

Specification
For
**Reservoir
Design and
Construction**

Pr9821



Unitywater

Pr9821 - Specification for Reservoir Design and Construction

Documents Details

This document is only valid on the day it was printed.

Version Review

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
	20/09/2013	F. Kashefzadeh			For comment
	25/11/2013	F. Kashefzadeh			Includes comments from Glen Morgan, Andrew Currie, Shannon McBride
		F. Kashefzadeh			Includes comments from Barry Maule, Jeremy Duncan, Shannon McBride, Sean Hinton
1	11/11/2015	L. Black			
2	20/06/2018		A Schoenmaker		Automated review: publication and upload to current Written Direction
3	20/12/2018	IS&PA Committee	A Creevey	18/12/2018	Mesh size updated within Section 10.10.8 and 10.10.9
4	10/04/2019	L. Bryson	N/A		Minor admin amendment to update WSAA reference

Written Direction Control

Document Sponsor	Infrastructure Technical Standards Committee
Document Author (Owner)	Manager, Capital Delivery, SIS
Subject Matter Expert	Team Leader Design, Capital Delivery, SIS
References	Refer to Section 3 of this document

Pr9821 - Specification for Reservoir Design and Construction

Contents

1. Purpose	7
2. Scope	7
3. References	7
3.1. General	7
3.2. Applicable Legislation and Regulation	8
3.3. Codes of Practice (ratified by Legislation)	8
3.4. Codes of Practice (not ratified by Legislation)	8
3.5. International and Australian Standards	8
3.6. Unitywater Technical Specifications	11
4. Definitions/Abbreviations	11
5. General Requirements	12
5.1. Language and Units of Measurement	12
5.2. Site Area	12
5.3. Site Selection	12
5.4. Geotechnical	13
5.5. Site Survey	13
5.6. Road Access	13
5.7. Perimeter Access	14
5.8. Landscaping	14
5.9. Safety Considerations	14
5.10. Quality Control	15
6. Materials and Workmanship	15
6.1. Materials	15
6.2. Workmanship	16
6.3. Guarantees/Warranties	17
6.4. Steelwork	17
6.5. Aluminium Works	17
6.6. Pipes and Fittings	17
6.7. Support Brackets	17
6.8. Thrust Restraint	17
6.9. Gaskets	18
6.10. Bolts and Nuts, Washers and Masonry Anchors	18

Pr9821 - Specification for Reservoir Design and Construction

7. Design	18
7.1. Design Scope	18
7.2. Safety in Design	20
7.3. Design Requirements	20
7.4. Whole-of-Life Costs	21
7.5. Design Report.....	21
7.6. Design Documentation.....	22
8. Pipework	22
8.1. General.....	22
8.2. Inlet Pipework.....	22
8.3. Outlet Pipework	23
8.4. Bypass Pipework	23
8.5. Overflow Pipework.....	23
8.6. Scour Pipework	24
8.7. Under Floor Drainage (Slotted HDPE Pipe)	24
8.8. Reinforced Concrete Stormwater/Overflow/Scour Drainage Pipes and Fittings ..	24
8.9. Water Sample Points	24
9. Valve and Valve Pits	25
9.1. General Requirements.....	25
9.2. Gate Valves	25
9.3. Ductile Iron Reflux/Check Valves.....	25
9.4. Control Valve	25
9.5. Valve Pit and Access Cover over the Valve Pit.....	26
10. Reservoir Roof.....	26
10.1. Design Objective.....	26
10.2. General Requirements.....	27
10.3. Aluminium Roof	27
10.4. Roof Flashings and Accessories.....	28
10.5. Roof Sheetting Handling and Storage.....	28
10.6. Concrete Roof	29
10.7. Roof Support Columns.....	29
10.8. Roof Stormwater and Overflow/Scour Management	29
10.9. Roof Sealant.....	30
10.10. Roof Ventilation	30

