trimmer on both sides of the flange.
- Install Hydrotite CJ-0725 seal on pipe 50mm from concrete surface.
- Apply “Nitobond HAR” primer or approved equivalent to concrete surface.
- Pour concrete/grout under pressure to fill opening.
- Cure concrete/grout to supplier requirements.

13.4 Epoxy Mortar Lining

13.4.1 Contractor Experience

The applicators shall be manufacturer-approved applicators of the lining material and shall have appropriate experience in the use of the material and application equipment. Experience in undertaking similar repairs shall be supplied to the Certifying Engineer.

13.4.2 Trial Application

A trial application to confirm the material and application methodology is adequate shall be undertaken. The trial application shall occur at two sites for each structure to be repaired.

The full scale of epoxy mortar lining work shall not be undertaken prior to successful completion of the trial.

13.4.3 Concrete Substrate Preparation

Unless otherwise required by the product manufacturer, the concrete substrate shall be prepared prior to application of the epoxy lining as follows:

- The area to be lined shall be demarcated using saw cuts 5mm deep to prevent feathered edges at the extremities of the repair area.
- The substrate shall be lightly scabbled via grit or water blasting to ensure good adhesion (and mechanical key) with the epoxy mortar coating.
- Subsequent to scabbling, thoroughly wash the substrate surface to ensure that the substrate is free from dust, loose particles and other contaminants.
- The Certifying Engineer shall witness the concrete substrate preparation prior to epoxy lining.

13.4.4 Mixing

Unless otherwise required by the product manufacturer, mixing of the epoxy mortar shall be undertaken as follows:

- Mixing of the epoxy mortar shall be undertaken in accordance with the manufacturer's recommendations. Mixing shall be undertaken on site using a slow speed electric drill with a suitable paddle. Hand mixing shall not be used.
- Whole bags of component material shall be used. Split bags shall not be used. Materials that have deteriorated in any way shall not be used.
- The use of thinners is not permitted.
- The volume of mix ingredients shall be measured and added in accordance with the mix proportions and procedures recommended by the manufacturer.

13.4.5 Application

Unless otherwise required by the product manufacturer, the application of the epoxy lining shall be undertaken as follows:

- The surface shall be primed using an epoxy resin primer Nitobond EP. Application of the primer shall be by brush or spray.
- The epoxy mortar lining material shall be applied within 90 minutes of priming, while the primer is still tacky. If the primer is allowed to dry, a second application is required.
- Application of the epoxy mortar shall be by gloved hand to allow the material to be thoroughly worked into the prepared surface. The epoxy mortar lining shall not be applied over the vertical wall joints.
- The lining shall be built up as required to thickness such that the outmost aggregate is covered by a minimum of 5mm of epoxy mortar in accordance with the manufacturers recommended application rates.
- The repair surface shall be finished with a steel trowel.

- Confirm that fresh material does not contaminate the tank by providing adequate containment to the work area. Dispose of trapped materials off-site in accordance with statutory authority regulations.
- Should the Contractor wish to use Nitomortar ELS (spray applied), work methods statement and evidence of experience in the application method must be submitted and accepted by the Urban Utilities prior to application.

13.4.6 Curing

Unless otherwise required by the product manufacturer, the epoxy mortar shall be allowed to cure for a minimum of 7 days. The finished surfaces shall be adequately protected whilst curing.

13.4.7 Limitations

Unless otherwise required by the product manufacturer, limitations for the works are as follows:

- The repair material shall not be applied when the substrate or ambient temperatures are below 5° C .
- Do not mix part bags.
- Do not use thinners.

13.4.8 Inspection and Testing

Inspection and testing of the coated areas is to include visual inspection of all surfaces, soundness survey and bond testing.

Where the manufacturers specify that additional testing is to be undertaken in order to adhere to their warranty schemes, then this additional testing is to be undertaken. If destructive testing is involved, then these test areas are to be repaired as indicated in this document.

13.4.9 Visual Inspection

Visual inspection is to be undertaken on the surface of all coated areas. Any defects identified in this visual inspection, such as voids, honeycombing, cracking, crazing, or any cracking at interfaces between old concrete and the coated area, shall be deemed unacceptable and are to be satisfactorily repaired.

13.4.10 Soundness of Repair (Hammer Sounding)

After 7 and 28 days curing, soundness surveys of all coated areas are to be undertaken. Any hollow sounding shall be deemed unacceptable and are to be removed and satisfactorily repaired, following the procedures outlined in this document.

13.4.11 Bond Testing

The bond strength of the applied materials shall be tested at a minimum of 3 locations after 7 days' curing. The testing shall be undertaken in accordance with EN 1542: 1999 *Products and systems for the protection and repair of concrete structures – Test Methods – Measurement of bond strength by pull off*. Areas of repair with bond strength below the performance criteria

shall be deemed unacceptable and are to be removed and satisfactorily repaired, following the procedures outlined in this document.

13.5 Joint Sealant

All expansion and contraction floor slab joints and internal wall joints shall receive joint sealant application.

Joint sealant works shall not commence until the concrete repair mortar and epoxy mortar lining have had adequate time to cure in accordance with the manufacturer's recommendations (minimum 14 days).

13.5.1 Contractor Experience

The applicators shall be manufacturer-approved applicators of the sealant material and shall have appropriate experience in the use of the material and application equipment. Experience in undertaking similar repairs shall be supplied to the Certifying Engineer.

13.5.2 Trial Application

A trial application to confirm the material and application methodology is adequate in sealing the joints shall be undertaken to the satisfaction of the Certifying Engineer. The trial application shall occur at four sites.

13.5.2.1 Trial Site 1

Floor slab contraction joint, 5m total trial length (include concrete repair, intersection and saw cut length).

13.5.2.2 Trial Site 2

Floor slab expansion joint, 5m total joint length (include concrete repair, intersection and saw cut length).

13.5.2.3 Trial Site 3

Internal wall contraction joint 5m total joint length.

13.5.2.4 Trial Site 4

Internal wall expansion joint 5m total joint length.

13.5.3 Joint Saw Cutting

Unless otherwise required by the product manufacturer, the following joint saw cutting shall be undertaken prior to joint preparation:

- The joint edges shall be saw cut and broken out to the nominal depth and width in order to achieve the specified dimensions (maintaining a width to depth ratio of 2:1).
- Concrete within the saw cut area shall be mechanically broken out to form the prescribed joint detail as detailed in the Project Documentation.
- Joints which do not require saw cutting shall have their surfaces ground to the depth of sealant application.
- A 3 to 5mm chamfer shall be ground on all joint edges.

13.5.4 Joint Preparation

Unless otherwise required by the product manufacturer, the following joint preparation shall be undertaken prior to the application of the joint sealant:

- Joint surfaces to receive replacement sealant shall be cleaned using mechanical grinding followed by water blasting to remove all traces of foreign material, moisture, or other contaminants.
- All traces of the existing sealant and other contaminants shall also be removed on the concrete surfaces adjacent to joint areas.
- The joint shall be cleaned of all loose material by vacuuming to its full depth.
- A sound, clean and dry (moisture content below the maximum allowed by the sealant manufacturer at time of sealant application) surface shall be achieved ready for the replacement joint sealant.
- Prior to application of sealant, a backing rod shall be installed. The backing rod shall be fitted at the depth of the joint as shown on the Project Documentation to maintain a width to depth ratio of 2:1. The diameter of the backing rod shall be approximately 25% larger than the joint width.
- Prior to application of the replacement sealant, the prepared concrete joint surfaces shall be primed using Sika Primer -3N (or direct equivalent accepted by Urban Utilities) in accordance with the manufacturer's recommendations unless otherwise approved by the Certifying Engineer.
- The surface either side of the joint shall be temporarily masked to prevent contamination with excess sealant and facilitate compaction of the sealant thus confirming full contact with the joint sides. The tape shall be removed after sealant application and prior to the manufacturer's specified skinning time.

13.5.5 Application

Unless otherwise approved by the product manufacturer, joint sealant application shall be undertaken as follows:

- Sikaflex Tank N shall be applied to the primed surfaces in accordance with the accepted ITP and sealant manufacturer's recommendations.
- The sealant shall have a minimum depth of 15mm and a maximum depth no greater than 20mm and also meet the required width to depth ratio of 2:1.
- Immediately after the sealant application, the sealant must be tooled and compacted into a regular cross section to the specified profile, using a small spatula or other suitable tool.
- The Contractor must ensure that the completed sealant is adequately protected during curing to prevent damage being caused to it by its or others operations.
- The sealant shall be allowed a minimum of 6 days curing time for 15mm depth, with an additional 24 hours per additional 2.5mm depth. The sealant manufacturer shall confirm the curing period and any other curing requirements deemed relevant for this project.

13.5.6 Inspection and Testing

The following inspection and testing shall be undertaken:

The sealant manufacturer shall recommend quality control testing on site and acceptance criteria appropriate to confirm the acceptable application of the product, which shall be included in the ITP, for the Certifying Engineer's approval.

As a minimum at one location per 100m of sealant installed, a "tongue" of sealant shall be cut using a sharp knife along either side of the joint so that the "tongue" can be lifted to project by approximately 150mm. The tongue shall then be pulled at an approximate angle of 45 to 90 degrees to the joint surface to tear the sealant out of the joint. The sealant shall fail in cohesion, i.e. tear within itself, rather than pull away from the concrete substrate. In the event that this is not achieved, the Certifying Engineer shall instruct additional testing in the 100m of sealant represented by the test and any areas failing to meet the requirement shall be replaced at the Contractors expense.

The Contractor shall inform the Certifying Engineer of all completed sealant replacement one day after final application for the Certifying Engineer's inspection and approval.

Areas where the replaced sealant does not comply with the quality control testing and/or is not properly bonded as demonstrated by hand probing, sagging, has voids, etc. or where the sealant is in the Certifying Engineer's opinion defective in other ways, it shall be replaced by the Contractor to the Certifying Engineer's satisfaction at the Contractor's own cost. Additional quality control testing may be carried out to non-compliant designated areas at the Contractor's cost.

All destructive tests required to the applied replaced sealant for quality control testing shall be made good and reinstated to the profile of the surrounding surfaces using the approved sealant materials and workmanship.

Upon acceptance that all sealant has been applied in accordance with this Specification the Contractor shall submit two original "As Repaired" documents in digital and hard copy to Urban Utilities for the purpose of recording the repair works inclusive of:

a) Tabulated listing of all applied replacement sealant.

b) Position marked on drawing plan of all applied sealant.

c) All quality control tests completed and results obtained.

d) Position marked on drawing plan of quality control tests.

13.6 Protective Coatings

Protective coatings for concrete structures shall be designed, supplied and installed in accordance with the Urban Utilities' standard technical specification TMS76 and WSA 201 *Manual for Selection and Application of Protective Coatings*.

The details of the proposed coating system, including warranty information, shall be submitted to Urban Utilities for acceptance prior to commencement.

The ITP shall incorporate all quality control procedures including those in relation to TMS76, WSA 201 and manufacturer 's requirements.

14. Metal Structures

14.1 Scope

This section specifies the minimum requirements for the supply of materials, shop detailing and fabrication, marking, packing, handling, surface treatment, transport to site, erection and installation of structural metalwork.

Metalwork shall include, but not be limited to, structural members, metal plates, anchor bolts, embedded items and any such other metalwork (whether permanent or temporary), as detailed in the Project Documentation or as determined necessary for the construction of the works.

Where not otherwise specified in this clause, metalwork must also comply with TMS1639 *General Mechanical Specification*.

Lifting facilities, including monorail and gantry crane rail beams must be in accordance with the requirements of TMS1639.

All materials, components, methods, and labour used in the work shall comply with the requirements of current and relevant standards, specifications in *National Construction Code* and/or Local Council publications and manufacturers' recommendations.

14.2 Referenced Documents

The documents listed in Table 14-1 are either referenced by; or shall be read in conjunction with this clause.

Table 14-1 Referenced Documents

Standard	Title
Australian Standards	
AS 1100	Technical Drawing
AS 1101.3	Graphic Symbols for General Engineering – welding and non-Destructive Examination
AS 1111	ISO metric hexagon bolts and screws
AS 1112	ISO metric hexagon nuts
AS 1171	Non-Destructive Testing – Magnetic Particle Testing of Ferromagnetic Products, Components and Structures
AS/NZS 1163	Cold-formed structural steel hollow sections
AS/NZS 1167	Welding and brazing – Filler metals
AS/NZS 1214	Hot dip galvanised coating on threaded fasteners
AS 1237.1	Plain Washers for Metric Bolts, Screws and Nuts for General Purposes
AS/NZS 1252	High strength steel fastener assemblies for structural engineering – bolts, nuts and washers
AS 1397	Continuous hot-dip metallic coated steel sheet and strip – coatings of zinc and zinc alloyed with aluminium and magnesium
AS 1418	Cranes, hoists and winches

Standard	Title
AS 1478	Chemical admixtures for concrete, mortar and grout
AS/NZS 1554	Structural steel welding
AS/NZS 1594	Hot-Rolled Steel Flat Products
AS 1627	Metal finishing – preparation and pretreatment of surfaces
AS 1657	Fixed platforms, walkways, stairways and ladders – design, construction and installation
AS/NZS 1664	Aluminium structures
AS/NZS 1665	Welding of aluminium structures
AS 1674	Safety in Welding and Allied Processes
AS 1710	Non-destructive testing - Ultrasonic testing of carbon and low alloy steel plate and universal sections - Test methods and quality classification
AS/NZS 1734	Aluminium and aluminium alloys – flat sheet, coiled sheet and plate
AS 1796	Certification of Welders and Welding Supervisors
AS 1858	Electrodes and Fluxes for Submerged Arc Welding
AS/NZS 1865	Aluminium and aluminium alloys – drawn wire, rod, bar and strip
AS/NZS 1866	Aluminium and aluminium alloys – extruded rod, bar, solid and hollow shapes
AS/NZS 1867	Aluminium and aluminium alloys – drawn tubes
AS 1874	Aluminium and aluminium alloys – ingots and castings
AS 2062	Non-Destructive Testing – Penetrant Testing of Products and Components
AS 2177	Non-Destructive Testing – Radiography of Welded Butt Joints in Metal
AS/NZS 2205	Methods of destructive testing of welds in metal
AS 2207	Non-destructive testing – ultrasonic testing of fusion welded joints in carbon and low alloy steel
AS/NZS 2214	Certification of Welding Supervisors – Structural Steel Welding
AS 2312	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings
AS 2331	Methods of test for metallic and related coatings
AS 2574	Non-destructive testing - Ultrasonic testing of ferritic steel castings
AS/NZS 2728	Prefinished/prepainted sheet metal products for interior/exterior building applications
AS 2841	Galvanised steel wire strand
AS/NZS 2980	Qualification of Welders for Fusion Welding of Steels
AS/NZS 3678	Structural steel – hot-rolled plates, floorplates and slabs
AS/NZS 3679.1	Structural Steel - Hot-Rolled Bars and Sections

Standard	Title
AS 3679.2	Structural Steel – Welded I Sections
AS/NZS 3750	Paints for steel structures
AS 3978	Non-destructive testing - Visual inspection of metal products and components
AS 4100	Steel structures
AS/NZS 4020	Testing of products for use in contact with drinking water
AS/NZS 4600	Cold-formed steel structures
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4854	Welded consumables – covered electrodes for manual metal arc welding of stainless and heat-resisting steels – classification
AS/NZS 4855	Welding consumables – Covered electrodes for manual metal arc welding of non-alloy and fine grain steels – Classification
AS/NZS 4856	Welding Consumables – Covered Electrodes for Manual Metal Arc Welding of Creep resisting Steels – Classification
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 5131	Structural Steelwork – Fabrication and erection
AS/NZS 16834	Welding consumables – wire electrodes, wires, rods and deposits for gas-shielded arc welding of high strength steels – classification
AS 60974	Arc welding equipment – Welding power sources
AS/NZS ISO 3834	Quality requirements for fusion welding of metallic materials
AS/NZS ISO 9000	Quality management systems – Fundamentals and vocabulary
AS/NZS 9004	Quality management — Quality of an organization — Guidance to achieve sustained success
AS/NZS ISO 14341	Welding consumables – wire electrodes and weld deposits for gas shielded metal arc welding of non-alloy and fine grain steels – classification
AS/NZS ISO 17020	Conformity assessment – requirements for the operation of various types of bodies performing inspection
AS ISO 17025	General requirements for the competence of testing and calibration laboratories
AS/NZS ISO 17632	Welding consumables – Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels
AS/NZS ISO 18273	Welding consumables – wire electrodes, wires and rods for welding of aluminium and aluminium alloys – classification
AS/NZS ISO 18276	Welding consumables – tubular cored electrodes for gas-shielded and non-gas shielded metal arc welding of high-strength steels – classification
MA1.8-1982	Manual for use in the design and construction of structural steelwork (known as the Manual on Steel Structures) – Fabrication
International Standards	

Standard	Title
ASTM A240	Standard specification for chromium and chromium-nickel stainless steel plate, sheet and strip for pressure vessels and for general applications
ASTM A276	Standard specification for stainless steel bars and shapes
ASTM A312	Standard specification for seamless, welded and heavily cold worked austenitic stainless steel pipes
ASTM A380	Standards for cleaning and passivation of stainless steel
ASTM A554	Standard specification for welded stainless steel mechanical tubing
ASTM A789	Standard specification for seamless and welded ferritic/austenitic stainless steel tubing for general service
AWWA D100	Standard for welded steel tanks for water storage
AWWA D102	Welded Steel Tanks Coating and Painting Specification
AWWA D103	Factory-coated bolted steel tanks for water storage
BS 7910	Guide to methods for assessing the acceptability of flaws in metallic structures
EN ISO 3690	Welding and allied processes
ISO 636	Welding consumables – rods, wires and deposits for tungsten inert gas welding of non-alloy and fine-grain steels – classification
ISO 3506	Mechanical properties of corrosion-resistant stainless steel fasteners
Codes	
WSA 201	Water Services Association - Manual for the selection and application of protective coatings
Urban Utilities Standards	
TMS76	Urban Utilities Corrosion Protection Supplement to the WSA 201
TMS1639	General Mechanical Specification
SEQ Code	SEQ Water Supply and Sewerage Design and Construction Code

14.3 Design Requirements

The design and engineering of all plant, facilities and equipment forming part of the works must comply with all applicable Acts, Regulations and Codes and other Laws governing in the State of Queensland, Australia and all government agencies having jurisdiction over the site.

The design of metal structures must be in accordance with the Section 6 *General Design Requirements*. Steel structures must be designed in accordance with AS 4100. Aluminium structures must be designed in accordance with AS/NZS 1664. The *SEQ Water Supply and Sewerage Design and Construction Code* for network assets may also apply.

14.4 Dissimilar Metals

Galvanic reaction is likely where dissimilar metals are in contact or within an electrolyte. The Contractor must recognise the dissimilar metal pair and the environment and, if they are unavoidable, detail the insulation or methodology for excluding the electrolyte. The most common occurrence of galvanic pairs is with fasteners.

14.4.1 Access Structures

The design and construction of fixed platforms, walkways, stairways and ladders are covered in TMS1639 *General Mechanical Specification* Section 6.14 *Access, (Stairs, walkways, ladders and handrails*) and shall fully comply with the requirements of AS 1657 *Fixed platforms, walkways, stairways and ladders – design, construction and installation*.

14.5 Fabrication Drawings

Fabrication drawings must be prepared and submitted before the scheduled fabrication date for approval by the Certifying Engineer. All submissions must identify the project, the subcontractor, the manufacturer, the applicable product, the model number and options, as appropriate. Include pertinent Specification and Drawing references.

All drawings must be provided in PDF format and comply with the requirements of the SEQ Code *Asset Information Specification* and PRO395 *Urban Utilities Asset Information Requirements*.

14.6 Quality Assurance

14.6.1 General

All materials supplied shall be manufactured by companies using quality management systems certified to AS/NZS ISO 9001 by a third party accredited by the Joint Accreditation System of Australia and New Zealand. All materials must comply with the relevant standards.

14.6.2 Inspection and Test Plans

The Contractor must prepare inspection and test plans (ITP) for the work before commencing the relevant works. The inspection and test plans must be certified by the Certifying Engineer and supplied to Urban Utilities upon request prior to commencement of the associated works.

The inspection and test plans will include the supply of records for each stage of the steel, stainless steel and aluminium metalwork fabrication and erection covering at least the following items:

- Materials proposed to be used, including welding consumables, before fabrication.
- Testing of welding procedures and welder qualification tests.
- Test results on materials or components including bolts.
- Preparation of welded joints before placing root runs of complete penetration butt welds.
- Surface preparation before shop painting.
- Specifications including types and colours of coating materials proposed to be used.

- Completion of protective coating before delivery to site, including checking of coating thicknesses.
- Checking of hold-down bolt geometry.
- Checking of steel, stainless steel and aluminium metalwork after erection to confirm compliance with tolerance requirements, before grouting of base plates, concrete encasement, site painting or cladding.
- Tensioning of bolts in categories 8.8/TB and 8.8/TF to AS 4100.

14.7 Materials and Components

14.7.1 General

The Contractor must provide mill and test certificates to the Certifying Engineer to confirm compliance with the relevant standard for grade, mechanical and chemical properties for all materials used in the works. These mill and test certificates shall be included in the quality documentation handed over to Urban Utilities. If requested by Urban Utilities, the material must also be tested by an independent testing authority for compliance in accordance with relevant chemical composition requirements and mechanical testing requirements.

14.7.2 Mild Steelwork

Minimum steel grade shall be as follows unless noted otherwise:

- Mild steel plate shall be Grade 250 U.N.O. complying with AS 3678. Mild steel rolled sections shall be Grade 300 complying with AS 3679.1.
- Mild steel welded sections shall be Grade 300 and Grade 400 complying with AS 3679.2.
- Rectangular hollow sections shall be Grade C350 complying with AS 1163. Tubes shall be Grade C250 or C350 complying with AS 1163.
- Cold formed purlins and girts shall be a minimum Grade C350 complying with AS 1397.
- Prefinished and pre-painted sheet metal products shall be in accordance with AS 1397 and AS 2728.

Dimensions and tolerances of the steel products shall comply with the appropriate Australian Standard.

14.7.3 Stainless Steel

Stainless steel material shall comply with the requirements of the following standards:

- Flat Bar ASTM A276.
- Round Bar ASTM A276.
- Round Tube ASTM A312.
- Square Tube ASTM A554.
- Plate, Sheet & Coil ASTM A240.
- Duplex Tube ASTM A789.

All austenitic grade stainless steel shall be Grade 316 (UNS S31600) or Grade 316L (UNS S31603).

Duplex stainless steel shall be Grade 2205.

Otherwise the grade(s) of stainless steel shall be as defined in the project specification.

All material will conform to the appropriate ASTM standard.

14.7.4 Aluminium

Aluminium shall comply with the following standards, as relevant:

- Plate AS/NZS 1734.
- Drawn bar and rod AS/NZS 1865.
- Extruded bar and rod AS/NZS 1866.
- Tube AS/NZS 1867.
- Castings AS 1874.

The grade of aluminium and/or the manufacturer's part number for fittings shall be as shown in the Project Documentation.

Unless defined otherwise in the project specification, aluminium components shall be in accordance with the relevant Australian Standards and shall be of the alloys and tempers outlined in Table 14-2.

Table 14-2 Aluminium Alloy and Temper Designations

Product	Alloy – temper
Roofing sheet and associated flashings	5251-H34
Purlins and girts	6061-T6
Extrusions	6061-T6, 6082-T5/T6 or 6351-T5/T6
Plate ≥3 mm thick	5083-H116/321
Round rod	6063-T5
Treadplate	5251-0

14.7.5 Carbon Steel Bolts

14.7.5.1 Steel Bolts

Where steelwork connection bolts are specified, hot-dipped galvanised high-strength steel bolts and associated nuts and washers that comply with the performance requirements of the latest edition of AS/NZS 1252 must be used.

Unless noted otherwise, carbon steel bolts, nuts and washers shall be galvanised to AS 1214.

Compliance certificates must be provided to the Certifying Engineer to verify specified requirements. Where certificates verifying compliance to the above standards are not available or are not satisfactory to the Certifying Engineer then bolts, nuts and washers from each type and batch to be used on the project shall be tested by a NATA accredited testing facility for AS/NZS 1252 compliance at the Contractor's expense, with particular consideration given to:

- Tensile strength.
- Proof load of bolts and nuts.

- Hardness of bolts, nuts and washers.
- Chemical composition from original heat certificate.

14.7.6 Stainless Steel Bolts

Stainless steel bolts, nuts and washers must conform to the requirements of ISO 3506.

Nuts and bolts must comply with ISO 3506 identifications or, if not so marked, must be provided with mill or NATA certified test results confirming grade and strength.

All stainless-steel bolts must be grade A4-70 (grade 316 stainless steel) as a minimum.

Stainless steel bolts and threaded rods shall be provided with stainless steel nyloc nuts and two stainless steel washers (one each under the head and nut).

14.7.7 Welding Consumables

14.7.7.1 Carbon steel

All electrodes must comply with the requirements of AS/NZS 1554. Unless specified otherwise, electrodes must be:

- B-E49XX to AS/NZS 4855 for manual metal arc welding.
- B-S49 to AS/NZS 14171 for submerged arc welding.
- B-T43 to AS/NZS ISO 17632 for flux cored arc welding.
- B-G49 to AS/NZS ISO 14341 for gas metal arc welding.

All low carbon and carbon manganese steel consumables must meet Grade 2 impact requirements as a minimum. All consumables must meet low hydrogen requirements of 5-10ml per 100g of deposited weld metal. The international standard that details the mercury method for diffusible hydrogen determination is EN ISO3690.

Welding consumables must be managed in accordance with AS/NZS 5131 and manufacturer's requirements.

14.7.7.2 Stainless steel

Electrodes for welding of stainless steel will be accordance with AS/NZS 1554.6 Table 4.6.1 and AS/NZS 4854.

14.7.7.3 Aluminium

Electrodes/wire for welding of aluminium must comply with the requirements of AS/NZS ISO 18273 and must be compatible with the materials being welded. Welding consumables shall be in accordance with AS 1665 and the manufacturer's recommendations.

14.8 Fabrication

14.8.1 General

Fabrication shall not commence until the Certifying Engineer has reviewed and approved the material test certificates.

ITPs shall be prepared for inspection at the following stages:

- Completion of fabrication prior to surface preparation.
- Completion of surface preparation prior to protective coating.
- Completion of erection prior to encasing or fixing cladding.

14.8.2 Structural steelwork

The fabrication of structural steelwork must be carried out in accordance with the requirements of the following standards:

- AS 4100 Steel structures.
- AS 4600 Cold-formed steel structures.
- AS 5131 Structural steelwork – Fabrication and erection.
- AS 1657 Fixed platforms, walkways, stairways, and ladders.

Generally, all structural steelwork must be fabricated off-site. All fabrication operations, including welding of steel and shear studs, must be carried out and completed where practicable in the fabrication workshops.

Only cold sawing may be used when producing full contact bearing surfaces. Full contact bearing surfaces in splices, at base plates and other connections must be as shown in the Project Documentation. Elsewhere, cold sawing, laser, plasma, water, or machine gas cutting, cropping and shearing may be used.

Flame cutting by free-hand is not permitted. Exposed flame cut surfaces must have a Class 2 finish as defined in WTIA Technical Note 5, Flame Cutting of Steels.

Holes shall be drilled or, where permitted by SAE AS5231, punched full size. Under no circumstances shall bolt holes be enlarged by flame cutting. Where excessive misalignment occurs, the holes shall be filled by electric welding and redrilled.

Re-entrant corners shall be smoothly rounded to a radius of 20mm.

Unless shown otherwise on the drawings, all corners on exposed edges shall be rounded to a radius of approximately 2.0mm, except where such edges are subsequently to be welded. Rolled edges must be rounded provided the corners have a similar radius.

Structural members must be provided in single lengths between nominated joints or splices.

The general tolerance of all dimensions shall be in accordance with AS 4100 and AS/NZS 5131.

A structural member shall not deviate from straightness or its intended length by more than that recommended in AS 4100 and AS/NZS 5131. Where tolerances are not specified, the absolute tolerance shall be 2.0mm.

Straightening methods are described in SAA MA1.8 Section 8.2.2.

If beam members have a natural camber within the straightness tolerance, fabricate and erect them with the camber up.

14.8.3 Additional Requirements for Fabrication and Erection of Stainless Steelwork

Fabrication of stainless steelwork must be performed by organisations accredited by the Australian Stainless Steel Development Association, or equivalent. Evidence of equivalent supporting knowledge and competence must be supplied by non-accredited fabricators.

Tools used for carbon steel may not be used to fabricate or assemble stainless steel components.

Work and storage areas for stainless steel must be isolated from those where carbon steel is processed to avoid contamination by dust and debris.

Limit the input of heat into the weld. The weld shall not be preheated, post-heated or stress relieved.

After shop fabrication, all components shall be pickled and passivated in accordance with ASTM A380

14.8.4 Additional Requirements for Fabrication and Erection of Aluminium Work

Aluminium components shall be fabricated in accordance with the requirements of AS 1664.

Aluminium may be cut by plasma arc cutting, sawing, or grinding unless specified otherwise herein or in the project specification. Flame cutting or shearing may not be used. Grinding may not be used on surfaces prepared for welding. Any cut surfaces to be incorporated into a weld must comply with the requirements of AS 1665.

Unless shown otherwise on the project drawings, all corners on exposed edges shall be rounded to remove sharp edges, except where such edges are to be subsequently welded. Rolled and extruded edges need not be rounded provided the corners are not sharp.

Re-entrant corners must be smoothly rounded to a radius of not less than 3mm.

14.8.5 Welding

14.8.5.1 General

The Certifying Engineer (independent of the Contractor, engaged by the Contractor) shall review all drawings, weld procedures, ITPs and other documentation relating to the weld work and verify they meet the specified technical standard.

Welding procedure shall be submitted to the Certifying Engineer and verified prior to fabrication of members utilising the particular procedure.

Welding records as agreed in the DRL shall be included in the quality assurance documentation handed over to Urban Utilities.

All fillet welds shall be minimum 6mm continuous welds unless noted otherwise on the Project Documentation. All welding shall be continuous and no intermittent welding shall be permitted.

All welding of structural steel shall be Category SP to AS 1554.1 unless shown otherwise on the drawings.

Welding of stainless steel must be in accordance with AS/NZS 1554.6.

Stainless steel welds shall undergo a mechanical and chemical clean, followed by passivation in accordance with Section 6.2.3 of AS 1554.6. Pickling and passivation of parts to achieve "Surface condition II" as defined in Section 6.2.3 of AS 1554.6 shall be included for all stainless steel fabricated equipment and shall be conducted in accordance with ASTM A380.

The application of pickle and passivation activities will not be permitted on site unless field welding is unavoidable and agreed to by Urban Utilities.

Welding of aluminium shall comply with the requirements of AS 1665.

14.8.5.2 Welding and NDT Personnel

All welding of steel items shall be carried out by skilled welders possessing the required qualifications as per AS 1554 and qualified in the particular welding procedure, welding position and steel being used.

Welding of aluminium shall be carried out by welders possessing the qualifications as per AS 1665.

Welding shall be inspected by a qualified welding inspector with suitable training and experience in the fabrication and inspection of welded structures satisfying the requirements of:

- Section 7.2 of AS/NZS 1554.1 for structural steel.
- Section 7.2 of AS/NZS 1554.6 for stainless steel.
- Section 7.2 of AS 1665 for aluminium.

Records must be maintained including the names, qualification(s), certifications, and experience of all the welders and welding inspectors engaged on the project. These records must be provided to the Certifying Engineer, and made available to Urban Utilities on request.

Weld inspection reports shall be in accordance with AS/NZS 5131.

All non-destructive testing shall be carried out by suitably qualified and accredited technicians for carrying out the examination method employed satisfying the requirements of:

- Section 7.4 of AS/NZS 1554.1 for structural steel.
- Section 7.4.2 of AS/NZS 1554.6 for stainless steel.
- Section 7.4.2 of AS 1665 for aluminium.

Companies providing the NDT services shall be NATA accredited and test technicians shall be accredited by the Australian Institute of Non-destructive Testing (AINDT).

14.8.5.3 Weld quality

Weld quality must conform to the requirements of AS 1554 and AS/NZS 1665.

Unless noted otherwise, the following must apply for the welding of stainless steel:

- Internal weld quality 1.

- External weld quality B.
- Surface finish II.

The finished surface and profile of welds shall be smooth and free from sharp edges or crevices. Slag, weld spatter, porosity and irregular weld contours shall be totally removed, and the weld surface replaced and ground back until a smooth surface is achieved.

14.8.5.4 Weld procedures

The weld procedures developed for the project must meet the requirements of Section 4 of AS 1554.1 for structural steel. Such procedures shall be fully documented on an approved form as indicated in Appendix C of AS 1554.1 and accompanied by NATA endorsed Test Certificates for any tests required.

Welding procedures for stainless steel structures shall meet the requirements of Section 4 of AS1554.6. Such procedures shall be fully documented on an approved form as indicated in Appendix C of AS 1554.6 and accompanied by NATA endorsed Test Certificates for any tests required.

Welding procedures for aluminium structures shall meet the requirements of Section 4 of AS 1665 and documented on an approved form as indicated in Appendix D of AS 1665 and accompanied by NATA endorsed Test Certificates for any tests required.

14.8.5.5 Weld inspections and testing

All welds must be inspected in accordance with the requirements of AS 1554.1 for structural steel, AS 1554.6 for stainless steel and AS 1665 for aluminium.

An ITP for the specific welding work shall be finalised before commencing work and contain all the necessary elements to ensure the completed welding work complies with the specified technical standards. The ITP shall contain the necessary witness points for the Accountable Party to audit the welding work for compliance to the weld procedures and standards.

Non-destructive testing (NDT) of welds shall be carried out by an independent inspection authority.

Unless specified otherwise in the Project Documentation weld inspection/testing requirements shall be as follows:

- For items fabricated in the shop the testing of SP weld shall be at least 100% visual and 10% NDT. In the case of butt weld, the NDT shall be radiographic.
- For field welding, except for reservoirs and tanks, the welds shall be 100% visual and 50% NDT. In the case of butt weld, the NDT shall be radiographic.
- For welded floor joints of elevated reservoirs, the minimum testing frequency shall be 100% visual and 50% radiographic NDT.

If 10% or more of each of the weld types selected for test prove defective, all welds of the defective type which have already been completed shall be tested.

Where it is necessary to repair welds that have failed the inspection criteria, a repair procedure shall be prepared prior to commencement of work. Repairs shall be made using qualified

procedures and personnel. The Contractor shall be responsible for meeting the cost of making repairs and their re-testing.

14.8.5.6 Shear Connectors

Shear connectors must be attached to beams by welding in accordance with AS/NZS 1554.2 and the Project Documentation. Stud welding operators must be qualified in accordance with the provisions of clause 4.3 of AS/NZS 1554.2

14.8.5.7 Site Welding

Site welding must not be undertaken without the Certifying Engineer's written approval.

Site welds must be to the standard of shop fabrication and welding and must be subject to inspection, testing and acceptability in accordance with this Specification.

14.8.6 Bolting

14.8.6.1 General

Unless noted otherwise in the Project Documentation, bolts must be high strength structural grade bolts, snug tightened bolting category 8.8/S.

Commercial bolts and nuts to AS 1111 (i.e. category 4.6/s) are only permitted where specified in the Project Documentation.

Unless specified otherwise in the Project Documentation, bolts material and grade shall be as noted in Table 14-2.

Table 14-3 Bolting Material and grades for Different Locations

Location	Bolting materials
Inside dry well, valve pits, and the like	Property Class 8.8 / Snug tight (Galvanised)
Above ground	Property Class 8.8 / Snug tight (Galvanised)
Inside wet wells, manholes and the like	A4-70 (316 stainless steel)
Buried	A4-70 (316 stainless steel)
In contact with liquid	A4-70 (316 stainless steel)
Cast into concrete	A4-70 (316 stainless steel)

All bolt assemblies must consist of at least 1 x bolt, 1 x nut, 2 x flat washers (washer under the bolt head and under the nut). Taper washers shall be used where the part under the bolt head is not perpendicular to the axis of the bolt.

Structural steel bolts must be coated with suitable lubricant to facilitate the initial tightening.

The length of bolts must be such that the threaded portion of the bolt projects through the nut at least two complete threads, but not more than 15mm.

Where bolted connections are used, except for TF bolts, all surfaces of individual members, cleats, and the like shall receive the full specified protective treatment before assembly.

Where steelwork is painted, bolts, nuts and washers shall also be painted after installation.

Where nuts are liable to work loose due to vibration, self-locking nuts or other approved locking devices shall be used. Black metal spring washers are not acceptable.

Any bolts that would require retightening to the full extent specified may not be reused.

14.8.6.2 Installation

Bolts in snug tight condition (S)

Commercial grade bolts and high strength structural bolts used in the "snug tight" condition shall be tightened as specified in AS 4100.

In no case shall the bolt tension exceed 65 percent or be less than 50 per cent of the guaranteed yield load of the bolt.

High strength bearing (TB) and friction (TF) type tensioned bolts

All category 8.8/TB and 8.8/TF bolt, nut and washer assemblies used on the Works must include one direct-tension indication device washer (DTI Squirters or approved equivalent) under the nut in addition to the nut/bolt/double flat washer combination.

Mating surfaces of friction type connections (TF bolting arrangements) must be coated with an approved primer in accordance with the Protective Treatment Specification.

In connections where the Certifying Engineer has approved bolts to be tensioned using the part-turn method as set out in AS 4100, match marking shall be permanent. After bolts have been tightened to their specified tension, the nut or bolt will be marked with a permanent marker to provide visual evidence that the bolted connection has been completed.

Stainless steel bolts

Stainless steel bolts shall be coated with an anti-seize product approved by the certifying engineer prior to tightening. The bolts shall be provided with stainless steel nyloc nuts and two stainless steel washers (one each under the head and nut). If in contact with drinking water, the anti-seize compound must comply with the requirements of AS 4020 and dissimilar metals corrosion implications must be considered.

Stainless steel bolts connecting to aluminium or another dissimilar metal must be fitted with insulating sleeves to isolate the dissimilar materials.

Stainless steel bolts shall be tightened to the correct torque using a torque wrench in accordance with the manufacturer's instruction. Tightening torques must take account of lubrication to threads.

Impact guns (electric or air) must not be used to assemble or tighten stainless steel bolted assemblies.

14.8.7 Identification Marks

Marks or other means for identifying each member, and for the setting-out, location, erection and connection of the steel metalwork must be provided.

If the work includes more than one bolting category, bolted connections must be marked to show the bolting category.

14.8.8 Surface Preparation

On completion of shop fabrication, prior to erection on site, and irrespective of any application of paint to the steelwork, clean the steelwork and fixings in accordance with the relevant requirements of the coating system to be applied.

14.9 Protective Coatings

14.9.1 Hot Dip Galvanising

Hot-dipped galvanised (HDG) coatings shall comply with the requirements of AS/NZS 4680. Coating thickness and mass shall be as follows:

- Minimum coating thickness: 85 µm.
- Minimum coating mass: 600 grams/sq. metre.
- System designation: HDG 600.

The company applying the galvanised coating shall have a current certification of a registered quality management system complying with AS/NZS ISO 9000:1 and AS/NZS 9004:1.

Where welding or cutting galvanised components is undertaken during installation the coating shall be reinstated in accordance with AS/NZS 4680 Appendix E.

Repair to galvanised surfaces shall be in accordance with Section 8 of AS/NZS 4680.

Galvanised steel surfaces that require coatings shall be prepared in accordance with AS/NZS2312.2 Clause 7.5.3.

14.9.2 Paint System

Paint protection systems and coatings shall be in accordance with WSA 201 and TMS76 – Urban Utilities Supplement to WSA 201.

Unless stated otherwise in the Project Documentation, the site shall be classified as Extreme as per table 5.1 of WSA 201 -2017-2.1, which is equal to Category C5-I *Atmospheric Industrial Zone (Very High)* as defined by AS/NZS 2312.1:2014.

The environment for steelwork subject to immersion shall be designated as *Sewage immersion for non-atmospheric environments* (Table C1 AS/NZS 2312).

The galvanised surface of that part of external steelwork which is buried, surrounded by paving or encased in concrete is to be painted with 2 coats of accepted bitumen paint.

Site welded areas and fasteners which are not suitably protected shall be coated with an approved paint system (complying with WSA 201 and TMS76) with similar properties, performance and compatibility with the protective system used on the surrounding surfaces.

Fasteners and bolt assemblies which are supplied with a protective treatment which is equivalent to the protective coating system on the steelwork need not be painted. Buried flanges, fasteners and bolt assemblies must also have a 'Denso' or equivalent petrolatum coating system applied.

Quality assurance must include ITPs for all applied coatings to demonstrate compliance with the requirements of TMS76 and WSA 201.

Surfaces inaccessible after shop assembly shall be cleaned and painted prior to assembly, except for contact surfaces, if required by the Project Documentation.

Paint is permitted in bearing-type connections. Slip-critical connections shall be prepared as detailed in the Project Documentation.

14.9.3 Protective Coating Quality Control

The application of protective coatings shall be covered by an ITP. This ITP, along with all quality control documentation, shall form the quality record for coatings and coatings repairs.

Where the protective coating has suffered damage, either during transport or during installation, it shall be repaired to meet the minimum technical requirements of the protective coating manufacturer. A suitable repair procedure endorsed by the manufacturer of the protective coating shall be prepared and provided to Urban Utilities upon request. The repair procedure shall include an ITP, with hold points for inspection by the Accountable Party.

Repainting or spot repairs to painted surfaces shall be in compliance with the coating or lining manufacturer recommendations and provided to Urban Utilities upon request, before commencing such repairs.

Repair to galvanized surfaces shall be in compliance with the requirements of AS 4680 Section 8.

14.10 Erection

14.10.1 General

Erection shall comply with AS 4100, AS/NZS 5131 and other relevant Standards, Statutory Regulations and the Project Documentation.

Temporary cleats must not be attached.

Site welding will not be allowed unless specified in the Project Documentation.

14.10.2 Work Method Statement

A work method statement (WMS) must be prepared for the erection procedure in accordance with Section 11 of AS/NZS 5131. It must also incorporate the information and requirements provided by the Certifying Engineer.

The WMS must include but is not limited to the following subjects:

- A general description of the erection process.
- Lifting and handling in the fabrication premises.
- Loading and transport to site.
- Lifting from the transport into position for fixing in place or storage on site prior to fixing in place.
- Bracing and propping of structural steelwork prior to building in.
- A statement identifying who is responsible for each activity.
- A risk analysis.
- An erection schedule.
- When bracing and propping is to be removed.

14.10.3 Handling and Storage

Handling, delivery and storage of steelwork shall be carried out in accordance with the requirements of AS/NZS 5131 and this Specification.

Stainless steel must be wrapped or otherwise protected during transport to avoid contamination. If an adhesive plastic film is used, all traces of adhesive must be removed from the steel with a suitable solvent on removal of the plastic.

14.10.4 Damaged Steelwork

Steel work damaged during off-loading, transportation, storage, or erection shall be replaced or repaired. Such repairs may be undertaken only with the consent of the Certifying Engineer. Where directed by the Certifying Engineer, damaged sections must be replaced.

14.10.5 Column Base Plates

Steel packs or levelling nuts are required to allow the structure to be properly lined and levelled. Steel packs shall be of sufficient size to prevent local crushing of concrete and be placed so they do not prevent subsequent grouting to completely fill all spaces directly under the base plate.

The base plate packs may be left permanently in place provided there are no corrosion issues in the future and do not compromise the capacity of the grout.

14.10.6 Base Plate Grouting

Grout for base plates must be precision non shrink grout complying with Section 17 of AS 3600 and AS 1478.2 and have a minimum characteristic compressive strength of not less than 40 MPa at 28 days. The thickness of the grout shall be in accordance with grouting manufacturer's recommendations.

When the grout has cured sufficiently to be able to carry the load of the structure without any detrimental effects, any temporary steel packs or wedges used to hold the column in position will be removed and the resultant cavities in the grout made good.

14.10.7 Stability and Safety during Erection

Work must include the planning of erection methodology, including the provision of materials, items and equipment for; and the design of temporary works such as guying, bracing and the like, so as to prevent damage, deformation or destruction of elements of the works and to ensure the safety, under all conditions of wind and erection loads occurring during the construction period of:

- The structure.
- Other site works.
- People on site.

14.10.8 Site Modification of Structural Steelwork

Modifications and repairs may not be undertaken on any structures during erection or to existing structures without a detailed written procedure and/or methodology submitted to, and approved by, the Certifying Engineer.

The written procedure and/or methodology must address all elements detailed in Section 14 of AS/NZS 5131.

15. Roads And Pavements

15.1 Scope

This specification applies only to Urban Utilities' internal roads; and identifies the minimum requirements for their design, materials and workmanship. Roads, pavements and access areas which are external to Urban Utilities sites must comply with the relevant road authority specification.

Roads and pavements include the following types:

- Access roads and driveways.
- Roads within the site including vehicular access to all structures as required.
- Vehicular access to bunding and chemical loading bays.
- Hard stand areas and footpaths.
- Site entry/ exit and transitions.

15.2 Referenced Documents

The documents listed in Table 15-1 are either referenced, or shall be read in conjunction with, this section.

Table 15-1 Referenced documents

Standard	Title
Australian Standards	
AS2876	Concrete kerbs and channels
AS/NZS 2890.1 2004	Parking facilities – off-street car parking
AS 2890.2 2018	Parking facilities – off-street commercial vehicle facilities
Austroads Specifications	
AGPT02-12	Austroads Guide to Pavement Technology Part 2: Pavement Structural Design
AGPT04K-18	Austroads Guide to Pavement Technology Part 4K: Selection and Design of Sprayed Seals
AGPT06-09	Austroads Guide to Pavement Technology Part 6: Unsealed Pavements
AP-G 34/06	Austroads Design Vehicles and Turning Path Templates (AP-G34/06)
Brisbane City Council Specifications and Documents	
City Plan 2014	Brisbane City Council Brisbane City Plan 2014 Chapter 3 Road Corridor Design (see https://cityplan.brisbane.qld.gov.au/eplan/#Rules/0/473/1/0/0)
S 120 Quality	Reference Specifications for Engineering Work – Quality
S 140 Earthworks	Reference Specifications for Engineering Work – Earthworks
S 150 Roadworks	Reference Specifications for Engineering Work – Roadworks
S 160 Drainage	Reference Specifications for Engineering Work – Drainage
S200 Concrete work	Reference Specifications for Engineering Work - Concrete work

Standard	Title
S 300 Quarry Products	Reference Specifications for Engineering Work - Quarry Products
S 310 Supply of Dense Graded Asphalt	Reference Specifications for Engineering Work - Supply of Dense Graded Asphalt
S 320 Laying of Asphalt	Reference Specifications for Engineering Work - Laying of Asphalt
S330 Sprayed bituminous surfacing	Reference Specifications for Engineering Work - Sprayed bituminous surfacing
Guidelines	
C&CAA T48	Cement, Concrete and Aggregates Australia - Guide to Industrial Floors and Pavements –design, construction and specification, October 2009
C&CAA T51	Cement, Concrete and Aggregates Australia – Guide to Residential Streets and Paths

15.3 Design Requirements

15.3.1 General

All weather vehicular access must be provided to facilitate servicing of all Urban Utilities infrastructure.

The roads and hardstand areas must be suitable for access by all those vehicles identified in the Project Documentation as being required for operations, maintenance, supply, demolition, and emergencies throughout the lifecycle of the asset.

All road and access areas must be designed in accordance with the Austroads *Guide to Road Design*. Road pavements must be designed in accordance with Brisbane City Council standards, unless otherwise specified in the Project Documentation. The design must also incorporate any requirements of local regulatory authorities.

The access and egress design shall take account of the manoeuvring requirements of specified vehicles.

15.3.2 Road access and appurtenant structures

Roads are required to enable the effective and safe operation and maintenance of assets including buildings, pumping stations, dosing facilities and other structures. Access design must consider the need for access by mobile cranes, tankers, articulated vehicles, emergency vehicles, coaches, vans, and passenger cars.

Roads must be provided with turning areas, passing bays, stormwater surface drainage, sub-surface drainage, trench drains and edge drains.

Concrete or bituminous surfacing must be provided for areas subjected to:

- The standing, parking and manoeuvring of all the specified vehicles.
- Regular cleaning or washing resulting of wetting of the ground surface.

The dimensions of these areas must provide necessary clearances from buildings and mobile plant such as generators, including when doors are fully open.

Appurtenances such as fencing, railing and vehicular barriers such as bollards, raised concrete slabs and kerb and channelling must be provided to protect facilities and structures from damage and people from injury by vehicles using the road.

Road lighting, road marking and traffic signage must be provided where appropriate and where required by the road authority.

Concrete kerb and channel must be provided:

- Along the full frontage of Urban Utilities sites, where required by the local council or DTMR.
- In areas where the stormwater runoff flow path will be along the edge of a sealed roadway into a kerb inlet or gully pit.
- In areas identified in the Project Documentation where it is required to provide a vehicular barrier.

15.3.3 Width of roads

The widths of roads must provide passageway and passing clearances for the appropriate vehicle classes using the road. The road width shall be designed to allow access by the vehicles specified in the Project Documentation.

The minimum roadway width is as follows:

- For two-way roads 6.2 m.
- For one-way roads 4.0 m.

The geometry and turning radii of roads must comply with the requirements of Austroads AP-G34/06 for the appropriate Design Vehicle classes. The design must undertake a swept path analysis and produce design drawings for vehicles required to access the facility.

The vehicles adopted for the swept path analysis shall include all vehicles required to access the site throughout the full lifecycle of the facility as accepted by Urban Utilities.

For the design of parking areas, the requirements of Australian Standard AS 2890.1 or AS 2890.2 must be met.

Access roads and manoeuvring areas must have dimensions adequate to ensure that all specified vehicles can enter and leave Urban Utilities' sites in a forward direction.

15.3.4 Pavement design

The design of pavements shall comply with the Brisbane City Council Brisbane City Plan 2014 Chapter 3 *Road Corridor Design*, Section 3.5 *Pavement Design* in accordance with the requirements of this specification and the minimum design criteria outlined below. The requirements of this specification shall take precedence.

The design life for road pavements shall be as specified in Brisbane City Council Brisbane City Plan 2014 Chapter 3 *Road Corridor Design*, Section 3 *Unsealed pavements* shall be classified as flexible pavements when considering the design life of these pavements.

The design traffic for pavement design shall be undertaken in accordance with Brisbane City Council Brisbane City Plan 2014 Chapter 3 *Road Corridor Design*, Section 3. Notwithstanding this, the minimum design traffic requirements for each pavement type shall be as specified below. Where the design traffic exceeds 1 x 10^6 equivalent standard axles (ESAs), direction shall be sought from Urban Utilities regarding the appropriate pavement type. Where traditional road pavement loading calculations are not appropriate, the design of rigid (concrete) pavements must be consistent with the guidelines in *Guide to Industrial Floors and Pavements* (Cement & Concrete Association of Australia, C&CAA T48, February 2009) for loading calculations.

The subgrade evaluation for pavement design purposes shall be undertaken in line with Brisbane City Council Brisbane City Plan 2014 Chapter 3 *Road Corridor Design*, Section 3.

15.3.4.1 Granular Pavements

Granular pavements with thin asphalt surface shall be designed in accordance with Brisbane City Council Brisbane City Plan 2014 Chapter 3 *Road Corridor Design*, Section 3.

The minimum design criteria for the pavement design shall be as follows:

- Unless otherwise specified in the Project Documentation, no growth shall be assumed over the design life.
- The minimum design traffic loading shall be TL20 (ESA) of 4.0 x 10^4.
- Higher mass limits (HML) value of 2 where applicable road is likely to carry multi combination vehicles (B doubles) for servicing of facilities (i.e. chemical deliveries, water or wastewater transport).
- Asphalt surfacing type and thickness shall be selected in accordance with the following table, Table 15-2.

Table 15-2 Granular Pavement Aggregate Applications

Nominal aggregate size	Typical applications
5 mm	Thin wearing course for footpaths.
10 mm	Surfacing course for roads subject to light traffic where 30mm (nominal) thick asphalt surface is specified.
14 mm	Surfacing course for roads subject to light traffic where 50mm (nominal) thick asphalt surface is specified. Surfacing courses for roads subject to heavy traffic.

15.3.4.2 Unsealed pavements

Unsealed pavements shall be designed in accordance with Austroads *Guide to Pavement Technology* Part 6: *Unsealed Pavements*, Section 4.

The minimum design criteria for the pavement design shall be as follows:

- Unless otherwise specified, no growth shall be assumed over the design life.
- The minimum design traffic loading shall be TL20 (ESA) of 4.0 x 10^4.

- Higher mass limits (HML) value of 2 where applicable road is likely to carry multi combination vehicles (B doubles) for servicing of facilities (i.e. chemical deliveries, water or wastewater transport).
- A sacrificial gravel wearing course shall be provided considering attrition of this layer due to environmental effects, traffic effects and/or frequency of patrol grading.

15.3.4.3 Rigid (concrete) pavements

Rigid pavements shall be designed in accordance with the requirements of the Brisbane City Council Brisbane City Plan 2014 Chapter 3 *Road Corridor Design*, Section 3. Design of rigid (concrete) pavements must also be in accordance with the *Guide to Industrial Floors and Pavements* (Cement & Concrete Association of Australia, C&CAA T48, February 2009) for pavement design.

As a minimum, rigid pavements consisting of reinforced concrete must be provided for:

- Vehicle washing bays.
- Hardstand area, parking area, loading bay, boom gate approach slabs etc. for vehicles transporting chemicals, sludge, and corrosive materials.
- Any area where heavy vehicles turning is likely.
- As otherwise required in the Project Documentation.

15.3.5 Drainage and Flooding

Roads shall be designed at levels free from flooding during storm events having an 1% AEP level. Where this is unavoidable, the road pavement must be designed to withstand the effects of submergence and stormwater flow during and after flood events, as well as when under traffic.

Stormwater Drainage systems must be designed in accordance with Section 6.5.5.

15.4 Pavement Construction

15.4.1 Subgrade Preparation

The subgrade shall be evaluated at construction stage in line with Brisbane City Council Brisbane City Plan 2014 Chapter 3 *Road Corridor Design*, Section 3 to confirm the subgrade properties assumed in the design. Where the assumed subgrade properties are not met, the Certifying Engineer shall instruct the required rectification measures.

Subgrade should be prepared in accordance with Brisbane City Council Specification S140 Clause 9.0.

15.4.2 Materials

15.4.2.1 Unbound granular

The material, quality and grading limits for flexible pavement shall be in accordance with Brisbane City Council Specification S300.

15.4.2.2 Gravel Wearing Course (Unsealed Pavements)

The use of unsealed pavements is not preferred and will be subject to the agreement of Urban Utilities and as specified in the Project Documentation. Unsealed pavements are not acceptable where the road grade exceeds 8%.

Gravel wearing course material shall meet the requirements of the Table 15-3.

Table 15-3 Gravel Wearing Course Specification

Sieve Size (mm)	Percent passing
55	100
37.5	95-100
26.5	90-100
19	80-100
2.36	35-65
0.425	15-50
0.075	10-40
PLASTICITY	Less than 500 mm annual rainfall – max. 20 More than 500 mm annual rainfall – max. 12 OR Weighted Plasticity Index (PI x % passing 0.425) Max. 500 for low rainfall Max. 250 for high rainfall
4 DAY SOAKED CBR	Minimum 40%

Gravel for wearing course shall be sourced locally as far as possible. Quality control of the Gravel Wearing Course shall be in accordance with Brisbane City Council Specification S300 Clause 2.0.

15.4.2.3 Sprayed Bituminous Seal

Selection and design of sprayed bituminous seals shall be conducted in accordance with *Guide to Pavement Technology* Part 4K: *Selection and Design of Sprayed Seals*. Sprayed bituminous seal materials and its application shall be in accordance with Brisbane City Council Specification S330.

15.4.2.4 Asphalt

Asphalt for pavement wearing surface and its application shall be in accordance with Brisbane City Council Specification S310.

15.4.2.5 Concrete for Pavements

Concrete for pavements shall be accordance with Brisbane City Council Specification S200. The minimum acceptable class of concrete is N32. Where small, solid-wheeled vehicles such as forklifts are expected to be operated, the minimum acceptable class of concrete is N40.

15.4.3 Placement

15.4.3.1 Unbound Granular Layers

Placement of unbound granular pavement layers shall be in accordance with Brisbane City Council Specification S150 Clause 3.0 and shall comply with the minimum requirements specified in Brisbane City Council Specification S120 Clause 6.0.

15.4.3.2 Gravel Wearing Course (Unsealed Pavements)

Placement of unbound granular pavement layers shall be in accordance with Brisbane City Council Specification S150 Clause 3.0 and shall comply with the minimum requirements specified in Brisbane City Council Specification S120 Clause 6.0. Gravel Wearing Course shall be prepared to the same specification as base course material.

15.4.3.3 Sprayed Bituminous Seal

Sprayed bituminous seal shall be placed in accordance with Brisbane City Council Specification S330 and shall comply with the minimum requirements specified in Brisbane City Council Specification S120 Clause 8.0.

15.4.3.4 Asphalt

The transport, laying of hot mix asphaltic concrete including the preparation of the base surface must be in accordance with Brisbane City Council Specification S320 and shall comply with the minimum requirements specified in Brisbane City Council Specification S120 Clause 7.0.

15.4.3.5 Concrete for pavements

Concrete for pavements shall be placed be accordance with Brisbane City Council Specification S200, Brisbane City Council Specification S150 Clause 6.0 and shall comply with the minimum requirements specified in Brisbane City Council Specification S120 Clause 5.0.

As a minimum concrete shall have a broomed finish with a surface texture of 0.40 mm (+-0.05 mm) in accordance with RMS Test method T192.

15.5 Kerb and Channel

Kerb and Channel shall be in accordance with Brisbane City Council Specification S150 Section 5. The profile of kerb and channel must be to the agreement of the relevant local authority.

15.6 Subsoil Drainage

Subsoil drainage shall be provided in accordance with the Brisbane City Council Brisbane City Plan 2014 Chapter 3 *Road Corridor Design*, Section 3 unless otherwise shown within Project Documentation.

15.7 Gully Pits

Gully pits must be in accordance with Brisbane City Council Specification 160 Clause 3.2.3.

16. Buried Site Electrical and Telecommunication Services

16.1 Scope

This specification applies to Urban Utilities' underground services involving conduits, cable pits and cable trenches in and adjacent to Urban Utilities sites.

16.2 Referenced Documents

The documents listed in Table 16-1 are either referenced, or shall be read in conjunction with this section.

Table 16-1 Referenced documents

Standard	Title
Urban Utilities	
TMS1200	Electrical Installation
TMS1732	General Electrical Standard Specification
TMS1582	Specification for Horizontal Directional Drilling (HDD)

16.3 General

The design must address all buried services potentially conflicting with the works as outlined in Section 6.4.3.

All new installed services shall be located and their details recorded by a licenced surveyor and the results incorporated with the as constructed drawings. All service locations including changes in direction shall be identified and detailed on the as constructed drawings.

16.4 Underground Conduits

Underground electrical conduits shall be in accordance with the TMS1200 *Electrical Installation*.

16.5 Cable Pits

Cable pits shall be compliant with the TMS1200.

Design, materials and construction of concrete pits shall be in accordance with Section 10 of this specification.

16.6 Cable Trenches

Cable trenches shall be compliant with TMS1200. Cable trenches must be free drainage and to allow for ease of access and maintenance.

Design, materials and construction of concrete trenches shall be in accordance with Section 10 of this specification.

17. Piling

17.1 Scope

This specification sets out the minimum requirements for design, construction and testing of piling systems to support permanent structures.

Urban Utilities' preference is for concrete piles, either of precast or cast in place construction. Pre-cast concrete piles require Urban Utilities approval subject to designer's assessment of risks including vibration and potential damage to adjacent services. All other proposed piling types are subject to acceptance by Urban Utilities. The pile type selection must consider vibration issues, ground conditions and settlement.

17.2 Referenced Documents

The documents listed in Table 17-1 are either referenced, or shall be read in conjunction with, Section 17 of this specification.

Table 17-1 Referenced Documents

Standard	Title
Australian Standards	
AS 1726	Geotechnical Site Investigations
AS 2159	Piling – Design and Installation
AS 3600	Concrete Structures
AS 5100	Bridge Design
Department of Transport and Main Roads	
MRTS63	Cast-in-Place Piles
MRTS63A	Piles for Ancillary Structures
MRTS65	Precast Prestressed Concrete Piles
Noise Management Code of Practice	Department of Transport and Main Roads - Transport Noise Management Code of Practice

17.3 Design

The piling system shall be designed in accordance with AS 2159. Cast in place and pre-cast pile structures shall have a design life of 100 years in accordance with Section 6.4.1.

17.4 Materials

The steel for liners shall be in accordance with MRTS63.

Concrete and reinforcement for piles shall comply with Section 10 of this specification.

17.5 Geotechnical

Geotechnical investigations must be undertaken to assess the appropriate pile type and prepare the pile design. Geotechnical investigations must be in accordance with AS 1726 and Sections 9.4 and 9.5.

17.6 Driven Piles

Precast prestressed concrete piles shall be manufactured and constructed in accordance with MRTS65. This must include quality system requirements, pre-stressed concrete piles, pre boring and pile driving, geotechnical certification and pile integrity testing.

17.7 Cast in Place Piles

Cast in place piles shall be constructed in accordance with MRTS63. This must include requirements in relation to fabrication of liners, sinking of liners, tolerances, excavation of cast in place piles, geotechnical certification and pile integrity testing.

17.8 Precautions with Driven Piles

a) pile driving and explosive blasting within close proximity of Urban Utilities sensitive infrastructure as defined in the Project Documentation is prohibited. Dilapidation reports for sensitive structures shall be prepared and provided with the design documentation.
b) heavy vehicle movements and jack-hammering, rock breaking and vibratory compaction must be minimised.
c) works relating to driven piles must address the requirements and processes for ground-borne vibration in the Department of Transport and Main Roads' "*Transport Noise Management Code of Practice: Volume 2 - Construction Noise and Vibration*" (the plan must include establishing and maintaining for the duration of works a vibration monitoring station adjacent to the sensitive infrastructure and restricting the PPV to no more than 2 mm/s) or as otherwise provided for in Project Documentation.
d) records of vibration monitoring must be provided to Urban Utilities immediately when construction starts, at intervals required by Urban Utilities and on completion of the works.

18. Demolition

18.1 Purpose

The purpose of demolition is to clear the site within the boundaries defined by the Project Documentation, so that it can be safely used by Urban Utilities for other purposes and as may be defined in the Project Documentation.

18.2 Performance Outcomes

Demolition activities shall achieve the following performance outcomes:

- Improved safety of remaining structures.
- Major waste streams (including but not limited to concrete, metal, rock, spoil), have been re-used or recycled, in accordance with Queensland Government legislation and policy (refer: https://www.qld.gov.au/environment/management/waste/recovery/strategy).
- All contaminated materials have been identified, safely removed from the site and disposed of to approved locations.
- Demolition works have not deleteriously affected any ongoing operations of Urban Utilities at the site.
- The site has been left in a clean, tidy and safe condition.

18.3 Scope

Demolition works shall be as depicted on the Project Documentation.

Demolition includes the removal of all above ground and below ground infrastructure such as plinths, structures and pipe work as specified in the Project Documentation and as outlined in Section 18.5.

Any excavated areas must be replaced with controlled fill using material that complies with this specification.

Urban Utilities shall be notified before commencing any demolition works.

A Form 16 (Building Regulation) certification must be provided to Urban Utilities upon completion of the demolition works.

18.4 Referenced Documents

The documents listed in Table 18-1 are either referenced, or shall be read in conjunction with, Section 18 of this specification.

Should there be any inconsistency between the provisions of any relevant regulatory authority and this specification, the current provisions of the relevant regulatory authority shall prevail.

Table 18-1 Referenced Documents

Standard	Title
Australian Standards	
AS 2601	The demolition of structures

Standard	Title
Brisbane City Council Specifications	
S140	Earthworks
S190	Landscaping
Legislation, Regulations and Codes	
Form 16	Department of Housing and Public Works – Form 16 – Inspection Certificate/Aspect Certificate/QBCCC Licensee Aspect Certificate
N/A	**Environmental Protection Act 1994 (Qld)**
N/A	Demolition Work Code of Practice 2021 (Qld)
N/A	Plant Protection Act 1989 (Qld)
N/A	Pest Management Act 2001 (Qld)
N/A	Land Protection (Pest and Stock Route Management) Act 2002 (Qld)
N/A	Planning Act 2016 (Qld)
N/A	Work Health and Safety Act 2011 (Qld)
N/A	Work Health and Safety Regulation 2011 (Qld)
Urban Utilities	
	Lock out tag out standard operating procedure
SWMS10	Urban Utilities' Safe Work Method Statement - Asbestos

18.5 Requirements

Demolition works shall be in accordance with AS 2601, the Workplace Health and Safety Queensland (WHSQ) *Demolition Work Code of Practice – 2021* and shall comply with the requirements of all associated industry standards and the relevant regulatory authorities. The following minimum requirements must also apply:

- Remove all contaminated material such as sewage sludge and asbestos. Asbestos must be removed in accordance with the requirements of the Urban Utilities'*SWMS10 Safe Work Method Statement - Asbestos*.
- All underground structures must be removed to a minimum of 1.5 m below the new finished surface, unless otherwise specified within the Project Documentation.
- Underground structures such as valve chambers and maintenance holes must be left free draining by means of core hole drilling or similar approved methods.
- All buried pipes to remain shall be capped and grout filled with minimum 5 MPa cementitious grout unless outside of a road pavement area. Buried asbestos pipelines beneath roads must be removed.
- Soil, unbound road pavements and aggregate may generally be reused. Bound pavements and concrete shall not be reused.

All underground structures proposed to be retained will be subject to the approval of Urban Utilities.

Removal of trees and vegetation shall be in accordance with Section 8.12.1.

18.6 Methodology

Plan all demolition work beforehand. The planning must include all details to ensure that the demolition works are undertaken in accordance with Urban Utilities' requirements and all regulatory requirements.

Demolition works shall be undertaken only by personnel appropriately qualified and adequately trained in demolition, with experience in the utilities industry, including RPEQ engineers who have demonstrated experience with demolition and site rehabilitation works.

Demolition crews must be appropriately experienced to readily identify hazards likely to exist at Urban Utilities' sites such as asbestos materials, contaminated material and uncharted services.

The demolition planning must incorporate risk assessment, nominate risk mitigations and eliminate hazards associated with potential unknowns for the activity, for example encountering uncharted services, contaminated/hazardous material and buried concrete. Demolition planning must include review of available records and information to assess the risks and plan the demolition activities to mitigate potential adverse outcomes.

The methodology must also:

- Identify the extent of any material to be reused. The reuse of any material yielded through demolition shall be subject to acceptance of Urban Utilities.
- Identify and plan compliance with relevant regulatory requirements, including but not limited to work method statements, accreditations, training, risk assessments and waste management.
- Identify locations for the disposal of all demolition material, including licenced waste facilities.
- Plan for de-energisation and isolation of energy sources in accordance with Urban Utilities PRO379 *Lock Out Tag Out Standard Operating Procedure*.
- Identify and schedule all de-isolation works required.
- Identify activities, dependencies and resources to appropriately schedule the work activities.

18.7 Methodology Submission

The proposed methodology submitted to Urban Utilities must include a detailed description of how it is proposed to carry out the works. Specific descriptions are required for, but not limited to, the following:

a) Coordination with staff of Urban Utilities, to avoid disrupting its operations.
b) Preliminary works, including site establishment and temporary works.
c) Demolition works, including confirming the required final depth of demolition.
d) Protection of existing services.
e) Materials and items handling, protection, and storage.
f) Handling and disposal of Asbestos-containing materials (ACM).

g) Contaminated soil and other waste material handling and disposal, including the disposal trail.
h) Occurrence of; and methods to mitigate any noisy and dusty work.
i) Protection of flora and fauna.
j) Protection of real property survey marks (and their reinstatement if disturbed).
k) A procedure to address the risk of explosion from cutting metal items in the presence of sewer gases.
l) The extent, details and coverage proposed for dilapidation surveys specific to the works.
m) Reinstatement.

18.8 Contaminated Soil and Other Wastes

18.8.1 General

All surplus materials including soil, spoil, concrete, masonry, damaged or rejected items, contaminated materials, etc. must be disposed of, or recycled via recognised organisations.

18.8.2 Presence of Contaminants

The possibility of any contaminants being encountered during the course of the work must be addressed in the Environmental Management Plan.

18.8.3 Waste Disposal Certificates

Demolition personnel must have been engaged by a 'suitable operator' for any environmentally relevant activities as required under the *Environmental Protection Act 1994* (Qld).

The 'suitable operator' is responsible for obtaining and holding waste disposal Registration Certificates for wastes, which may include but are not limited to the following:

- Acid sulphate soils if encountered.
- Contaminated soils if encountered.

The 'suitable operator' must be (or use) a licensed asbestos removalist. If the 'suitable operator' uses an asbestos removalist, it must ensure that the removalist is licensed and carries out work in accordance with the requirements of the *Work Health and Safety Act 2011* (Qld) and the *Work Health and Safety Regulation 2011* (Qld).

The 'suitable operator' shall manage RIFA in accordance with the provisions of the *Plant Protection Act 1989*, *Plant Protection Regulation 2002* (Qld) and *Pest Management Act 2001* (Qld). The 'suitable operator' must ensure that only a licensed pest management technician carries out this activity.

18.8.4 Contaminated Soil Disposal

The 'suitable operator' is responsible for obtaining and holding the permit and associated approval for the removal of contaminated soil, including managing the transportation, treatment and disposal methods of the material in accordance with the provisions of the *Environmental Protection Act 1994* (Qld).

18.9 Disposal and Clean Up

All material removed from site must be disposed of to an appropriately licenced waste facility. Waste tracking certificates must be completed for all waste transfers and compiled into quality assurance documentation. Materials may not be burned.

All retained underground structures shall be clearly marked on as-constructed drawings and provided to Urban Utilities at handover. The drawings shall provide a detailed and accurate (by licensed surveyor) location for all remaining assets exposed or identified during the works.

All demolition areas shall be reinstated in accordance with Section 9.17.

18.10 Immunisation

All personnel engaged on the works including employees, any subcontractors or suppliers, who may be subject to any potential risk of exposure to sewage or effluent, must be immunised against Hepatitis A, Hepatitis B and Tetanus before performing work at the site.

Proof of the immunisation status of all persons proposed to work on the work site must be produced to Urban Utilities before any works involving exposure to sewage or effluent may commence.

19. STEEL TANKS AND RESERVOIRS FOR WATER STORAGE

19.1 Scope

Steel tanks and reservoirs shall be designed in accordance with Urban Utilities standard TMS1581 and relevant Australian Standards and codes of practice. Where not covered by the relevant Australian Standards and codes of practice, then other Industry Standards referenced in Table 19.1 shall apply where relevant.

19.2 Referenced Documents

The documents listed in Table 19-1 are either referenced, or shall be read in conjunction with, Section 19 of this specification.

Table 19-1 Referenced Documents

Standard	Title
International Standards	
AWWA D100	American Water Works Association - Welded carbon steel stanks for water storage
AWWA D103	American Water Works Association - Factory coated bolted steel tanks for water storage
ISO 28765	Vitreous and Porcelain enamels - design of bolted steel tanks for the storage and treatment of water or municipal or industrial effluents and sludges
Codes	
WSA 201	Water Services Association - Manual for selection and application of protective coatings
Urban Utilities	
TMS76	Urban Utilities Technical Standard - Supplement to the WSA 201 manual for selection and application of protective coatings
TMS1581	Urban Utilities Technical Standard - Drinking Water Reservoirs and Tanks Specifications