Engineering

Technical Standard

TS 0600 - Watertightness Testing of Liquid Retaining Structures

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Government of South Australia

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Application & Interpretation of this Document

It is the responsibility of the users of this Standard to ensure that the application of information is appropriate and that any designs based on this Standard are fit for SA Water's purposes and comply with all relevant Australian Standards, Acts and regulations.

Users of this Standard accept sole responsibility for interpretation and use of the information contained in this Standard. Users should independently verify the accuracy, fitness for purpose and application of information contained in this Standard.

Only the current revision of this Standard should be used which is available for download from the SA Water website.

Significant/Major Changes Incorporated in This Edition

- Section 1.4 updated to include definition of Representative for different engagements under which this Technical Standard may be applied.
- Section 2.1 lists documents superseded by this standard
- Updated Section 3 to align with other standards
- Sections 4.1 and 4.4 reformatted for improved clarity
- Section 4.5 added to clarify requirements previously shown in Section 4.4
- Included Section 4.8.3 to allow for volume corrections due to temperature whilst testing
- Section 5 combines the testing of Sewer Chambers (MHs and wet wells) into a single Section
- Section 5.1.1 now aligns with historical SA Water practices, tolerances and acceptance criteria
- Section 5.3 amends requirements for backfilling of sewer chambers/maintenance holes prior to testing
- Separated out 5.4 for clarity and to be considered as part of the Work Method Statement required as per Section 3.5
- Section 6 provides known hazards associated with the testing activities nominated in this Technical Standard
- Minor updates throughout.

Document Controls

Revision History

Revision	Date	Author	Comments
0.1	15/07/20	MC, JS, LH	90% Issue for SAW Review
0.2	17/09/20	MC	90% Issue for Industry Review
1.0	12/11/20	HH, MD	Final Issue
2.0	02/09/21	HS, HH	Updated documentation requirements

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1 Introduction

SA Water is responsible for the construction and commissioning of an extensive amount of engineering infrastructure such that it is safe and fit for purpose.

This Standard has been developed to assist in the design, construction and commissioning of this infrastructure.

1.1 Purpose

The purpose of this Technical Standard is to provide clear, consistent and concise requirements for watertightness testings of liquid retaining structures.

1.2 Glossary

The following glossary items are used in this document:

Term	Description
DAFI	SA Water – Development Agreement Formal Instrument
FoS	Factor of Safety
MH	Maintenance Hole
SA Water	South Australian Water Corporation
TG	SA Water Technical Guideline
TS	SA Water Technical Standard

1.3 References

1.3.1 Australian and International

The following table identifies Australian and International standards and other similar documents referenced in this document:

Number	Title
AS 1210	Pressure Vessels
AS 2124	General Conditions of Contract (AS 2124-1992)
AS 3735	Concrete Structures for Retaining Liquids
AS 4037	Pressure Equipment - Examination and Testing
AS 4041	Pressure Piping
AS 4300	General Conditions of Contract for Design and Construct
WSA 02-2014	Gravity Sewerage Code of Australia
ACI 350.1	Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures (ACI 350.1-10) and Commentary
ASTM C969	Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines1
ASTM C1244-05	Standard Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test Prior to Backfill
ASTM F1759	Standard Practice for Design of High-Density Polyethylene (HDPE) Manholes for Subsurface Applications

1.3.2 SA Water Documents

The following table identifies the SA Water standards and other similar documents referenced in this document:

Number	Title
TS 0210	Pressure Testing of Pipelines
TS 0460	Liners and Floating Covers for Earth Bank Storages for Potable or Recycled Water
TS 0510	Supplement to WSA 02-2014
TS 0512	Supplement to WSA 04-2005
TS 0710	Concrete
TS 0711	Concrete Repairs (when released)
WSCM	Water Supply Construction Manual (SA Water Standard Drawing Set)
SCM	Sewer Construction Manual (SA Water Standard Drawing Set)
SAWO-NO-0022	Inspection and Maintenance of Storages - Offline (available upon request)
SAWS-WQ-0004	New Assets – Water Quality and Monitoring Requirements for Commissioning (available upon request)
SAWP-WQ-0035	Storages – Chlorine Dosing (available upon request)

1.4 Definitions

The following definitions are applicable to this document:

Term	Description
Accepted	Determined to be satisfactory by SA Water's Representative
Containment Structure	A basin, reservoir, channel, or conduit to be tightness tested regardless of whether it has a closed or open top or is constructed partially or entirely of concrete.
Containment Structure, Closed	A containment structure where the roof or cover is used to prevent the escape of the contents, including gases emanating from the contents to the outside atmosphere.
Containment Structure, Covered	A containment structure where the contents are protected from exterior contamination by the presence of a cover or roof over the top of the containment structure.
Containment Structure, Open	A containment structure where the top surface of the containment structure's contents is exposed to the atmosphere.
Contract Documents	A set of documents supplied to Constructor as the basis for construction; these documents contain contract forms, contract conditions, specifications, drawings, addenda, and contract changes
Constructor	The organisation responsible for constructing and installing infrastructure for SA Water whether it be a third party under contract to SA Water or an in-house entity.
Designer	The organisation responsible for designing infrastructure for SA Water whether it be a third party under contract to SA Water or a Constructor, or an in-house entity
Designer's Representative	For works delivered under a Development Agreement Formal Instrument (DAFI), is the person accountable for the design (or their representative)
Fitting	An object that passes through the concrete or is embedded in the concrete to facilitate a connection to the containment structure

Rated (or class) pressure and PN	A long-term (i.e. design life) internal pressure capacity for a pipe, fitting or valve. The PN 'number' is used as a pressure rating for pipeline components. The number is 10 times the rated pressure in MPa, e.g. PN 12 rating means the allowable long-term internal pressure is 1.2 MPa
Representative	The Representative shall be either one of the following: • For Works delivered under a Developer Agreement Formal Instrument (DAFI), this shall be the Designer's Representative. o Where witness or hold points on site are required under this standard, SA Water's Representative shall also be provided with notice to attend at their discretion. • For works delivered directly for SA Water under a Contract or engagement, this shall be SA Water's Representative.
Responsible Discipline Lead	The engineering discipline expert responsible for TS 0600 defined on page 3 (via SA Water's Representative)
'Shall' and 'Should'	In this Standard the word 'shall' indicates a requirement that is to be adopted in order to comply with the Standard. The word 'should' indicates practices which are advised or recommended.
SA Water's Representative	The SA Water representative with delegated authority under a Contract or engagement, including (as applicable): • Superintendent's Representative (e.g. AS 4300 & AS 2124 etc.) • SA Water Project Manager • SA Water nominated contact person
Sewer Chamber	Typically referring to pumping station wet-well chambers. Whilst not always 'water retaining', these structures are required to be watertight and must be tested as such in accordance with this Standard.
Sewer Maintenance Holes (MHs)	Inspection/access points located on sewer mains/plants, typically referred to simply as Maintenance Holes (MHs). Whilst not always 'water retaining', these structures are required to be watertight and must be tested as such in accordance with this Standard.
TDRF	Technical Dispensation Request Form. This form is part of SA Water's Technical Dispensation Request Procedure which details the process by which those required to comply, or ensure compliance, with SA Water's technical requirements may seek dispensation from those requirements.
Trade Waste Discharge(s)	Commercial or Industrial wastewater discharge(s) for which an SA Water trade waste discharge authorisation is required.
Works	Elements of a project which require design and/or construction

2 Scope of the Technical Standard

2.1 Scope and Application of this Technical Standard

This Technical Standard specifies SA Water minimum requirements for watertightness testings of the liquid retaining/containment structures mentioned in the sections below.

The main objective of the testing is to ensure the structure's watertightness, as part of commissioning and prior to deploying into service.

In this Technical Standard, liquid retaining, and liquid containment structures are used interchangeably.

Requirements, in addition to this Standard, for the Pressure Testing of Pipelines are further described in TS 0210.

This Technical Standard has been written to conform to the relevant provisions of WSA-02 (Gravity Sewerage Code of Australia), WSA-03 (Water Supply Code of Australia, WSA-04 (Sewer Pumping Station Code of Australia) and WSA-07 (Pressure Sewer Code of Australia, as a minimum, whilst also establishing SA Water Specific Requirements.

As such, this Technical Standard, in conjunction with TS0210, shall supersede the following test provisions of WSA-02, WSA-03, WSA-04 and WSA-07 (including SA Water's current supplements to these):

- WSA 02-2014 Part 2, Section 21.4
- WSA 03-2011 Part 2, Section 19.4
- WSA 04-2005 Part 3, Section 36.4
- WSA 04-2005 Part 3, Section 36.5
- WSA 07-2007 Part 3, Section 21.4
- WSA 07-2007 Part 3, Section 21.5
- WSA 07-2007 Part 3, Section 21.6

2.1.1 Liquid Retaining Structures

This Technical Standard specifies procedures and requirements for tightness testing applicable to new and remediated reservoirs, basins, and tanks constructed of concrete and other materials, and are designed to hold liquids at ambient temperature.

The hydrostatic tightness testing procedures and requirements herein are also applicable for tightness testing of open concrete liquid transmission structures such as cast in-place concrete channels and conduits. Preparatory items indicated are required, unless otherwise specified, but the waiver of such items shall not change the test criteria.

Each cell of multi-cell containment structures shall be considered a single containment structure and tested individually unless otherwise permitted.

The included tests are listed below:

- Hydrostatic Testing of Liquid Retaining Structures (Refer Section 4)
- Testing of Sewer Chambers (MHs and Wet Wells (Refer Section 5)

The scope of this Technical Standard applies to structures designed to contain, primarily, the following liquids:

- Potable water
- Recycled water
- Raw/bore water
- Wastewater

2.2 Works Not in Scope

This Technical Standard does not cover the pressure testing and/or hydrostatic testing of the following infrastructure, nor the following systems or processes:

General

- Commissioning procedures generally, apart from those commissioning tasks in scope herein
- Hazardous material primary or secondary containment structure
- Cryogenic storage structures
- Small bore or high-pressure process pipework for water, sewage, desalination, chemicals, gases, membranes, filters, etc
- High pressure piping or associated pressure vessels covered by AS 1210
- Copper pipe up to and including DN50
- Surge vessels
- Testing of pipes associated with building roof drainage, surface water or road drainage systems, at treatment plants for instance
- Structural tests, such as testing of welds or testing of coatings and spool linings, etc.
- Deflection testing of pipes and spools

Pressure/Vacuum Systems - Sewage

The following are not in scope:

- Systems associated with products authorised under TS 0506 – Vacuum Sewer Systems

Liquid Retaining Structures

The following are not in scope:

- Testing of earth bank storages; these are covered by TS 0460
- Testing of structures specifically designed to contain concentrated chemicals
- Testing of structures specifically designed to contain non-aqueous phase liquids

3 Quality Requirements

3.1 Quality Management System

The Constructor shall establish and maintain a Quality Assurance System in accordance with AS/NZS ISO 9001.

The Constructor and its major sub-constructors and suppliers shall, from the commencement of the Contract until the Date of Practical Completion, establish, file and maintain quality records that demonstrate implementation of the Constructor's Quality Management System (QMS), for inspection by the Representative.

3.2 Quality System Audits

Internal audits in accordance with the requirements of AS/NZS ISO 9001 shall be undertaken by the Constructor to ensure compliance with the Quality Management System.

The Representative may also carry out audits of the Constructor's quality system and/or site records by way of review and verification of Constructor's documentation, quality assurance measures or inspection and testing records.

3.3 Quality Plan

The Constructor shall submit, within 10 working days of the Date of Acceptance of Tender, a draft Quality Plan. This document is to include details of the Constructor's proposals for the management and control of quality for the Contract. Receipt of the draft Quality Plan provided under this clause constitutes a **HOLD POINT.**

A finalised Quality Plan shall be submitted within 10 working days of receiving comments from the Representative.

The Quality Plan shall provide for quality assurance activities on site and provide for dedicated site quality control resources (that do not undertake the testing works) to plan, manage and undertake quality control of the entire works.

The Quality Plan shall, as a minimum:

a) Address specific minimum testing requirements listed in the various sub-parts of this Technical Standard

b) Provide for submission of test results to confirm compliance or non-compliance with the Technical Standard

c) Include all test results in the Test/As-Repaired Report.

SA Water reserves the right to instruct the Constructor to complete additional testing, or to engage an independent testing authority to undertake additional testing at the Constructor's cost if testing is not performed to the Representative's satisfaction.

3.4 Identification and Traceability

The Constructor shall divide the Works into lots for the purpose of:

a) Positive identification and traceability of all work activities, measurements and tests

b) Submission of work to the Representative via a conformance/non-conformance report

c) Submission of Technical Dispensation Request Form (TDRF) for any proposed deviation from a requirement(s) of this standard

d) Rejection of work.

The Constructor shall define a system of lot numbering which is practical for the Works and which shall be logical, suit the specific application and be consistent with any specified computerised system.

All work and/or activities shall be able to be readily identified with the relevant lot.

The lot identification system, site records and sample numbering system shall allow test results to be positively identified with the lot they represent.

3.5 Work Method Statement

The Constructor shall prepare and submit a detailed work method statement (WMS) for all construction processes, which details controls to be exercised to ensure satisfactory achievement of Contract requirements, where the absence of such procedures could adversely affect quality of the work.

Where appropriate, such procedures may be included in the Inspection and Test Plans (ITPs) or other documentation.

Work Method Statements shall be submitted to the Representative at least 10 working days before construction of the relevant work commences, unless alternative times are specified elsewhere in the Contract. Review and acceptance of the WMS provided under this clause constitutes a **HOLD POINT**.

The work method statement shall include, but is not limited to, the following:

a) Purpose and scope of the activity

b) Work item or work lot identification

c) Details of when, where, how and by whom the work will be done

d) The sequence of operations, in accordance with the testing sequence as nominated in this Technical Standard

e) Plant, equipment and materials proposed

f) Detailed requirements applicable to the testing being undertaken

g) Quality Assurance measures to be implemented

h) Details of any temporary works associated with required testing, including general arrangements, dimensions, and relevant design details and certifications

i) All matters affecting the safety of the site including control of access to the site, isolations and management of vehicles and other plant

j) How the activity will be controlled and recorded.

The work method statement shall include identification of hazards/risks associated with the works or the site, and corresponding measures to eliminate the hazards. Where the risks cannot be eliminated, risk control and/or manage method shall be specified to reduce them so far as is reasonably practicable. The work method statement and hazard/risk identification shall encompass all site works and temporary works required to facilitate the intended activities.

Testing shall be undertaken in accordance with the submitted work method statement.

Any revisions to the accepted WMS shall be submitted to the Representative for review and acceptance with details including, but not limited to, the following:

a) Why the Work Method Statement has required alteration

b) Assessment of any new hazards (whether safety, quality or others) associated with any change to the work method

c) Actions to be taken to mitigate hazards identified in point b) above

3.6 Inspection and Test Plan

The Constructor shall prepare and submit inspection and test plan(s) (ITPs) for all significant construction activities, where the absence of such procedures could adversely affect quality of the work.

ITPs shall explicitly reference acceptance criteria and all performance requirements of the Contract and be prepared by suitably qualified and experience personnel.

- Personnel involved in preparation of ITPs should include product suppliers, applicators and design engineers as appropriate to the works being undertaken
- Constructors are encouraged to standardise ITPs for commonly encountered work activities or for projects/programs across which the same work activities are repeated.

The Constructor shall submit ITPs to the Representative not less than 10 working days before the work activity commences. Review and acceptance of ITPs provided under this clause constitutes a **HOLD POINT**.

The content of ITPs shall include, but not be limited to, the following:

a) Description of the work activity/sequence of activities

b) Work item or work lot identification

c) Specification requirements/reference

d) Title of the person responsible for activity and verification of an ITP item

e) Witness, hold and surveillance points

f) Relevant checklists, forms or procedures

g) Quality assurance activities, including test type, tolerances or other acceptance criteria

h) Identification of relevant test procedure/s and quality records

i) Details of test equipment to be used for specified tests

j) Sequence and frequency of tests

k) Identification of records (including photographic records) to be maintained of particular tests.

The Constructor shall provide the Representative with one copy of each signed off ITP (including accompanying records) within 5 working days of completion of the activity to which the ITP relates.

3.7 Hold Points and Witness Points

3.7.1 Hold Points

The minimum required Hold Points are detailed within Appendix A of this Technical Standard. Additional Hold Points are at the discretion of the Representative or the Constructor.

Hold points represent a critical stage of the work that requires release by the Representative before works can proceed further. The process for hold points release is provided below:

a) For Hold Points associated with design or documentation submissions, these shall be submitted to the Representative for release within the nominated timeframes

b) For Hold Points associated with inspections, the Constructor shall submit a request for a Hold Point inspection when work is at such a stage and is ready for inspection. A minimum of 48 hours' notice shall be provided before the hold point is reached.

   ii) This request should also contain photographic evidence of the works that:

   - Consist of "jpg" files with a minimum size of 4 megapixels
   - Clearly denote where the image was taken
   - Are provided with a time and date stamp

   iii) Submission of the photographic evidence may allow the hold point to be released without physical inspection having to occur, at the discretion of the Representative.

c) If after the Hold Point inspection further work is required prior to proceeding, submit a request for re-inspection by the Representative prior to written approval being given.

d) Subject to prior approval from the SA Water Representative (via a TDRF), the Constructor-nominated Quality Representative may be authorised to release the project-specific hold points. This is conditional on all records (including photographic evidence) being retained and furnished for later inspection. SA Water also reserves the right to undertake a random audit inspection of works being delivered.

   i) **Note:** Part d) above is not for use in works delivered via a DAFI agreement.

3.7.2 Witness Points

The minimum required Witness Points are detailed within Appendix A of this Technical Standard. Additional Witness Points are at the discretion of the Representative or the Constructor.

Witness points represent a point at which compliance of the works with the drawings, WMS or ITP is to be verified.

The Constructor shall provide a minimum of 24 hours' notice to the Representative of a witness point being reached, with attendance by the Representative to be at their discretion.

3.8 Nonconformance

The Constructor shall promptly advise the SA Water Representative and the Designer's Representative of any non-conformance, together with its location and proposals for corrective action where:

a) There is potential for progress of the work to be seriously affected

b) The proposed action to correct the non-conformance will result in work not complying with the requirements of the Technical Standard

c) The time requirements of the Technical Standard have not been complied with

d) The non-conformance may cause a health and safety hazard

e) The non-conformance has resulted from a deficiency in the drawings or Technical Standard

f) Material or serious environmental harm has occurred.

Each such notification shall include details of:

- The action proposed for correction of the non-conformance, or the arrangements made for its disposition
- The amendments to the quality system to mitigate recurrence of the non-conformance.

The Constructor shall not proceed to cover up or otherwise incorporate the non-conforming work before the SA Water Representative has approved of the proposed action in writing via Technical Dispensation Request Form (TDRF), completion and submission of which shall be undertaken by the Designer's Representative.

Works that are carried out without being appropriately sanctioned by SA Water may be classed as defective work. Such work or material is liable to rejection by SA Water, who may require the defective work to be removed and replaced.

3.9 Retesting

If any of the tests outlined in this Technical Standard prove to be unsatisfactory, the fault shall be detected and rectified. The asset shall be rectified/repaired, then retested until a satisfactory test result is obtained. Even if testing produces satisfactory results, rectify any structure or appurtenance that has a visible or detectable leak, blockage, malfunction, or other defect.

3.9.1 Repair Procedures

At least 10 working days before the commencement of repair works, the Constructor shall submit to the Representative the proposed repair methods, materials, and modifications needed to assure that the requirements of this Technical Standard are met.

Review and acceptance of Repair Procedures provided under this clause constitutes a **HOLD POINT**.

provide to the Representative, for monthly site meetings, a summary report listing completed ITPs, and number of status of all non-compliance reports.

3.10 Permits and Certificates

Obtain all necessary permits, certificates and other like consents from SA Water, government and other relevant authorities required to carry out the Works and submit copies of all such permits to the Representative.

3.11 Site Records

Throughout the progress of the work the Constructor should:

1. Keep at least one copy of any standard or other document quoted or referred to in the Technical Standard on site readily available to personnel for reference purposes.
2. Maintain a complete set of all up-to-date Drawings, Quality Documents and Specification(s), together with copies of all variations and additional drawings issued after the date of commencement.
3. Maintain records of any change to working drawings or shop drawings which may have been approved for construction purposes such that on completion of the works accurate "as constructed" information is available.

The Constructor shall also provide to the Representative, for monthly site meetings, a summary report listing completed ITPs, and number of status of all non-compliance reports.

3.12 Test/As-Repaired Report

Within four weeks of the issue of the Certificate of Practical Completion, the Constructor shall submit a draft Test/As-Repaired Report. Receipt of the draft Test/As-Repaired Report provided under this clause constitutes a **HOLD POINT.**

The report shall be in a format acceptable to the SA Water Representative, for review and acceptance that includes the following records:

1. The lot register that clearly identifies location of a lot as described in the project Technical Specification for Work under the Contract.
2. Full details of the remedial and construction works undertaken (inclusive of completed ITP's, test results, analyses, reports, measurements, photographic records, drawings, manuals and all non-conformance reports for the purpose of recording the repair and construction works
3. A complete set of any shop drawings, Manufacturer product and safety data sheets and the like.
4. Warrant that the required testing/repairs have been completed in accordance with the Work Method Statement and material Manufacturer's specification/s.

The Test/As-Repaired Report shall also include items, as detailed below, but not limited to:

a) Drawings

- Record of repair type/material used, including batch information, location and extent on marked up scaled plan and elevation drawings
- Plan and elevation drawings identifying inspection and test locations.

e) Materials

- Record of materials used, including repair batch information, material product data and materials safety data sheets.

f) Quality Assurance Records

- Complete all tests (including materials, components, Manufacturers' approvals and commissioning) in accordance with requirements of this Technical Standard
- Inspection and test record sheets
- Summary data tables for all testing completed.

g) Certifications

- Provide a legible copy of all warranties, guarantees and certifications
- Include a summary table that lists all warranties, guarantees and certifications.

Upon completion of the SA Water review of the draft Test/As-Repaired Report, the Constructor shall finalise the document and submit final copies comprising two (2) original hard documents and one (1) electronic document.

A finalised Report shall be submitted within 10 working days of receiving comments from the Representative.

4 Hydrostatic Testing of Liquid Retaining Structures

4.1 General

All newly constructed structures used for the containment of liquids shall undergo a liquid-tightness test which consists of two parts (including roof testing, if applicable), unless otherwise advised by SA Water's Representative.

Part 1 shall be a qualitative criterion, where virtually no water is lost through the walls and wall-base joints of containment structures (the visible portion of the containment structure).

Part 2 shall be a quantitative criterion expressed as the maximum allowable percent volume loss per day.

Unless required otherwise by the Contract Specification, liquid-tightness test shall also apply to remediated structures.

Unless specifically allowed by SA Water's Representative, the containment structure shall not be tested before full construction of the structure is complete to ensure:

a) The concrete has attained its specified compressive strength

b) No damage or safety concerns arise from testing an incomplete structure

c) Testing undertaken represents a true test of watertightness of the containment structure, with full realisation of shrinkage cracks that may continue to propagate during the construction period after any premature testing

d) The fastening of any walkways, exterior stairways, roof beams, or other structural elements above or outside of the containment structure's liquid containment shell, are in place to accurately represent any additional shell restraint which may result in the formation of concrete cracks.

Hydrostatic testing shall only be carried out following successful completion of roof tests, if applicable (Section 4.9), thorough cleaning and sterilisation in accordance with Section 4.4, and prior to any disinfection.

Any mechanical equipment shall not be installed in a tank until the watertightness test is completed successfully.

4.2 Testing Materials

Unless specified otherwise, potable water shall be used.

Water shall be conserved through collection and reuse in subsequent tests.

Following completion of testing work, the water shall be disposed of in a manner acceptable to SA Water's Representative and, unless otherwise permitted, shall not be allowed to enter other parts of the system.

Unless required otherwise in the Contract Documents, the Constructor shall supply water for the hydrostatic testing, supply and install pumps and pipes to transfer the water and to empty the structures on completion of the hydrostatic tests.

Any cost incurred for discharging water from the tank, to enable repairs to be made, and for refilling the tank shall be borne by the Constructor.

Disposal of test water shall be in accordance with Section 4.12.

4.3 Test Equipment

All necessary connections between the structure to be tested and the water source or other test medium, together with pumping equipment, any necessary metering devices, pressure gauges, and all other equipment, materials, and facilities required to perform the specified tests and dispose of the test medium after completion of testing, shall be provided by Constructor.

The Constructor shall be responsible for providing all required temporary flanges, valves, bulkheads, bracing, blocking, and other sectionalizing devices that may be necessary to perform the testing.

All temporary devices shall be removed upon satisfactory completion of testing.

4.4 Test Preparation

Upon completion of construction, and before any testing, internal surfaces of structures designed to retain or convey an aqueous liquid shall be cleaned thoroughly and prepared for liquid-tightness testing in accordance with the following:

a) Complete removal of all debris and clean surfaces of all oil, grit and other deleterious matter (sprayed water may be necessary to wash foreign material from the concrete surfaces). The requirement to clean the containment structure surfaces is to:

- Allow cracks and defects to be observed and not obscured by mud, material spills, or stains.
- Ensure mud, soil, or other foreign material on the containment structure floor does not obscure the floor condition or temporarily fill defects, voids, or cracks, thus giving test results that may not reflect the true condition of the containment structure

b) Removal of standing water in or outside of the structure that would interfere with the examination of exposed surfaces

c) Where required, repair areas of potential leakage before filling the containment structure

d) Temporary blank flanges, covers in walls, plugs or caps on pipework are installed as necessary to prevent the loss of water from the containment structure during the test

e) Where practical, all openings, fittings, and pipe penetrations in the containment structure shell shall be visually examined at both faces.