Pr9821 - Specification for Reservoir Design and Construction

11. Roof Access	31
11.1. Roof Access Platform	31
11.2. Roof Access Hatch	32
11.3. Reservoir Roof Access by Stairs.....	32
11.4. Internal Reservoir Access by Ladder	33
11.5. Fall Arrest Anchor	33
11.6. Davit Arm.....	33
12. Water Quality aspects	34
12.1. Mixing/Circulation Arrangement.....	34
12.2. Re-Chlorination.....	35
13. Concrete Works	35
13.1. General.....	35
13.2. Finishes to Formed Concrete Surfaces.....	35
13.3. Materials and Coatings	35
13.4. Construction	35
14. Painting and Corrosion Protection.....	36
14.1. General.....	36
14.2. Pipework Protective Coatings	36
15. Electrical/Telemetry.....	36
15.1. General Requirements.....	36
15.2. Power supply	37
15.3. Switchboard.....	37
15.4. Telemetry and Instrumentation Cubicle.....	37
15.5. Radio Path Survey.....	37
15.6. Site Lighting.....	37
15.7. Site GPOs.....	38
15.8. Lightning Protection	38
16. Instrumentation.....	38
16.1. Level Sensor.....	38
16.2. Level Floats	39
16.3. Electromagnetic Flow Meters.....	40
17. Site Security Requirements	40
17.1. Perimeter Fencing	40
17.2. Perimeter Fencing Entry Points	40

Pr9821 - Specification for Reservoir Design and Construction

17.3. Security Signage.....	41
17.4. External Security Lighting	41
17.5. Intruder Alarm System (IAS)	41
17.6. Key System	41
17.7. Locking	41
18. Signage and Labelling.....	41
18.1. Safety Signage	41
18.2. Labelling	41
18.3. Piping Identification.....	42
19. Site Workmanship	42
20. Testing, Commissioning and Post Construction Documentation.....	42
20.1. Hydrostatic Pressure Testing	42
20.2. Commissioning	42
20.3. Water Quality Testing	44
20.4. Post Construction Documentation and Practical Completion	46
20.5. As Constructed Information	47
20.6. Asset Manuals	47

List of Tables

Table 1 – Number of Roof Ventilator	30
Table 2 – Water Quality Acceptance Criteria.....	44

List of Figures

No table of figures entries found.

List of Annexes

List of Enclosures

Pr9821 - Specification for Reservoir Design and Construction

1. Purpose

- 1.0.1 The purpose of this Specification is to set out minimum requirements for the design, supply, construction, installation, testing, commissioning and hand-over to Unitywater of a new water supply reservoir.

2. Scope

- 2.0.1 This Specification covers the Unitywater requirements on design and construction of ground level reinforced or prestressed/post-tensioned concrete water supply reservoir. This specification does not cover Unitywater's requirements on steel reservoirs nor elevated reservoirs.
- 2.0.2 This Specification shall apply to works to be constructed by contract, sub-contract or direct labour.
- 2.0.3 This document does not relieve the designer's responsibility for compliance with relevant Australian and International standards. Any variation from the minimum requirements set out in this specification shall be justified by the designer in a design report.

3. References

3.1. General

- 3.1.1 Unless otherwise specified, all infrastructure and related components covered by this Specification shall be designed, manufactured, installed and tested and shall perform in accordance with the following, listed in order of precedence:
- The Project Contract documents;
 - Requirements of the Statutory Authorities having jurisdiction over all or part of the manufacture, installation or operation of the plant;
 - The SEQ Water Supply and Sewerage Design and Construction Code, available via the SEQCODE website: www.seqcode.com.au;
 - All relevant Australian and governing Queensland standards where applicable (latest relevant version);
 - Water Services Association of Australia (WSAA) codes; and
 - Water Services Association of Australia (WSAA) Guideline: Dechlorination of Drinking Water to Discharged Waterways, National Guidance for the Urban Water Industry 2019.
- 3.1.2 Reference to specific clauses of the various specifications and standards is intended to highlight those points and shall not be taken to imply a lesser importance for all other applicable clauses.
- 3.1.3 All the works shall conform to the rules and regulations of the Statutory Authorities having jurisdiction over the site.

Pr9821 - Specification for Reservoir Design and Construction

- 3.1.4 Where conflict exists between different codes, standards or regulations, the higher requirement shall apply.
- 3.1.5 If the requirements highlighted in this Specification do not comply with the minimum requirements of the statutory regulations and standards, the latter shall apply. If the requirements of this Specification are more exacting than the minimum requirements of the statutory regulations and standards, the former shall apply.
- 3.1.6 All Materials, fittings, accessories and equipment supplied shall be new and the best obtainable of their kind and shall comply in all respects with the requirements of the relevant Standards Australia specifications.

3.2. Applicable Legislation and Regulation

At least the following legislation and related regulation shall apply:

- a. *Workplace Health and Safety Act 2011;*
- b. *Workplace Health and Safety Regulation 2011;*
- c. *Water Supply (Safety and Reliability) Act 2008;*
- d. *Environmental Protection Act 1994;*
- e. *Queensland Building Services Authority Act 1991;*
- f. *Professional Engineers Act 2002.*

3.3. Codes of Practice (ratified by Legislation)

- 3.3.1 At least the following Codes of Practice ratified by legislation shall apply:
 - Workplace Health and Safety Queensland Code of Practice; Managing noise and preventing hearing loss at work 2011;
 - Workplace Health and Safety Queensland Code of practice; Scaffolding Code of Practice 2009;
 - SEQ Water Supply and Sewerage Design and Construction Code (SEQ WS & S D & C Code).

3.4. Codes of Practice (not ratified by Legislation)

None applicable.

3.5. International and Australian Standards

- 3.5.1 This Specification makes reference to a number of Australian and international Standards, including but not limited to the following:

Standard	Title
Quality Systems	
AS 2990	Quality Systems for Engineering and Construction Projects
AS 3901	Quality Systems for Design/Development, Production, Installation and Servicing
AS 3902	Quality Systems for Production and Installation

Pr9821 - Specification for Reservoir Design and Construction

Standard	Title
AS 3903	Quality Systems for Final Inspection and Test
Drawings	
AS 1110	Technical Drawings
AS 1101	Graphical Symbols for General Engineering
AS 1102	Graphical Symbols for Electrotechnology
Materials and Workmanship	
AS 1012	Methods of Testing Concrete
AS 1111	ISO metric hexagon commercial bolts and screws
AS 1112	ISO metric hexagon nuts, including thin nuts, slotted nuts and castle nuts
AS 1170.4	Structural design actions
AS 1180	Methods of test for hose from elastomeric materials
AS 1214	Hot dip galvanised coatings on threaded fasteners (ISO metric coarse thread series)
AS 1311	Steel tendons for prestressed concrete – 7 wire stress relieved steel strands for tendons in prestressed concrete
AS 1314	Prestressing anchorages
AS 1319	Safety signs for the occupational environment
AS 1345	Identification of the contents of pipes, conduits and ducts
AS 1379	The Specification and Supply of Concrete
AS 1478.1	Chemical admixtures for concrete, mortar and grout – Admixtures for concrete
AS 1478.2	Chemical admixtures for concrete, mortar and grout – Methods of sampling and testing admixtures for concrete
AS 1554	Structural steel welding
AS 1532.1	Design and installation of sheet roof and wall cladding – metal
AS 1627	Metal finishing - Preparation and pre-treatment of surfaces - Method selection guide
AS 1646	Elastomeric seals for waterworks purposes
AS 1654	ISO System of Limits and Fits
AS 1657	Fixed platforms, walkways, stairways and ladders — Design, construction and installation
AS 1664	Aluminium structures
AS 1683	Methods of test for elastomers
AS 1734	Aluminium and aluminium alloys – flat sheet, coiled sheet and plate
AS 1891.3	Industrial fall-arrest system and devices
AS 2032	Installation of UPVC pipe systems
AS 2033	Industrial fall-arrest system and devices
AS 2280	Ductile iron pipes and fittings
AS 2312	Guide to the protection of iron and steel against exterior atmospheric corrosion

Pr9821 - Specification for Reservoir Design and Construction

Standard	Title
AS 2350	Methods of testing Portland and blended cements
AS 2528	Bolts, studbolts and nuts for flanges and other high and low temperature applications
AS 2549	Cranes (including hoists and winches) - Glossary of terms
AS 2566	Plastics pipelaying design
AS 2638	Resilient Seated Gate Valve
AS 2700	Colour standards for general purposes
AS 2728	Prefinished/pre-painted sheet metal products for interior/exterior building applications - Performance requirements
AS 2758	Aggregates and rock for engineering purposes
AS 2865	Safe working in a confined space
AS 2885	Pipelines - Gas and liquid petroleum - General requirements
AS 3600	Concrete Structures
AS 3610	Formwork for concrete
AS 3725	Design for installation of buried concrete pipes
AS 3735	Concrete Structures Retaining Liquids
AS 3972	General purpose and blended cements
AS 4020	Products for use in contact with drinking water
AS 4037	Pressure equipment - Examination and testing
AS 4041	Pressure piping
AS 4058	Precast concrete pipes (pressure and non-pressure)
AS 4087	Metallic flanges for waterworks purposes
AS 4024	Safeguarding of Machinery
AS 4100	Steel structures
AS 4158	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS 4600	Cold-formed steel structures
AS 4671	Steel reinforcing materials
AS 4680	Hot-dip galvanised (zinc) coatings on fabricated ferrous articles
AS 4791	Hot-dip galvanized (zinc) coatings on ferrous open sections, applied by an in-line process
AS 4792	Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process
AS 4991	Lifting devices
AS 4998	Bolted unrestrained mechanical couplings for waterworks purposes
AS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

Pr9821 - Specification for Reservoir Design and Construction

3.6. Unitywater Technical Specifications

3.6.1 This Specification makes reference to a number of Unitywater's technical specifications, including but not limited to the following:

Standard	Title
	SEQ Asset Information Specification
Pr9902	Civil and Earth Works Specification
Pr9903	Building and Structural Works Specification
Pr9875	Non Pressure Pipe Construction
Pr9904	Pressure Pipe Construction
Pr9680	Electrical Installations at Unitywater Network Sites Specification
Pr9693	Mechanical Specification
Pr9080	CAD Drafting Standard
Pr9078	Specification for As Constructed Information
Pr8703	Specification for Commissioning of Network Project Assets
Pr9087	Pressure testing of Water Mains Work Instruction
Pr9079	Specification for Commissioning of New Water Mains
Pr9032	Procedure for determination of acceptability of new water mains
Pr9834	SCADA and PLC Standard
Pr9845	SCADA and PLC Implementation

4. Definitions/Abbreviations

Term	Meaning
Actions	<ul style="list-style-type: none"> 'Shall', 'will' or 'must' indicates mandatory action; 'Should' indicates preferred/recommended action; 'May' or 'can' indicates possible or optional action.
ADAC	Asset Design As Constructed
AS	Australian Standard
CFD	Computational Fluid Dynamics
CSE	Confined Space Entry
CSP	Construction Safety Plan
FRP	Fibre-reinforced plastic
GPO	General Power Outlet
IO	Input/ Output
IPAM	Infrastructure Products and Materials

Pr9821 - Specification for Reservoir Design and Construction

Term	Meaning
ITPs	Inspection and Test Plans
OH&S	Occupation Health and Safety
QUDM	Queensland Urban Drainage Manual
P&ID	Piping & Instrumentation Diagram
PLC	Programmable Logic Controller
RPEQ	Registered Professional Engineer of Queensland
RTU	Remote Telemetry Unit
SCADA	Supervisory Control & Data Acquisition
SEQ	South East Queensland
WHO	World Health Organisation
SEQ WS&S D&C Code (SEQ Code)	South East Queensland Water Supply & Sewerage Design & Construction Code

5. General Requirements

5.1. Language and Units of Measurement

- 5.1.1 All drawings and documentation shall be written in English.
- 5.1.2 The units used throughout the project shall be the SI metric system of measurement, in accordance with AS ISO 1000-1998. Where units of another convention are nominated, conversion to SI units shall be made in accordance with AS 1376.

5.2. Site Area

- 5.2.1 The size of the parcel of land shall be large enough to accommodate the infrastructure and its appurtenances, provide for maintenance and for the access and egress of vehicles large enough to maintain the infrastructure.

5.3. Site Selection

- 5.3.1 The order of preference for land choice for a reservoir site shall be:
- Land provided by the developer; the freehold title or easement rights for any reservoir sites, access and services shall be given to Unitywater;
 - Unitywater-owned land.
- 5.3.2 The following factors shall be considered when selecting the site:
- Ownership of the land is dedicated to Unitywater;
 - All weather access to the reservoir for routine and emergency operation and maintenance activities;
 - Availability of power facilities or able to be economically provided to the site;

Pr9821 - Specification for Reservoir Design and Construction

- Adequate radio communication access;
- Provision of sufficient buffer from houses, built-up areas and future development;
- Adequacy of stormwater management drainage from the site;
- The site and access road shall not be liable to flooding during a 1 in 100 year flood event.

5.4. Geotechnical

- 5.4.1 A geotechnical investigation is required to be undertaken by the design engineer to determine ground conditions.
- 5.4.2 The designer shall address reservoir foundations, pipework thrust restraint, access road and hardstand area and settlement issues. The report shall provide the details of investigation and findings.
- 5.4.3 The geotechnical report shall be prepared by a Registered Professional Engineer Queensland who shall have recent experience in geotechnical engineering for large structures and who is employed by a consulting engineering practice having quality assurance certification to AS/NZS ISO 9001 for geotechnical engineering.
- 5.4.4 When benching or battering the walls of an excavation, an angle of repose of 45 degrees to the horizontal must not be exceeded unless certified in writing by a Geotechnical Engineer.

5.5. Site Survey

- 5.5.1 The reservoir site shall be surveyed by a registered surveyor to identify the surface contours, boundaries and existing services in accordance with the SEQ WS&S D&C Code.
- 5.5.2 This information will be used by the designer in locating the reservoir, considering the operating levels for reservoir (top water level, bottom water level, etc.), pipework routes, water service, power supply, drainage, access roadway and turning areas.

5.6. Road Access

- 5.6.1 The Concept Design shall nominate the route into the reservoir with regard to its suitability for all-weather access and manoeuvring by operations, maintenance, emergency and supply vehicles nominated by Unitywater (site specific). Access roadways and parking areas shall be trafficable in all weathers.
- 5.6.2 Unless agreed otherwise, all access roads shall have the same flood immunity criteria as required for the connecting road network.
- 5.6.3 Where the reservoir does not front a public road, the land defined for transfer to the Unitywater shall embrace the access road. Where that is not practicable, a suitable access easement shall be created in favour of Unitywater.
- 5.6.4 Vehicular access from Council's/Road Authority road shall be in accordance with the road authorities Access Standards.
- 5.6.5 Road shall be designed in accordance with Council's/ Road Authorities Standard Specifications.

Pr9821 - Specification for Reservoir Design and Construction

- 5.6.6 The access road shall be designed as flexible pavement with asphalt seal or concrete pavement.
- 5.6.7 New roads shall join neatly to existing roads by a straight line cut and any damage to existing roads shall be repaired as necessary.

5.7. Perimeter Access

- 5.7.1 A reinforced concrete pathway 1500 mm wide shall be provided right around full extent of the base of the reservoir:
- The perimeter pathway shall include a 200 mm high concrete hob to contain rain water from the roof of the reservoir and direct it to at least two (2) stormwater pits;
 - The pathway shall extend around all structures and pits where these restrict the continuity of the pathway;
 - The Design Engineer shall ensure that the stormwater discharge from the site is non-worsening, in accordance with QUDM Second Edition 2007.
- 5.7.2 A minimum 3 m wide clear vehicular, crushed rock or gravelled, access way shall also be provided around the full perimeter of the reservoir and also around all maintainable items, on the outside of the concrete pathway where possible.

5.8. Landscaping

- 5.8.1 The Contractor must ensure that the aesthetics of the area are maintained, not in the least by way of preparing a Landscape Plan that can be inspected by Unitywater upon request.
- 5.8.2 The Landscape Plan must be designed to blend the reservoir site into the local area and require minimum maintenance:
- Choices of flora shall be suitable to the area;
 - Trees and shrubs shall be Australian natives that require little post-planting maintenance;
 - Lawns are not be permitted to be used in landscaping unless specified by Unitywater;
 - No planting over infrastructure services or under overhead power lines is allowed;
 - Special attention must be paid to the type of trees and shrubs planted in the vicinity of pipework (Unitywater has a brochure 'Planting Trees and Shrubs' which explains these details);
 - Consideration shall also be given to the location of plants in the vicinity of appurtenances.

5.9. Safety Considerations

- 5.9.1 Safety shall be considered in the design, material selection, construction, operation and maintenance, signage and shall comply with relevant Australian Standards and Work Health and Safety requirements.

Pr9821 - Specification for Reservoir Design and Construction

5.10. Quality Control

- 5.10.1 An accredited Quality Control System in accordance with ISO 9001 shall be implemented for all construction works on the project.
- 5.10.2 Inspection and Test Plans shall be submitted for review and acceptance prior to procuring all associated materials.

6. Materials and Workmanship

6.1. Materials

- 6.1.1 Materials and equipment shall include all machinery, equipment and components which form a part of the works to be provided by the Contractor.
- 6.1.2 All materials and equipment supplied shall be new and of the best industrial quality and manufacture and shall be suitable for its intended duty and the sewage treatment plant and its associated environment, with appropriate abrasive and corrosion resistance
- 6.1.3 All materials in contact with drinking water shall comply with the requirements of AS/NZS 4020.
- 6.1.4 All materials and equipment shall be:
 - Of a duty rating appropriate to the application;
 - Suitable for the purpose;
 - Proven in service;
 - Suitable for installation in the spaces allocated with suitable access and clearances for normal and long term maintenance requirements;
 - Compatible with other materials and equipment to be used in the works;
 - Complying with the Conditions of Contract;
 - Supported by appropriate servicing facilities and locally available spare parts;
 - Corrosion resistant;
 - Wear resistant.
- 6.1.5 The design shall be suitable and adequate for the respective application for which the particular items are installed.
- 6.1.6 All work performed, equipment provided and materials shall conform to the most recent requirements of relevant statutory local, state and Commonwealth requirements and applicable, current Australian Standards, including:
 - The Standards Association of Australia;
 - The Division of Workplace Health and Safety; and
 - Any authority having jurisdiction over any of the works covered by the Contract.
- 6.1.7 Where products of alternative manufacturers are proposed, their acceptability and approval must be obtained from the Superintendent.

Pr9821 - Specification for Reservoir Design and Construction

- 6.1.8 The Contractor shall be responsible for ensuring that materials and equipment supplied meet the specified performance, construction, quality, space and structural loading requirements.
- 6.1.9 Material and equipment characteristics other than those specifically covered by the drawings and specifications, shall be at least equivalent to those of any mentioned trade name, or if no trade name is mentioned, typical of the respective material or equipment kind.
- 6.1.10 The Contractor shall be responsible for ensuring that full allowance is made for the proper connection and interfacing of the materials and equipment with other portions of the works.
- 6.1.11 Samples of material shall be taken in accordance with the appropriate Australian Standard where applicable.
- 6.1.12 Fibre Reinforced Plastic (FRP) products shall be manufactured from materials and by processes complying with international standards for the water industry.
- 6.1.13 Where dissimilar metals come into contact, the surfaces shall be kept from direct metal to metal contact by use of PTFE gaskets, high strength phenol washers or other approved
- 6.1.14 The following materials are prohibited and shall not be included in any components of the equipment supplied:
- Asbestos and materials containing asbestos;
 - Polychlorinated biphenyls (PCBs) and materials containing PCBs;
 - Ceramic fibres;
 - Formaldehyde insulation;
 - Halon;
 - Lead based paints;
 - Chlorofluorohydrocarbons (CFCs);
 - Radioactive materials.
- 6.1.15 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.

6.2. Workmanship

- 6.2.1 All workmanship shall:
- Be in accordance with the best modern trade practice, relevant Standards and Codes of Practice;
 - Comply with the Contract Documents;
 - