

S-SPE-STD-001 Reservoir Roofs

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Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	2 of 24

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Contents

1.	Purpose	4
2.	Scope	4
3.	Design Requirements	5
3.1.	Design Objectives	5
3.2.	Safety in Design	5
3.3.	Design Life	6
3.4.	Whole of Life Cost	6
4.	Functional Requirements	6
4.1.	Structural Requirements	6
4.1.1.	Materials Selection Criteria	7
4.1.2.	Materials Handling and Storage Criteria	8
4.1.3.	Roof System Design Criteria	8
4.1.4.	Design Action (Loads)	10
4.1.5.	Durability and Sustainability	10
4.2.	Operation and Maintenance Requirements	11
4.2.1.	General	11
4.2.2.	Roof Access	11
4.3.	Security Requirements	13
4.4.	Ventilation Requirements	13
4.5.	Water Quality Requirements	15
4.6.	Stormwater Management	15
4.7.	Other Requirements	16
5.	Documentation, Testing and Liability	17
5.1.	Design Documentation and Drawings	17
5.2.	Testing	17
5.3.	Defects Liability	17
6.	Definitions & Abbreviations	17
7.	Reference Documents and Related Materials	19
8.	Changes from previous version	23
9.	Verification	23
10.	Further Information	23
11.	References	23

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	3 of 24

1. Purpose

This document is part of a suite of Seqwater Engineering Standards which are in alignment with the Seqwater Quality Management System. Their purpose is to provide a consistent approach to the development, modification, and management of Seqwater infrastructure that is fit for purpose, economic over the life of the asset, and meets Seqwaters Work Health and Safety obligations.

This Standard Specification provides the minimum requirements and recommendations for Roofs on Seqwater Water Storage Reservoirs.

For the purpose of this Standard Specification, Water Storage Reservoir includes a reservoir, tank, balance tank, break of head tank, or chlorine contact tank which is used to store potable (drinking) water, raw water, purified recycled water, settled/clarified water, backwash water, or pure water.

This Standard Specification is not intended to be relied upon solely for design, supply and installation works; advice from specialist engineers and/or Manufacturers may be required on a case-by-case basis.

This document must be used in conjunction with the documents it references to assist in ensuring fit for purpose infrastructure. This Standard Specification is not intended to be relied on solely for design, supply, and installation works; advice from specialist engineers and/or manufacturers may be required on a case-by-case basis.

2. Scope

This Standard Specification applies to all Seqwater employees, contractors, suppliers and consultants working for or on behalf of Seqwater unless otherwise stated. It applies to all new assets and to all existing assets undergoing refurbishment or modification. It must be used in conjunction with other relevant Seqwater Engineering Standards and project specific documents to define the technical requirements for infrastructure design and construction.

Where single or discrete components of an existing non-compliant system are to be replaced, refurbished or modified, this standard should not automatically be applied to the entire system retrospectively, however consideration should be given, in consultation with relevant stakeholders, to the extent of the application of the standard outside of the components requiring replacement, refurbishment or modification, to ensure safe, economic, and fit for purpose infrastructure.

Seqwater Engineering Standards detail Seqwater's minimum requirements and recommendations to provide infrastructure that will be fit for purpose, and safe to operate and maintain. However, compliance with these requirements and recommendations does not remove, and cannot be relied on as meeting, the designer's overarching responsibility for ensuring infrastructure designed is fit for purpose and safe to construct, operate, maintain, and demolish. The designer must exercise appropriate due diligence to identify and manage hazards so far as is reasonably practicable.

Designers must also ensure compliance with relevant Australian Legislation, Standards, Codes and Guidelines (including those produced by Water Services Association of Australia). Where no Australian Standard exists for a particular application, work must conform to the most current version of an industry accepted international standard.

Deviation from meeting the minimum requirements in this Standard Specification requires written agreement from Seqwater as per the deviation process detailed in Procedure X-PRO-STD-008 Asset Standards Management and

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	4 of 24

Application. That process includes completion of an X-TMP-STD-022 Asset Standards Deviation Request Form and submission by the Seqwater Project Representative to the Seqwater Engineering Mailbox. Where noted in this Standard Specification that Seqwater approval, agreement, or acceptance shall/must be sought, such approval, agreement or acceptance must be gained through the Seqwater Asset Standard Deviation process, as outlined above.

Responsibility for ensuring compliance with Seqwater Engineering Standards lies with those engaged in the management and execution of design, construction, and modification of Seqwater infrastructure. This includes modifications to the functional design of the infrastructure including technical changes made which would extend an asset outside of its design operating envelope and/or approved operation and maintenance practices.

Any ambiguities or conflicts identified between specific requirements within this Standard and project documents, another Seqwater Engineering Standard or Australian Legislation, Standards, Codes or Guidelines, these must be brought to the attention of the Seqwater Document Owner, via the Engineering Mailbox, for clarification. Where it is proposed to proceed without meeting the requirements of this standard, agreement must be obtained via the Deviation Process, as outlined above.

Seqwater undertakes regular updates of its Engineering Standards. Before utilising this Engineering Standard the complete list of Seqwater Engineering Standards should be reviewed to ensure currency and applicability of standards to be applied to the works. These can be accessed on the Waternet Engineering and Asset Standards page or using the REX Saved Search "Engineering Stds Controlled Documents by CD Owner".

3. Design Requirements

3.1. Design Objectives

The objective of this Standard Specification is to standardise and reduce the variability of reservoir roof designs undertaken for, and on behalf of, Seqwater. To achieve this, reservoir roofs shall be designed and constructed to:

- Be compliant with relevant standards, codes and legislation as outlined in Section 0.
- Be structurally sound, usable, and fit for purpose throughout its operational life.
- Be durable and sustainable.
- Be reliable and safe for operation and maintenance.
- Be sufficiently secured against unauthorised entry.
- Protect the water quality within the reservoir through relevant WHS and environmental requirements, and
- Ensure compliance with any additional requirements identified in a particular project scope.

3.2. Safety in Design

Requirements for Safety in Design of Seqwater infrastructure are detailed in Seqwater Standard *Procedure X-PRO-STD-009 Engineering Design, Construction, Operation and Maintenance*, which forms an integral part of this Standard Specification.

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	5 of 24

3.3. Design Life

The Design Life is the period assumed in design for which components are required to perform their intended purpose without replacement or major repairs, assuming scheduled maintenance has been carried out.

Design Life expectations for the various roof components are shown in Table 1 Asset Design Life. Where relevant these are consistent with Seqwater Standard Specification M-SPE-STD-001 "General Mechanical".

Table 1 Asset Design Life

Component	Minimum Design Service Life (Years)
Rafters and Columns	50
Purlins	50
Platforms, walkways, stairways, ladders, handrails etc.	50
Roof Sheeting (including fasteners)	25
Vermin Screens	25
Rotary Ventilators	25

3.4. Whole of Life Cost

Where requirements nominated in this document allow a choice in the type and material of reservoir roof and its method of construction, the final choice shall be determined by the most cost-effective method for meeting the intended purposes of the roof structure using net present value analysis of capital, access, maintenance and end-of life costs over the asset life.

4. Functional Requirements

To ensure the quality of water stored in a reservoir, it shall be roofed. Functional requirements for the design of the reservoir roof and associated infrastructure are detailed herein under the following headings:

1. Structural Requirements
2. Operation and Maintenance Requirements
3. Security Requirements
4. Ventilation Requirements
5. Water Quality Requirements
6. Stormwater Management Requirements
7. Other Requirements

4.1. Structural Requirements

The design of the roof system shall ensure the following structural design criteria have been addressed:

- a. Material Selection
- b. Material Handling and Storage
- c. Roof System Design

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	6 of 24

- d. Design Action (Loads)
- e. Durability and Sustainability

4.1.1. Materials Selection Criteria

1. The Contractor shall be responsible for ensuring that materials and equipment supplied meet the specified performance, construction, quality, space and structural loading requirements.
2. All reservoirs shall have reinforced or prestressed concrete floor and walls and comply with AS 3735 – Concrete Structures Retaining Liquids.
3. Roofs shall either be made of:
 - a. Steel Materials (complying with AS4100 – Steel Structures, AS/NZS 4600 – Cold-formed steel Structures and AS1562.1 – Design and Installation of Sheet Roof and Wall Cladding – Metal), or
 - b. Aluminium Materials (complying with AS/NZS 1664 – Aluminium Structures – Limit state design and AS1562.1 – Design and Installation of Sheet Roof and Wall Cladding – Metal)
4. All materials used in the works that will be in contact with water or be located within the interior of the reservoir (whether in contact with water or otherwise) shall comply with federal regulations as applicable, e.g., the requirements of AS/NZS 4020 – Testing of products for use in contact with drinking water. For further information in relation to AS4020 compliance refer to Seqwater Engineering Standard M-SPE-STD-001 General Mechanical (SPE-00367).
5. Fabric, ferrocement, corrosive or uncoated metals, plastics or liner materials shall NOT be used.
6. External structural components shall be hot dip galvanised in whole components following fabrication and bolted on site. On-site welding of hot dip galvanised, exposed structural components shall not be permitted except where specifically approved otherwise by the owner.
7. All materials, finishes, flashings and fixings shall have protection from the effects of galvanic corrosion.
8. Flashing materials shall also be durable, weather resistant and compatible with adjoining materials.
9. The flashing material shall be the same material used for roof sheeting.
10. All roof components must be made of compatible materials or appropriate measures used in order to prevent galvanic action occurring:
 - a. Galvanised steel shall not be placed in contact with aluminium
 - b. Water run-off from galvanised steel shall not discharge onto aluminium components.
 - c. If dissimilar materials are used adequate and suitable isolation measures shall be applied and areas shall be inspectable and accessible.
11. Roof framing materials, roof sheet, and fixing screws shall be suitable for use in moist, humid conditions and be chemically resistant. Hot dipped galvanized steel purlins or solid aluminium rolled framing are preferred materials. Purlins with down-turned bottom lips shall be used to prevent accumulation of moisture.
12. Any used materials and components that are cut or trimmed to shape shall be left with a clean-cut edge without jags and no distortion of the profile or cross section.
13. The roof design (e.g., roof geometry, colour finish, aesthetics etc.) shall comply with visual and environmental requirements including aspects of light reflection and glare.

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	7 of 24

4.1.2. Materials Handling and Storage Criteria

1. All materials used in the works shall be handled, transported and stored in accordance with the relevant Australian Standard and the relevant manufacturer's recommendations.
2. Materials shall be handled, shipped and stored carefully to avoid damage to surface of aluminium or surface coatings if one is applied. In particular materials:
 - a. shall not be dragged and shall be protected from swarf.
 - b. shall be kept dry and clear of the ground to prevent water and/or condensation being trapped.
 - c. that are wet shall be separated, and wiped with a clean, dry cloth and stacked to dry thoroughly before use.
 - d. shall be handled using clean dry gloves.
3. No stained or damaged sheeting shall be used in the finished work.
4. Touch up of scratched pre-painted sheets shall be by brush only. Manual post painting is not permitted.

4.1.3. Roof System Design Criteria

The roof system design shall comply with the following minimum requirements:

General Roof Design Requirements

1. Unless prior approval is obtained from Seqwater the roof design shall be in accordance with the manufacturer's recommendations (including instructions for coastal environments) and applicable standards.
2. The flattest part of the roof shall have a minimum slope of 1 in 30 (2 degrees). Where sheeting with a corrugated profile is used, the slope shall be of minimum 1 in 10 (5 degrees).
3. Roof system shall be pre-finished metal profiled sheeting, screw fixed to roof framing.
4. Roof eaves overhang shall be a minimum of 300mm and suitably supported structurally.
5. If gutters and downpipes are required, they shall be designed in a way that they:
 - a. are maintenance free,
 - b. do not get blocked by leaves and flows are not restrained in anyway.
 - c. handle the flow from a 20-year ARI design storm without overflowing,
 - d. Ensure all discharges, including stormwater overflows from the gutters and/or downpipes resulting from extreme rainfall events are directed to the environment in accordance with Section 4.6 herein, and not into the reservoir.
6. Pumps, pipes, valves, conduits, cable trays, and other items not essential to the reservoirs primary purpose of storing water for use and maintaining the water quality thereof shall not be placed on the roof in order to avoid unnecessary roof penetrations and avoid interfering with regular inspection and maintenance requirements required to ensure the integrity of the roof and thus the water quality within. Where possible essential items such as level sensors, telemetry and associated cables shall be mounted on the wall rather than the roof.

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	8 of 24

7. The design shall ensure minimal joints in roof and avoidance of any unnecessary roof penetrations. Roof penetrations shall be carefully designed and constructed to ensure complete watertightness and to allow effective drainage of storm water around the penetrations.
8. Vermin and contaminant proofing shall be as detailed in Section 4.5.
9. Where submersible mixers are present, a cathodic protection system using impressed current is usually provided. The roof design shall make provisions where appropriate to suspend anode, electrodes, support junction boxes, conduits and cabling, etc., for this system.
10. The roof shall be designed to cater for expected thermal effects, galvanic corrosion, and corrosion due to coastal environment (where applicable).

Roof Sheeting and Flashings

11. Roof sheeting and associated flashings shall be in conjunction with plans, details and specifications relating to the works.
12. Material to comply with AS/NZS 2728 Type 4 and AS1397, with minimum 0.48mm base metal thickness, minimum yield strength G550 (550MPa) and minimum coating mass AM150 (150g/m²). Acceptable product is Colorbond® Ultra steel or approved equivalent. Materials used shall be AS/NZS4020 certified or equivalent. The minimum base metal thickness may be reduced provided there are purpose built walkways located on the roof which provide access to all areas required for regular operation and/or maintenance purposes.
13. Thermal expansion considerations shall be designed into the roof beams and sheeting.
14. Roof sheeting shall be of adequate length to cover length from ridge to edge of reservoir roof with no end-lapping of sheets. Justification for end-lapping such as transport restrictions, handling or other constraints must be demonstrated if required.
15. Flashings shall be designed and installed to provide a tight seal against water penetration, to prevent build-up and entry of debris into the reservoir, to ensure self-cleaning with no ponding of water on the roof, and to accommodate movement of the roof and/or wall elements. Flashings shall be designed to meet these objectives independent of the use of sealants or other materials. Similar requirement applies to movement joints of sheeting if any.
16. Flashings and mouldings shall overlap sheeting as per manufacturers recommendations or RPEQ Certification.
17. Never use hot cutting or carborundum discs to cut sheets to prevent damage to the paint.

Fasteners

18. Fasteners used shall have the same or superior service life to the life of the roof sheeting and flashing. They shall be corrosion resistant and be compatible with the materials used for roof sheeting and flashing. Stainless steel screws are not to be used for Colorbond® Ultra steel roof sheeting.
19. All fasteners shall be installed normal to the plane of the roof sheeting and flashing and all fasteners which pierce the sheeting/flashing shall be provided with adequate sealing to prevent leakage and of material compatible with the roof sheeting.
20. As a minimum requirement, screws shall be AS3566: Class 4.

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	9 of 24

21. To maximize water tightness, always place roof screws through the crests. Screws instead of rivets shall be used for fastening flashings.

Sealant and Gasket Material

22. Sealants and gaskets when used in conjunction with roof sheeting and flashing shall be suitable for contact with water without chemical extraction.
23. Sealants and gaskets shall achieve a life compatible with the performance of materials used for roof sheeting and flashing.
24. Sealants and gaskets shall provide good adhesion to the steel surfaces.
25. Sealants and gaskets shall retain good flexibility without tearing, cracking or becoming brittle over a temperature range of -5 degree Celsius to +70 degree Celsius.
26. Sealants and gaskets shall provide high resistance and no significant change to elongation, tensile strength, hardness and adhesion through the effects of aging, or the exposure to ozone, ultraviolet light or from vapours (e.g., chlorine, humidity, etc.) from the water stored in the tank.

4.1.4. Design Action (Loads)

1. All permanent and imposed actions (loads) and their combinations used in the Design of the roof shall be in accordance with AS/NZS 1170.
2. Wind actions used in the design of the roof shall be in accordance with AS/NZS 1170.2.
3. Design imposed actions for platforms and supporting structure shall be:
 - a. a superimposed live loading of not less than 2.5 kPa uniformly distributed and a concentrated loading applied through a 100 mm x 100 mm pad of not less than 1.1kN at any point in accordance with AS 1657; and
 - b. other loads and their combinations in accordance with AS/NZS 1170.
4. Construction drawings for the roof shall include:
 - a. Dimensions of the roof system and sizes of the principal members.
 - b. Details of attachment to the reservoir structure.
 - c. Number, names and sizes of all accessories and appurtenances.
 - d. Appearance, coatings or finish information if specified.
 - e. Design loads and maximum loads transferred to the reservoir.

4.1.5. Durability and Sustainability

The reservoir roof design shall ensure sustainable management and long-term integrity of the water resources, in order to minimise/eliminate material degradation and the need for ongoing maintenance.

Selected materials shall:

- a. meet the intended Design Life and Whole of Life Cost requirements set out in Sections 3.3 and 3.4.
- b. be readily available.

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	10 of 24

The roof shall be designed and installed in accordance with manufacturers requirements to achieve the following products warranty:

- a. The roof sheeting shall have a material warranty against corrosion to perforation of minimum 20 years.
- b. Ventilators shall have a warranty of a minimum of 20 years.

All aspects of the reservoir roof design shall consider sustainability aspects and ensure sustainable management and long-term integrity of the water resources, in order to minimize/eliminate material degradation and the need for ongoing maintenance.

The roof shall be designed to cater for expected thermal effects, galvanic corrosion, and corrosion due to coastal environment (if applicable).

4.2. Operation and Maintenance Requirements

4.2.1. General

Best practices in Operation and Maintenance must be applied to all components of the reservoir. This includes being periodically inspected, maintained, repaired and, if necessary, replaced in accordance with the Reservoir Asset Class Plan (PLN-00441).

Tank inspections provide information used to identify and evaluate current and potential water quality problems. Regular inspections shall be undertaken in accordance with the Reservoir Asset Class Plan to ensure physical integrity, security and high-water quality.

Based on these activity requirements the reservoir roof shall be designed:

- a. To have adequate safety provisions to allow safe access for inspection, operations, repair and maintenance of the reservoir roof (including all lifting devices and appurtenances located on the roof).
- b. Provide adequate fall arrest systems which are easily accessible for use by inspection/maintenance and emergency response crews.
- c. To have sufficient access for inspection, maintenance and repair.
- d. To ensure that used metal members are free of unprotected raw edges.

4.2.2. Roof Access

Roof Platform

1. Compliance with Standard Specification M-SPE-STD-002 for Fixed Platforms, Walkways, Stairways and Ladders is required for areas relevant to the roof.
2. The roof platform shall be of sufficient size and suitably located to allow:
 - a. direct and safe access by inspection/maintenance crew to areas of the roof requiring regular inspection, repair and maintenance. These areas include anchorage points for fall arrest system, hatches, davit arm, winches (if any), ridge and perimeter of the roof,
 - b. efficient and safe operations davit arm and winches for hatches (if any),
 - c. direct and safe access to all roof mounted appurtenances including vent and ventilator, level sensor and telemetry, cathodic protection (if any), etc.,

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	11 of 24

- d. ease of setting up of confined space entry and exiting of the tank,
- e. space for accommodating equipment during inspection, repair and maintenance.
- 3. The roof platform shall be installed in such a way that it minimises the chance for vermin to nest underneath.
- 4. Where Seqwater's reservoirs are not taken offline as part of a programmed cleaning and maintenance schedule, the platform shall be large enough to allow the maintenance personnel to set up equipment (i.e., robotic cleaning equipment, diving gear) for entry.
- 5. All surface areas of the platform shall be self-draining to prevent ponding which may cause slip hazard and material corrosion. Kick rails need to be lifted up adequately to allow for effective drainage off the platform and away from entry hatch area.
- 6. Roof Platforms shall be designed to prevent debris build up under the platform and to provide adequate clearance to the roof sheet (ridge and trough) to allow ease of cleaning.
- 7. The roof platform is to have a guardrail on its perimeter. Guardrails for platforms shall be designed in accordance with AS1657.
- 8. The platform shall be finished as a constant level surface, with no protrusions above the level of the grill flooring (except for the access hatch).

Roof Hatches

- 9. Design imposed actions (loads) for roof hatches and their supporting structures shall be as for platforms and supporting structures as detailed in Section 4.1.4 (3) herein.
- 10. Sufficient space should be provided around the perimeter of the hatches to allow ease of access and opening of the hatches. Safety provisions (including removal safety grill) shall be provided to prevent the fall of personnel and/or equipment into reservoir when the hatches are opened.
- 11. All hatches are to be hinge operated and lockable. If the cover cannot be laid flat, then it must be securable when opened.
- 12. All hatches shall be designed in such a way, that personnel are able to stand up-wind when opening hatches to prevent potential chlorine gas exposure.
- 13. Handles shall be designed in such a way, that they do not compromise the vermin proof requirements or allow stormwater and potential contaminant entry when closed.
- 14. Access Hatches shall:
 - a. Provide a hatch for access to the inside of reservoir.
 - b. Provide mechanical means of opening, hand operated winch or similar, for heavy hatch covers, hatch covers over large areas or hatch covers positioned with restricted access.
 - c. An access hatch is required on opposite sides of the reservoir.
- 15. Maintenance Access Hatches provide a large opening on the roof to allow for large equipment to be placed into the reservoir.
- 16. A separate hatch (instrumentation hatch) is to be used for hanging the level instrumentations.

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	12 of 24

4.3. Security Requirements

1. All roof hatch covers shall be sufficiently secured against unauthorised entry.
2. Roof hatch covers shall:
 - a. Be lockable.
 - b. Be made of strong material that cannot be compromised or forced open by vandal activity on the roof area,
 - c. Be secure against any prevailing wind or storm events
3. All hatches on roof shall be provided with tamper switches which are connected to the control systems for monitoring and alarming.
4. Components of the assets that can easily compromise access to the inside of the reservoir (e.g., vermin screens, etc.) shall be made of suitable materials to provide suitable security to prevent unauthorised entry or covered by a suitable security screen.

4.4. Ventilation Requirements

1. The roof shall be designed to provide sufficient natural ventilation:
 - a. To prevent pressurisation upon filling,
 - b. To prevent vacuum upon drawdown,
 - c. to reduce the build-up of a corrosive environment (i.e., humidity, chlorine gas) inside the reservoir
 - d. to limit corrosion of the roof structure and components, and
 - e. to assist in minimising WH&S risks during inspection, repair and maintenance to the roof/reservoir and confined space entry.
2. This can be achieved by a combination of inlet ventilation openings provided at the top of the wall together with fixed grilled vents or rotary ventilators located on the roof. It is important to match ventilation with the surrounding environment.
3. Based on environmental factors all vents, ventilators and eaves shall:
 - a. Prevent the entry of surface water and rainwater into the reservoir.
 - b. Prevent entry of vermin such as rodents, birds, bats, snakes and insects and any pathogens and diseases they may harbor.
 - c. Prevent entry of dust and animal-related debris (e.g., feathers, skin, faecal matter, etc.).
 - d. Provide sufficient security to prevent the entry of personnel.
 - e. Minimise the potential for entry of solid/liquid agents as a result of vandalism or sabotage.
 - f. Be installed in a way that does not cause or accelerate corrosion.
4. For high wind areas, fixed roof vents are preferred over rotary roof ventilators which will wear out quickly through overuse.
5. Systems shall exhaust rising hot air at ceiling level through the roof mounted vents and draw in fresh cooler air at lower level through the wall vents.
6. Ventilation shall be designed to allow for air to be discharged during reservoir filling and to ensure:

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	13 of 24

- a. a minimum of 6 air changes per hour based on the enclosed air volume above the Top Water Level of the reservoir, with roof vent/ventilator performance based on the mean 9 am wind speed for the reservoir location.
- b. Where roof mounted rotary ventilators are used, these shall be of a minimum 450mm diameter up to a maximum 900mm diameter and appropriately spaced to ensure adequate ventilation of the entire roof cavity.
- c. The minimum number of roof vents shall be as stated in Table 2 Minimum Number of Roof Vents.
7. Air entry into the roof cavity shall be provided by wall mounted fixed vents evenly spaced around the perimeter of the reservoir installed not less than 100mm above the top water level
8. An inlet (wall) vent net area to discharge (roof) vent net area ratio of no less than 1.5 to 1 shall be adopted.
9. Demonstration that the roof (and all its components) can carry the loads of the proposed ventilators is required. In particular:
 - a. Live loading
 - b. Dead loading
 - c. Additional structural engineering requirements
10. Roof ventilators shall be:
 - a. made of aluminium or stainless steel
 - b. provided with removable vermin screens in accordance with Section 4.5 Water Quality.
 - c. secured against tampering.
 - d. rated and tested to resist rain and wind in accordance with AS2428.1 and AS2428.2.
11. Installers accredited by the manufacturers, shall be used to install any mechanical ventilation systems.
12. The roof shall be designed so that any gap between the roof sheeting and the top of reservoir wall and/or roof structure is minimised, except to the extent required to providing adequate inlet ventilation openings above the top water level in accordance with Section 4.4 (7) above. The gap shall be sealed with approved materials providing a long lasting seal to prevent vermin, rain and wind-borne contaminant entry.
13. Ventilators shall be secured against tampering.

Table 2 Minimum Number of Roof Vents

Area of Roof (m ²)	Minimum Number of Roof Vents/Ventilators
<100	1
100 – 250	3
250 – 500	4
500 – 1,000	6
1,000 – 2,000	8
> 2,000	1 per 200m ² or part thereof

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	14 of 24

4.5. Water Quality Requirements

The Australian Drinking Water Guidelines stress the importance of securing the distribution system. The design of the reservoir and its roof (i.e., sizing, type, appurtenances, etc.) is critical to the water system's ability to manage water quality while providing an adequate water supply with adequate pressure. Reservoirs are a known critical risk to water quality if not carefully managed and maintained.

Design of appurtenances and other installations on reservoir facilities, such as vents, hatches, drains, wash out piping, sampling taps, overflows, valves, walkways, etc. can be critical in maintaining water quality.

In order to prevent potential contamination of the water supply the below considerations shall be applied to the design:

1. All ventilation openings, overflow structure outlets, etc. shall be designed to prevent the entry of stormwater into the reservoir and include security mesh and vermin screens designed to exclude rodents, birds, bats, snakes and insects and any pathogens and diseases they may harbor, as well as animal-related debris (e.g., feathers, skin, faecal matter, etc.).
2. All openings including roof vents and wall vent openings shall include a vermin and contaminant proof security mesh consisting of corrosion resistant materials suitable for a moist chlorine vapour environment (Hastelloy C or approved equivalent product) with a maximum 2mm aperture.
3. For fixed vents and openings, this mesh shall sit flat and be securely fixed to all edges of the vent using a fixing strip and Class 4 Corrosion Resistance fasteners in accordance with AS3566.
4. All appurtenances installed on a roof shall be designed in such a way prevent build-up of potential contaminants such as leaves or vermin nests, and to ensure regular inspections and maintenance of the roof as required under the Seqwater Reservoir Asset Class Plan (PLN-00441) can be easily undertaken as described in Section 4.2 herein.
5. Other items not directly connected with the reservoirs primary purpose of storing water and protecting the quality of that water shall not be installed on the roof of the reservoir (e.g., telecommunications installations, rooftop solar PV panels etc.).

4.6. Stormwater Management

1. Where roofs are designed with gutters and downpipes they shall be designed to ensure:
 - a. The gutters and downpipes are maintenance free, do not get blocked by leaves or are not restrained in anyway.
 - b. Gutters and downpipes can handle the flow from a design storm with a 5% Annual Exceedance Probability (AEP) and a duration of 5 minutes without overflowing.
 - c. All stormwater, including gutter and downpipe overflows in extreme rainfall events up to a 1% AEP storm, discharge to the environment and not into the reservoir.
2. Where roofs are designed without gutters allowing rainwater to flow off the roof onto a hardstand area around the reservoir base and managed using a network of site drainage pits and pipes, they shall be designed to ensure:
 - a. The hardstand is designed to avoid splashing, erosion and property damage due to rainwater and runoff.

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	15 of 24

- b. For sites where there is limited space for a hardstand, the designer shall design a suitable rainwater collection system for special consideration and approval by Seqwater.
3. Full length sheeting is to be used where practical and the laps of roof sheeting are to be in accordance with the manufacturer's recommendations.
4. Roof sheeting and/or guttering shall project a minimum of 300mm beyond the external face of the reservoir wall to prevent ingress of roof water.
5. The surface drainage system shall be designed to capture all stormwater discharge from the roof for storm events up to a 1% AEP with a duration of 5 minutes in accordance with the Queensland Urban Drainage Manual, Australian Rainfall and Runoff and relevant Australian Standards.
6. Site drainage shall be designed so that it provides adequate protection to access roads, reservoir, other structures and surrounds, and also complies with Seqwater, local Council and other authority's requirements.
7. Box gutters running across the roof shall not be used as they are prone to vegetation and debris blockage of drainage points. Leaking joints or defective areas in box gutters are difficult to detect and any problems may lead to significant contamination of the reservoir.
8. All hatches, vents, and roof openings must be designed to prevent ponding and the ingress of roof water into the reservoir, including:
 - a. All hatches shall have a continuous raised edge to protect against any direct drainage, ponding or debris build up.
 - b. The hatches shall be framed at least 100mm above the surface of the roof at the opening and shall be fitted with a solid watertight cover which overlaps the framed opening and extends down around the frame at least 50mm. The cover shall have a tight seal with the supporting frame.
 - c. Ensures free draining surfaces and avoid ponding behind fixtures such as vents and platforms.
9. All stormwater discharges from the site must be made via a lawful point of discharge, be managed to prevent surface erosion and not cause any actionable nuisance.

4.7. Other Requirements

1. All work performed, equipment provided, and materials shall:
 - a. Be in accordance with the best modern trade practice, and Codes of Practice;
 - b. Comply with the Contract Documents;
 - c. Be carried out by appropriately qualified and experienced tradesmen;
 - d. Be carried out under the supervision of a competent foreman;
 - e. Result in a high standard of construction and leave a thoroughly efficient, robust, tidy and fully operational and safe installation.
2. The roof shall also be designed to meet all electrical, mechanical and control system requirements specified by Seqwater.
3. Lightning protection for the roof structure may be required.

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	16 of 24

5. Documentation, Testing and Liability

5.1. Design Documentation and Drawings

1. The designer shall prepare and submit a Design Report detailing the options considered and recommended, for consideration by Seqwater. The recommended options should be backed up with adequate substantiations.
2. The Design Report shall include the following:
 - a. Detailed drawings, calculations and specifications as required for the various components of the system,
 - b. Detailed drawings for roof penetrations, flashings, movement joints and end treatments of sheets for waterproofing; prevention of vermin and contaminants entry, etc.,
 - c. All design loads to be detailed on drawing,
 - d. Design life of the main components of roof structure
 - e. How Safety in Design has been addressed, in particular in relation to Operational and Maintenance requirements.
3. All drawings shall be prepared in accordance with Seqwater's standards including PRO-STD-002 Engineering Drawing Number Procedure, X-PRO-STD-007 Drawing & Spatial Data Standards, and X-PRO-STD-009 Engineering Design, Construction, Operation and Maintenance.

5.2. Testing

The Supplier shall propose a detailed procedure and acceptance criteria for performing a watertightness test of the roof for Seqwater approval which meets the requirements outlined for testing of roofs in AS3735 "Concrete structures for retaining liquids". The test shall be conducted, and results submitted to Seqwater for acceptance prior to handing over of the reservoir roof.

5.3. Defects Liability

The roof shall have a defects liability of minimum 12 months from date of Practical Completion, or longer period if provided for in the project contract documentation.

6. Definitions & Abbreviations

The following definitions (Table 3 Definitions and Abbreviations) apply to this Standard Specification.

Table 3 Definitions and Abbreviations

Term	Definition
AS	Australian Standard
Contractor	An entity engaged by Seqwater to undertake work in accordance with an agreed contract with a defined scope of work.
Employees	Means persons employed directly by Seqwater in a permanent, temporary or casual capacity.

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	17 of 24

Term	Definition
ESA	Engineering Standards and Assurance
Leader	Means any Level 1, 2, 3 and 4 Leader with responsibility for managing a functional area of the business, including people management responsibilities within their functional area.
Manufacturer / Supplier / Vendor / Original Equipment Manufacturer (OEM)	The entity that manufactures or supplies equipment to meet the specifications of the Contractor.
O&M	Operations and Maintenance
Owner / Principal / Seqwater	The entity that engages the Contractor to undertake the work and takes custody of the outcome. The Owner may delegate responsibilities to other entities to act on its behalf (e.g. a consultant).
REX	Seqwater Electronic Document and Records Management System.
RPEQ	A Registered Professional Engineer of Queensland who performs professional engineering services within the meaning of the Professional Engineers Act 2002 (Qld)
Seqwater Approval / Agreement / Acceptance	Written sign-off gained via the deviation process, as detailed in <i>X-PRO-STD-008 Asset Standards Management and Application Procedure</i> .
Seqwater Engineering Standard	Includes Standard Procedures and Standard Specifications and associated supporting documents such as Standard Drawings, Guidelines, Lists, Datasheets, Manuals, Registers, and Templates.
shall / must	Indicates a mandatory requirement.
should	Indicates a recommendation.
Water Supply Reservoir	Includes a reservoir, tank, balance tank, break of head tank, or chlorine contact tank which is used to store potable (drinking) water, raw water, purified recycled water, settled/clarified water, backwash water, or pure water.
WH&S	Workplace Health and Safety
Worker(s)	Includes all permanent, temporary, and casual employees of Seqwater, and: • vocational and work experience placements • volunteers • suppliers, contractors, and consultants temporarily engaged to do work for or on behalf of Seqwater.
WSAA	Water Services Association of Australia

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	18 of 24

7. Reference Documents and Related Materials

The documents listed in Table 4 below, and the requirements therein, are relevant to this Standard Specification. In their latest editions these documents form a part of this document. Note that this is not an exhaustive list of documents relevant to the works. Where no Australian Standard or WSAA Standard exists, work shall conform to the most current and applicable international standard.

Seqwater undertakes regular updates of its Engineering Standards. Before utilising this document, the complete list of Seqwater Engineering Standards should be reviewed to ensure currency and applicability for the proposed works.

Table 4 Reference Documents and Related Materials

Description	Location
PLN-00441 Reservoir Asset Class Plan	REX & Waternet
PRO-00015 WH&S Prevention of Falls Procedure	REX & Waternet
PRO-00657 WHS Hazard Identification and Risk Management Procedure	REX & Waternet
PRO-01617 X-PRO-STD-009 Engineering Design, Construction, Operation and Maintenance	REX & Waternet
PRO-01872 X-PRO-STD-002 Engineering Drawing Number Procedure	REX & Waternet
PRO-01873 X-PRO-STD-001 Asset Standards Documentation Classification and Naming Structure	REX & Waternet
PRO-01874 X-PRO-STD-004 Development and Review of Asset Standards	REX & Waternet
PRO-02187 X-PRO-STD-007 Drawing and Spatial Data Standards	REX & Waternet
PRO-02190 X-PRO-STD-006 Equipment Numbering and Naming Convention	REX & Waternet
PRO-02205 X-PRO-STD-008 Asset Standards Management and Application	REX & Waternet
SPE-00366 M-SPE-STD-002 Fixed Platforms, Walkways, Stairways and Ladders Standard Specification	REX & Waternet
SPE-00367 M-SPE-STD-001 General Mechanical Standard Specification	REX & Waternet
TEM-00008 WHS Risk Assessment Template	REX & Waternet
TEM-00216 X-TMP-STD-005 Engineering Statement – ES1 – Design Template	REX & Waternet
TEM-00217 X-TMP-STD-006 Engineering Statement – ES2 – Construction Template	REX & Waternet
TEM-00224 X-TMP-STD-022 Asset Standards Deviation Request Template	REX & Waternet
AS/NZS 1170 Structural Design Actions	SAI Global / Waternet
AS 1397 Continuous Hot-dip Metallic Coated Steel Sheet and Strip	SAI Global / Waternet
AS 1445 Hot-dipped zinc-coated, aluminium/zinc-coated or aluminium/zinc/magnesium-coated steel sheet – 76 mm pitch corrugated	SAI Global / Waternet
AS 1562 Design and Installation of Sheet Roof and Wall Cladding – Metal	SAI Global / Waternet
AS 1657 Fixed Platforms, Walkways, Stairways and Ladders	SAI Global / Waternet
AS/NZS 1891 Industrial Fall-arrest System and Devices	SAI Global / Waternet

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	19 of 24

Description	Location
AS/NZS 2179 Specifications for rainwater goods, accessories and fasteners - Metal shape or sheet rainwater goods, and metal accessories and fasteners	SAI Global / Waternet
AS 2428 SET Methods of testing smoke/heat release vents	SAI Global / Waternet
AS/NZS 2728 Prefinished/Prepainted Sheet Metal Products for Interior/Exterior Building Applications	SAI Global / Waternet
AS 2865 Confined Spaces	SAI Global / Waternet
AS/NZS 2904 Damp-proof courses and flashings	SAI Global / Waternet
AS 3566 Self-drilling Screws for the Building and Construction Industries	SAI Global / Waternet
AS 3959-2009 Construction of buildings in bushfire-prone areas	SAI Global / Waternet
AS/NZS 4020 Testing of Products for Use in Contact with Drinking Water	SAI Global / Waternet
AS 4040 Methods of testing sheet roof and wall cladding - Introduction, list of methods and general requirements	SAI Global / Waternet
AS 4300 General Conditions of Contract for Design and Construct	SAI Global / Waternet
AS/NZS 4600 Cold-formed Steel Structures	SAI Global / Waternet
AS/NZS 4671 Steel Reinforcing Materials	SAI Global / Waternet
AS/NZS 4792 Hot-dip Galvanized (Zinc) Coatings on Ferrous Hollow Sections, Applied by a Continuous or a Specialized Process	SAI Global / Waternet
SAA HB39 Installation code for metal roofing and wall cladding	SAI Global / Waternet
ISO 3506 Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners	SAI Global / Waternet
Structural Steelwork:	
AS 1100.101 Technical drawing – General principles	SAI Global / Waternet
AS 1100.201 Technical drawing – Mechanical engineering drawing	SAI Global / Waternet
AS 1110 ISO metric hexagon bolts and screws – Product grades A and B	SAI Global / Waternet
AS 1111 ISO metric hexagon bolts and screws – Product grade C	SAI Global / Waternet
AS 1112 ISO metric hexagon nuts	SAI Global / Waternet
AS/NZS 1163 Structural steel hollow sections	SAI Global / Waternet
AS 1214 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)	SAI Global / Waternet
AS 1237 Plain washers for metric bolts, screws and nuts for general purposes	SAI Global / Waternet
AS/NZS 1252 High strength steel bolts with associated nuts and washers for structural engineering	SAI Global / Waternet
AS 1275 Metric screw threads for fasteners	SAI Global / Waternet
AS/NZS 1554 SET Structural steel welding Set	SAI Global / Waternet
AS/NZS 1594 Hot-rolled steel flat products	SAI Global / Waternet
AS/NZS 3678 Structural steel – Hot-rolled plates, floor plates and slabs	SAI Global / Waternet

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	20 of 24

Description	Location
AS/NZS 3679.1 Structural steel – Hot-rolled bars and sections	SAI Global / Waternet
AS 4100 Steel structures	SAI Global / Waternet
AS/NZS 4291.1 Mechanical properties of fasteners made of carbon steel and alloy steel – Bolts, screws and studs	SAI Global / Waternet
AS/NZS 4291.2 Mechanical properties of fasteners – Nuts with specified proof load values – Coarse thread	SAI Global / Waternet
AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles	SAI Global / Waternet
AS/NZS 4855 Covered electrodes for manual metal arc welding non-alloy and fine grain steels- Classification	SAI Global / Waternet
AS/NZS ISO 14174 Welding Consumables – Fluxes for submerged arc welding and electroslag welding – Classification	SAI Global / Waternet
AS/NZS ISO 14341 Welding Consumables – Wire electrodes and welding deposits for gas shielded metal arc welding of not alloy and fine grain steels – Classification	SAI Global / Waternet
AS/NZS ISO 17632 Welding Consumables – Tubular cored electrodes for gas shielded and non gas shielded metal arc welding of not alloy and fine grain steels – Classification	SAI Global / Waternet
Stainless Steel:	
AS/NZS 1167.2 Welding and Brazing – Filler Metals – Filler Metal for Welding	SAI Global / Waternet
AS/NZS 4854 Welding Consumables – Covered Electrodes for Manual Metal Arc Welding of Stainless and Heat-Resisting Steels - Classification	SAI Global / Waternet
ISO 3506 Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners	SAI Global / Waternet
ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications	SAI Global / Waternet
ASTM A276 Standard Specification for Stainless Steel Bars and Shapes	SAI Global / Waternet
ASTM A312 Standard Specification for Seamless, Welded and Heavily Cold Worked Austenitic Stainless Steel Pipes	SAI Global / Waternet
ASTM A380 Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems	SAI Global / Waternet
ASTM A 480M Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, sheet, and Strip	SAI Global / Waternet
ASTM A554 Standard Specification for Welded Stainless Steel Mechanical Tubing	SAI Global / Waternet
ASTM A789 Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service	SAI Global / Waternet
Aluminium:	
AS 1231 Aluminium and aluminium alloys – Anodic oxidation coatings	SAI Global / Waternet
AS/NZS 1664 Aluminium Structures	SAI Global / Waternet
AS/NZS 1665 Welding of Aluminium Structures	SAI Global / Waternet

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	21 of 24

Description	Location
AS/NZS 1734 Aluminium and aluminium alloys – Flat sheet, coiled sheet and plate	SAI Global / Waternet
AS/NZS 1865 Aluminium and aluminium alloys – Drawn wire, rod, bar and strip	SAI Global / Waternet
AS/NZS 1866 Aluminium and aluminium alloys – Extruded rod, bar, solid and hollow shapes	SAI Global / Waternet
AS/NZS 1867 Aluminium and aluminium alloys – Drawn tubes	SAI Global / Waternet
AS 1874 Aluminium and aluminium alloys – Ingots and castings	SAI Global / Waternet
AS/NZS 18273 Welding consumables – Wire electrodes, wires and rods for welding of aluminium and aluminium alloys – Classification	SAI Global / Waternet
AS/NZS 3834.2 Quality requirements for welding – Fusion welding of metallic materials – Comprehensive quality requirements	SAI Global / Waternet
AS/NZS 3834.3 Quality requirements for welding – Fusion welding of metallic materials – Standards quality requirements	SAI Global / Waternet
Quality Management:	
AS/NZS ISO 9001 Quality management systems - Requirements	SAI Global / Waternet
ISO 3834 Quality requirements for fusion welding of metallic materials	SAI Global / Waternet
BCM-P-011 Registration Procedure: Approved Suppliers of Steel Fabricated Products	SAI Global / Waternet
CTP-SM01 Procedure Manual: Register for Approved Fabricators of Steelwork, Aluminium and Stainless Aluminium Components	SAI Global / Waternet
AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles	SAI Global / Waternet
Others:	
Queensland Professional Engineers Act 2002	Queensland Legislation
Queensland Work Health and Safety Act	Queensland Legislation
Queensland Workplace Health and Safety Regulations	Queensland Legislation
Managing the Risks of Falls at Workplaces Code of Practice	Workplace Healthy and Safety Qld
Queensland Urban Drainage Manual	Institute of Public Works Australasia
Australian Rainfall & Runoff – A Guide to Flood Estimation	Geoscience Australia

In addition, a range of industry publications, standards, guidelines, and codes were consulted in the preparation of this Standard Specification. For reference, these are listed in Section 11 of this Standard Specification.

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	22 of 24

8. Changes from previous version

This Standard Specification will be regularly reviewed in accordance with the requirements of the Seqwater Controlled Document Management Procedure. Reviews will include consideration of suggestions for alteration or improvement made in accordance with Seqwater Procedure X-PRO-STD-004 Development and Review of Asset Standards. Changes made from the previous version are summarised in Table 5 below.

Table 5 Changes from previous version.

Section Number	Change
All	Reformatting to new Seqwater Style Guide and Controlled Document format.
Cover and Page Headers	Title amended to remove the word "Metal".
1	Standard boilerplate wording updated to latest version as endorsed by Legal Services and the word "Metal" removed from the purpose statement to clarify that the provisions of the standard are intended to be applied to all Seqwater Water Storage Reservoirs unless approved via the Deviation process.
2	Standard boilerplate wording updated to latest version as endorsed by Legal Services.

9. Verification

Compliance with this document may be verified by internal audit.

10. Further Information

For further information please contact the document owner of this document.

11. References

This Standard Specification was prepared taking into consideration of good practices and recommendations from the documents referenced in Table 6 References.

Table 6 References

Description
Design Standard DS 61 – Water Supply Distribution – Tanks, Water Corporation (Version 4, 2017)
EPA Region 8 Drinking Water Unit Tech Tips; Sanitary Protection of Drinking Water Storage Tanks: Vents, Sanitary Protection of Drinking Water Storage Tanks: # 24 Mesh Non-corrodible Screen, and Sanitary Protection of Drinking Water Storage Tanks: Overflows
EPA Finished Water Storage Facilities, AWWA (2002)
SS11 Specification for Construction of Concrete Reservoirs, Gold Coast City Council (2004)
Section 7 Tank/Reservoir Standards, Water and Sewer Design Manual, Hunter Water Corporation (2011)

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	23 of 24

Description
Section 5 Building Design Standards for Department of Education and Training Facilities (2011)
Papers presented at the Water Industry Operations Conference and Exhibition: - Hannah Busch & David Barry (2014), Reservoir Design for the Next 80 Years, Aqualift Project Delivery Pty Ltd - David Barry, When is reservoir cleaning not just cleaning? Following the Evidence Trail, Aqualift Potable Diving Pty Ltd - Jillian Busch (2014), Reservoir Inspections to Protect and Preserve Water Quality, Data Based Solutions P/L - Stefan Claveria (2011), Service Reservoir Refurbishment, Sinclair Knight Merz - Chris Andrews, David Barry, Peter Duzevich (2010), Reservoir Renovations: Best Chance or Lost Chance, Nextep/Aqualift Pacific, Aqualift Potable Diving, Aqualift Pacific
David Barry (2014), Reservoir Design for the Next Generation, Aqualift Project Delivery Pty Ltd
Finished Water Storage Facilities, EPA United States (2002)
Design Guidelines for Drinking Water Systems, Ministry of Environment, Ontario (2008)
Technical Bulletins, BlueScope
MRTS78 Fabrication of Structural Steelwork, Technical Specification, Transport and Main Roads Specifications (October 2014)
MRTS79 Fabrication of Aluminium Components, Technical Specification, Transport and Main Roads Specifications (June 2013)
MRTS71A Stainless Steel Reinforcing, Technical Specification, Transport and Main Roads Specifications (June 2009)
Roofing & Walling Installation Manual – For design and Installation Professionals 2014-2015 Edition, Lysaght
Flashing Guide – For Architect and Detailing Professionals, Lysaght
SAA HB39 Installation Code for Metal Roof and Wall Cladding
Queensland Public Health Regulation 2005 (Clause 2P)
Pamphlet 6, “Piping Systems for Dry Chlorine”, The Chlorine Institute Inc. (Ed 15, May 2005)

Version No.	Document No.	Document Owner:	Approval Date:	Document Approver:	Page:
4	SPE-00370	Principal Engineering Standards and Assurance	26/02/2024	General Manager - Engineering Standards & Assurance	24 of 24