- Fittings and pipe penetrations have the potential for allowing water to flow along the contact surface between the fitting or pipe and the concrete. Metal fittings and pipes, unlike concrete, do not change in volume during wetting or drying.
- Metal pipes and fittings may resist the volume change of the concrete, and result in the formation of concrete cracks. It is usually impractical to observe the bottom of pipe penetrations passing through the base slab

f) Containment structure penetrations and pipe, channel, and conduit inlets/outlets shall be monitored before and during the test to verify the watertightness of these appurtenances. Seepage at these locations shall be repaired before test measurements. No allowance shall be made in test measurements for uncorrected known points of seepage

g) If the containment structure is to be filled using the containment structure inlet/outlet pipe, positive means shall be provided to check that water is not entering or leaving the containment structure through this pipe once the containment structure is filled to the test level

h) The flow from any underdrain system, if a system is provided, shall be monitored during this same period, and any increase in flow shall be recorded and considered for information as a part of the hydrostatic tightness testing. An increase in flow from an underdrain system may indicate water lost through the containment structure floor. It may, however, also be due to rain or some other external source of water. The conditions at each event should be evaluated to estimate the most probable cause of the increased flow

i) Generally, ensure that each structure is water-tight and ready for testing by visual examination of joints or other potential leakage points

j) Interior liners (that are mechanically locked to concrete surfaces) shall be installed before the hydrostatic tightness testing. They shall be visually examined for defects by the Constructor. Integrity testing of interior liners, when required by the Contract Documents, shall be performed, and passed prior to hydrostatic testing. Deficiencies shall be repaired.

    ii) Liners are generally used to obtain a very tight structure. Therefore, the basic structure should also be reasonably tight to serve as a barrier to the stored material if pinholes occur in the liner.

    iii) Generally, the same review and observation procedures are required for the concrete that is to be covered by a liner as for concrete that will be exposed. However, concrete surfaces to which liners are mechanically locked during the placement of concrete cannot be visually observed. Different liner materials require different liner tests and different methods of repair. It is beyond the scope of this document to go into the details of testing liner material

k) Unless otherwise specified, coatings shall not be applied until after the hydrostatic tightness testing has been completed

l) The groundwater level shall be brought to a level below the top of the base slab (or base of the structure) and kept at that level or lower for the full duration of the test.

    ii) Ground water can cause a back pressure on the walls and floor of containment structures and reduce the outflow of the test water through defects. The presence of ground water may indicate a greater watertightness of the containment structure than is actually present

m) Where required, the structure being tested shall be adequately propped/supported, until satisfactory completion of testing.

4.5 Backfilling

All testing shall be undertaken prior to placement of backfill in order to:

- Facilitate adequate visual inspection and identification of leaks/defects and
- Allow repairs of leaks/defects to be easily undertaken.

No backfill shall be placed against the walls or on the wall footings of the subject structure to be tested, as backfill against the wall or on top of the wall footing would interfere with Part 1 of the hydrostatic test

Backfilling prior to testing will require completion of a Technical Dispensation Request Form (TDRF), in accordance with the Technical Dispensation Procedure, to be sent to SA Water for approval. All backfilling prior to satisfactory testing shall be at the risk of the Constructor and works required to rectify a failed test (which may be significant) shall be at the Constructor's expense.

As a minimum, the TDRF shall include:

a) A description of, and reasoning for, the proposed change

b) Submission of an updated Quality Plan, Work Method Statement, and Inspection and Test Plans (Sections 3.3, 3.5 and 3.6), outlining all new risks, hazards and proposed controls associated with backfilling prior to satisfactory testing. This shall also include:

- Design measures used to minimise the likelihood of a failed test
- Details of works to be undertaken in the event of a failed test, inclusive of any Safety in Design considerations for ongoing maintenance by SA Water personnel.

4.6 Testing Acceptance Criteria

The acceptance criteria for the hydrostatic testing of liquid retaining structures shall be as follows:

Table 1: Hydrostatic Testing Acceptance Criteria

Type of containment structure	Part 1 – Qualitative[1]	Part 2 – Quantitative[2,3]
Fully lined prior to hydrostatic test[4]	No water leakage is observed on the exposed exterior surfaces	No measurable loss[9]
Required to have secondary containment[5]		No measurable loss[9]
Non-concrete		No measurable loss[9]
With monolithically placed floors designed to be shrinkage crack free[6,7]		0.0125% of volume per day
Other types[6,7]		0.035% of volume per day
Concrete paved reservoirs and channels[8]		0.070% of volume per day

Notes:

1. Part 1 deals with the visible portion of the containment structure, particularly the walls and wall - base joint.
2. Part 2 primarily deals with the floor, where water loss is not normally visible. Because Part 1 of the test requires that virtually no water is lost through the walls and wall-base joints of containment structures, the tightness criteria of containment structures is mainly controlled by the floor details. Consequently, Part 2 quantitative criteria adopted above vary according to the construction details of the floor.
3. The quantified maximum water loss included in this table is for unexplained losses; it is not a criterion for acceptance of known sources of lost water such as observed Part 1 leakages.
4. Liners, especially mechanically locked, are generally used to obtain a very watertight structure. Therefore, a lined containment structure has a more stringent tightness than an unlined containment structure.
5. Secondary containment is where an additional line of defence is required to prevent loss of containment in the event of failure of the primary containment systems (such as bulk storage containers and drums).
6. A monolithically placed, prestressed concrete, containment structure floor with the concrete always in compression have a more stringent water tightness requirement than a monolithically placed non prestressed concrete containment structure floor with the concrete partially in tension.
7. A monolithically placed floor using shrinkage-compensating concrete is expected to have greater watertightness than the same containment structure floor with

construction joints. This is due to the difficulty of placing honeycomb free concrete on the undersides of PVC waterstops.

8. Concrete pavement is placed, finished, and jointed in a different manner with potential joint leakage reflected in the qualitative criteria adopted.

9. "No measurable loss" of water means the drop in the water surface shall not exceed an average of 3mm in 3 days when adjusted for evaporation and precipitation and temperature.

4.7 Filling Rate and Testing Duration

4.7.1 Filling Rate

The initial filling of the containment structure being tested shall be at a uniform rate generally not greater than 2m in 24h.

Filling shall be continued until the water surface is at the design maximum liquid level, or either 25mm below any fixed overflow level in covered containment structure or 100mm in open containment structure, whichever is lower.

Secondary effects such as structure movement or settlement shall be closely monitored throughout the filling process and conveyed to SA Water and the structure's Designer for consideration and acceptance.

Levels shall be taken on the settlement measurement pins when the tank is empty, at the end of each filling day and when the tank is full. At the end of testing period of holding water at the full supply level, levels on the settlement measurement pins shall again be taken.

4.7.2 Stabilising and Testing Periods

For hydrostatic testing, the stabilising and testing periods shall be as follows:

Table 2: Stabilizing and Testing Periods

Test	Stabilizing Period[1] Part 1 (Days)	Test Period[2] Part 2 (Days)	Notes
7-Days Test	7.0	7.0	General unlined concrete structures
10mm Water Surface Drop	7.0	As calculated[3]	As for the 7-day test
3-Days Test[4]	3.0	3.0	Lined concrete and non-concrete structures
24-Hrs Test	1.0	1.0	Where structure's locations preclude a testing period greater than 24-hours (e.g. in a main arterial road)

Notes

1. Stabilizing Period: A period specified to allow for moisture absorption by the concrete and temperature stabilization of the test water and for autogenic healing to take place. During the stabilising period specified in Table 2, the liquid level shall be maintained by the addition of further liquid. Part 1of the hydrostatic tightness test is executed during this stabilizing period.

2. Test Period: A period specified for the execution of Part 2 of the hydrostatic tightness test, in which measurement of water surfaces and adjustment for evaporation and precipitation take place.

3. The test period shall be at least the theoretical time required to lower the water surface 10 mm, assuming a loss of water at the maximum allowable rate. The test

period need not be longer than 7 days. For example, a flat-bottom concrete containment structure, required to pass a tightness test, has a 6 m water depth. The acceptance criterion is a maximum of 0.035% loss of water volume in 24 hours. The required duration of the test would be:

$$\frac{10mm}{0.00035mm/mm/day \times 6m \times 1000mm/m} = 4.8\ days.$$

As measurements are taken at 24-hour intervals; therefore, the test duration shall be at least 5 days.

4. For non-concrete tanks and for lined or coated concrete structures, lesser stabilising period is specified to reflect the lack of moisture absorption by the concrete.

4.8 Testing Procedure

Testing of liquid retaining structures shall be undertaken in two parts, referred to as Part 1 and Part 2, as follows.

Adjacent structures having common walls shall be tested individually at different times to permit examination of the dividing walls for leaks.

Each cell of multi-cell containment structures shall be considered a single containment structure and tested individually unless otherwise permitted. Chambers adjacent to the chamber under test shall be empty during the test if they are designed for such a loading case or otherwise adequately propped.

4.8.1 Part 1- Qualitative Criteria

Following the initial filling and during the stabilising period of Table 2, Part 1 of the hydrostatic tightness test shall be undertaken as follows:

1. The exterior surfaces of the containment structure shall be observed in both the early mornings and late afternoons for the duration of the stabilising period. If any water is observed on the containment structure exterior surfaces, including joints, repaired honeycombed areas and cracks, where moisture can be picked up on a dry hand, the containment structure shall be considered to have failed Part 1 of the hydrostatic test.
2. Wet areas on top of the wall footing shall not result in failure of Part 1 of the hydrostatic tightness test unless the water can be observed to be flowing.
3. Although Part 2 of the test may begin prior to completion of Part 1, all defects causing the failure of Part 1 of the hydrostatic tightness test shall be repaired prior to acceptance of the containment structure.
4. Any defects in the structure shall be remedied by the Constructor as soon as they are disclosed. The cost of repairing leaks, if required to be undertaken either before or after testing, shall be borne by the Constructor. Leak repairs shall be undertaken in accordance with SA Water Technical Standard TS 0710 and TS 0711 (upon release).

4.8.2 Part 2 - Quantitative Criteria

Part 2 of the hydrostatic tightness test shall be undertaken as follows:

1. Part 2 of the hydrostatic tightness test shall not be scheduled for a period when the forecast is for a difference of more than 19°C between the ambient temperature readings at the times of the initial and final level measurements of the water surface.
    a. This requirement is to minimize temperature change of the water during the test.
    b. It would also minimize computed temperature corrections of measurements.
    c. Temperature stratifications can occur in the contained water and affect the test results.
2. The vertical distance to the water surface shall be measured to within 2 mm from a fixed point on the containment structure above the water surface. Measurements shall be recorded at 24-hour intervals.
    a. Measurements shall be undertaken at four points, 90 degrees apart, to give more accurate results.
    b. Measurements shall also be taken at the same time of day to reduce the probability of temperature difference.
    c. Measurements shall be taken at the same location to reduce the probability of measurement differences.
3. The test period for the no measurable loss criterion shall be 3 days (72 hours). For other criteria, the test period shall be as per Table 2.
4. The water temperature shall be recorded at a depth of 450 mm, unless otherwise specified, below the water surface at the start and end of the test. Volume corrections for temperature differences shall be included in Part 2 of the test, as per Section 4.8.3.
5. If the specified tightness criterion for the tank is "no measurable loss," the water temperature should be recorded at 1.5 m intervals of depth for volume change corrections.
6. In uncovered containment structures, evaporation and precipitation shall be measured. Evaporation shall also be measured in well-ventilated covered containment structures.
    a. A floating, restrained, partially filled, calibrated, open container for evaporation and precipitation measurement should be positioned in open containment structures, and the water level in the container recorded.
    b. Determination of evaporation by a shallow pan-type measuring device is discouraged. The heating of the bottom of a shallow pan can cause accelerated evaporation of water compared with that taking place from a deep containment structure.
7. The containment structure shall continue to be observed in both the early mornings and late afternoons to verify compliance with Part 1 of the hydrostatic tightness testing during Part 2 of the hydrostatic test.
    a. Observed flow or seepage of water from the exterior surface, including that from cracks and joints, should be considered as a failure of Part 1 of the testing.
    b. Because flow and evaporation rates can vary with the angle of the sun, it is recommended that the wall surfaces be checked at different times of the day.
    c. The limits of flowing water on the footing or wet spots on the walls, observed during daily observations, should be marked for later repair.

8. At the end of the test period, the water surface shall be recorded to within 2 mm at the location of the original measurements. The water temperature and the evaporation and precipitation measurements shall be recorded.
9. The change in water volume in the containment structure shall be calculated and corrected, if necessary, for evaporation, precipitation, and temperature.
    a. If the loss exceeds the required criterion, the containment structure shall be considered to have failed Part 2 of the test.
    b. The allowable loss of water during the tightness test accounts for the undetected losses of water from the containment structure; test values should be corrected for temperature change, evaporation, and precipitation, if present.
    c. Temperature corrections to the water volume should be based on the change in water density but may also include the effect of the thermal change to the structure dimensions.
    d. Structure dimension changes may be slightly larger for circular containment structures that have a sliding joint at the base of the perimeter wall and/or of non-concrete shell construction.

4.8.3 Volume Corrections for Temperature Changes

The volume of water changes due to temperature. The change in the unit volume resulting from a temperature change can be expressed as:

$$dV = V_0 \beta (t_1 - t_0)$$

Where

$dV = V_1 - V_0$ = change in volume (m^3)

V_1 = final volume (m^3)

V_0 = initial volume (m^3)

t_1 = final temperature (^oC)

t_0 = initial temperature (^oC)

β = volumetric temperature expansion coefficient ($m^3/m^3\ ^oC$)

Table 3: Volumetric Temperature Coefficient for Water

Temperature	B ($m^3/m^3\ ^oC$)
0°C	-0.000050
4°C	0
10°C	0.000088
20°C	0.000207
30°C	0.000303
40°C	0.000385
50°C	0.000457
60°C	0.000522

4.8.4 Retesting

A restart of the test shall be required when test measurements become unreliable due to unusual precipitation or other external factors. Unusual precipitation would be when the amount of precipitation would exceed the capacity of the precipitation gauge or would cause water to spill over the containment structure overflow.

A subsequent follow-up test shall be undertaken as soon as practicable to retest a containment structure failing Part 2 of the hydrostatic test when Part 1 is passed. If the containment structure fails the second test or if not immediately retested after the first test failure, the interior of the containment structure shall be observed for probable problem areas by the Constructor. The containment structure shall only be retested after the probable problem areas are repaired.

Containment structures shall be retested until they meet the required Part 1 and Part 2 criteria. Repairs shall be made before each retest.

4.9 Testing of Roofs

Where required by the Contract Documents, the roofs of liquid-retaining structures should be watertight and should, where practicable, be tested on completion by flooding the roof with water to a minimum depth of 25 mm for a period of 24 h or longer if so specified.

Where it is not possible, to contain 25 mm depth of water, because of roof falls or otherwise, a hose or sprinkler system should provide a sheet flow of water over the entire area of the roof for a period of not less than 6 hours.

In either case, the roof shall be considered satisfactory if no leaks or damp patches show on the soffit.

Where the structure fails to satisfy either of these tests, then after the completion of the remedial work it should be retested in accordance with this clause.

The roof covering, if any, should be completed as soon as possible after satisfactory testing.

4.10 Overflow Testing

If required in the contract, the structure overflow shall be tested in accordance with the contract technical specification.

4.11 Testing of Liners and Membranes

Liquid retaining liners and membranes shall conform to the manufacturing requirements and installation testing regimes outlined in SA Water Technical Standard TS0711-05 Surface Protection and Lining of Concrete and where applicable TS 0460 Liners and Floating Covers for Earth Bank Storages for Potable or Recycled Water.

4.12 Disposal of Water from Cleansing, Testing or Disinfection

Water used in the cleansing and testing of structures shall be rendered safe prior to discharge to the environment.

The Constructor shall be responsible for determining a suitable location and method for disposing of the used test water. Water discharged to overland disposal or to a sewer system shall be discharged at flow rates and locations acceptable to SA Water, the local councils and in compliance with applicable rules and regulations. No debris, objects and material fragments shall be disposed of into the existing SA Water sewer system.

A Trade Waste Discharge application, including a description of the proposed methodology, shall be submitted to SA Water for authorisation prior to discharging test water to the environment where volumes exceed 50kL per day.

All structures shall be sterilised by SA Water after the completion of testing and disposal of water from cleansing.

4.13 Disinfection of Structures for Potable Water

Immediately before acceptance of any structure for potable water, the interior shall be disinfected in accordance with the following procedures (available upon request from Manager Water Quality Improvement and Compliance):

a) SAWO-NO-0022

b) SAWS-WQ-0004

c) SAWP-WQ-0035

On completion of the disinfection, the structure shall be left full of potable water, under operating pressure for handover to SA Water Operations. SA Water Operations to ensure sufficient flow or changes of water to maintain water quality until handover is completed.

5 Sewer Chambers (MHs and Wet Wells)

This Section applies to both concrete and non-concrete sewer chambers. All small-sized submersible packaged pumping stations (Wet-well Chambers) and all newly constructed concrete/non-concrete Maintenance Holes shall be hydrostatically tested.

Where it is impractical to undertake hydrostatic testing, the Constructor shall submit a Technical Dispensation Request Form (TDRF), in accordance with the Standard Dispensation Procedure, to alternatively undertake Air Vacuum Testing (Section 5.2) or Low Air Pressure Testing (TS 0210).

5.1 Hydrostatic Testing

5.1.1 Testing Method

Hydrostatic testing of sewer chambers shall be in accordance with the method described in Section 4, with the following variations:

a) A stabilisation period of 2.0 hrs shall be allowed after the structure has been filled; testing shall commence thereafter

b) The duration of the test shall be a minimum of 24 hours as per Table 2 of Section 4.7.2

c) The default hydrostatic test quantitative criterion for sewer chambers, irrespective of the type of construction, shall be a maximum loss of 3 mm/hr

d) Disinfection following completion of testing is not required

e) At the completion of the test, the water shall be pumped from the chamber and not released into the sewer being constructed, or any other existing sewer.

If the sewer chamber fails the tests, any leaks shall be repaired by the Constructor and following the repairs, the testing shall be repeated at the Constructor's expense until approved as satisfactory by the SA Water Representative.

5.2 Air Vacuum Testing of Sewer Maintenance Holes

5.2.1 General

This section sets out the requirements for testing Maintenance Holes (MHs) where they are to be tested individually and separately to sewer pipes; refer to TS0210 for low pressure air testing between manholes.

Air vacuum testing is primarily used for testing concrete manhole sections utilising mortar, mastic, or gasketed joints.

All concrete and non-concrete Maintenance Holes shall be vacuum tested.

Vacuum testing is only qualitative as pressure losses do not directly reflect water leakage rates. It is used to identify points of leakage and potential structure infiltration and exfiltration due to damaged seals and joints.

The testing of containment structures shall occur after any lining or interior waterproofing membrane is in place.

Maintenance Holes to be tested shall be selected independently of the Constructor; The SA Water Representative shall nominate the MHs to be tested.

5.2.2 Test Preparation

The test preparation shall be in accordance with Section 4.4 and the following:

a) The Maintenance hole riser(s) shall be sealed

b) All lift holes shall be plugged

c) All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole

d) All joints between the top of the casting to the bottom of the maintenance hole base shall be included in the test

e) Visually inspect all sewer maintenance structures and vents prior to testing to ensure their assembly and the type and locations of maintenance structures, including access covers, and vents are as specified

f) Equipment used shall be made specifically for vacuum testing maintenance holes

g) All pumping and test equipment for air testing shall be supplied by the Constructor. Pressure gauges shall each have a certificate of calibration issued within the last 12 months by an approved NATA registered testing facility. Provide calibration certificates for all air pressure and vacuum testing equipment to the SA Water Representative and/or the Designer's Representative upon request

h) Verify by inspection of purchasing records and/or visual examination and/or other appropriate means that all products and materials used are approved by SA Water.

5.2.3 Testing Frequency

Vacuum test not fewer than the number of structures as shown in Table 4 (maintenance holes, MH, in the table), which is drawn from WSA02-2014 Part 2, Table 21.4.

Where projects contain both precast concrete and cast in-situ structures, view each type as a separate population and apply the criteria of Table 4 to each population separately within the project.

If any of the sample structures fail the initial test, all remaining structures in that population shall be tested.

Table 4: Concrete Sewer Chamber Testing Frequency

Number of each type of MHs in the project	Minimum percentage tested initially	
	Cast in-situ concrete	Pre-cast concrete
≤ 5	20%	100%
6 to 10		50%
11 to 20		33%
>20		25%

5.2.4 Testing Method

Apply an initial test vacuum pressure (negative pressure) of approximately -37 kPa to the top of the MH. Close the valve on the vacuum line and shut off the vacuum pump. Allow the air pressure to stabilise for at least 3 minutes to identify any initial leakage.

When the pressure has stabilised and is at or below the starting test vacuum of -34 kPa, commence the test by allowing the gauge pressure to rise above -34 kPa, at which point initiate the time recording. Record the time for the vacuum to rise to -30.4 kPa.

Accept the MH under the test if the time for the vacuum reading to rise from -34 kPa to -30.4 kPa meets or exceeds the relevant time in Table 5, which is drawn from WSA 02-2014 Part 2, Table 21.5.

If the time is less than the minimum specified in Table 5:

a) Re-apply the vacuum to identify any leaks

b) Rectify all defects prior to conducting any further testing.

c) Rectify any visible or audible faults even if the vacuum testing is satisfactory.

Table 5: Minimum Test Times for Sewer Chambers

MH Depth	MH Diameter mm				
	900	1050	1200	1500	1800
m	Time* s				
2.4	14	17	20	26	33
3.0	18	21	25	33	41
3.7	21	25	30	39	49
4.3	25	30	35	46	57
4.9	29	34	40	52	65
5.5	32	38	45	59	73
6.1	35	42	50	65	81
6.7	39	46	55	72	89
7.3	42	51	59	78	97
7.9	46	55	64	85	105
8.5	49	59	69	91	113
9.1	53	63	74	98	121

Note: Times for intermediate diameters and depths may be interpolated

5.3 Backfilling

All testing shall be undertaken prior to placement of backfill in order to:

- Facilitate adequate visual inspection and identification of leaks/defects and
- Allow repairs of leaks/defects to be easily undertaken. Structures to be tested shall be thoroughly propped/supported, as necessary, throughout the testing period.

Backfilling prior to testing will require completion of a Technical Dispensation Request Form (TDRF), in accordance with the Technical Dispensation Procedure, to be sent to SA Water for approval. All backfilling prior to satisfactory testing shall be at the risk of the Constructor and works required to rectify a failed test (which may be significant) shall be at the Constructor's expense.

As a minimum, the TDRF shall include:

a) A description of, and reasoning for, the proposed change

b) Submission of an updated Quality Plan, Work Method Statement, and Inspection and Test Plans (Sections 3.3, 3.5 and 3.6), outlining all new risks, hazards and proposed controls associated with backfilling prior to satisfactory testing. This shall also include:

   - Design measures used to minimise the likelihood of a failed test
   - Details of works to be undertaken in the event of a failed test, inclusive of any Safety in Design considerations for ongoing maintenance by SA Water personnel.

5.4 Disposal of Water from Cleansing, Testing or Disinfection

Water used in the cleansing and testing of structures shall be rendered safe prior to discharge to the environment.

A Trade Waste Discharge application, including a description of the proposed methodology, shall be submitted to SA Water for authorisation prior to discharging test water to the environment where volumes exceed 50kL per day.

6 Hazards

SA Water has provided known hazards associated with the testing activities nominated in this Technical Standard below for reference by users of this document.

Specific hazards/risks and their proposed controls relating to testing shall be included within the project Quality Plan and Work Method Statement submission (Sections 3.3 and 3.5).

Hazards/risks may include, but are not limited to, the following:

a) Installation of temporary propping or support systems within an excavation
    i. Depending on the configuration, this has the potential to create issues for site access and egress
b) Failure of temporary propping or support systems
c) Local traffic near an open excavation
d) Engulfment due to failure of surrounding soil grading, benching and/or soil retention systems, possibly due to surcharge or vehicle loading at the top of an excavation/embankment
e) Manual handling risks associated with moving equipment into position for propping, testing or repairs
f) Safe access into excavations or tanks for personnel to facilitate testing or repairs
g) Access (working at heights) to the top of structures to:
    - Release lifting equipment used during construction
    - Secure hoses and/or sprinkler systems to facilitate testing
    - Take measurements required by the test
    - Facilitate visual checks of roof soffits
h) Roof mounted equipment, and it's impact on roof testing

Appendix A : Schedule of Hold Points and Witness Points

A1 Schedule of Hold Points, Witness Points and Approval Points

Clause	Type	Description
3.3	Hold	Draft Quality Plan - within 10 working days of the Date of Acceptance of Tender
3.5	Hold	Work Method Statement – 10 working days' notice, in writing, is required to be provided by the Constructor, to the Representative, prior to commencement of any testing.
3.6	Hold	Inspection and Test Plan – 10 working days before the relevant work commences
3.6	Hold	Signed ITP - within 5 working days of completion of the relevant activity
3.9.1	Hold	Repair Procedures – 10 working days before the relevant work commences
3.12	Hold	Draft Test/As-Repaired Report - within 4 weeks of the issue of the Certificate of Practical Completion
0 and 5.4	Approval	The provisions for the removal and disposal of water used for disinfection, swabbing or testing shall be stated in the project specification. Discharges to sewers or through overflow pipework shall not take place without the authorisation of SA Water.

A2 Schedule of Identified Records

Clause	Description of Identified Record
3.3	Final Quality Plan - within 10 working days of receiving comments from the Representative
Error! Reference source not found.	Permits and Certificates
3.12	Final Test/As-Repaired Report - within 10 working days of receiving comments from the Representative
4.13 and 5.4	Discharge Authorisation
4.3, 0 and 5.2.4	Pressure gauges shall each have a certificate of calibration issued within the last 12 months by an approved NATA registered testing facility
4.3, 0 and 5.2.4	Calibration certificate for all air pressure and vacuum testing equipment.

Appendix B : Testing Methods

B1 Liquid Retaining Structures Testing Methods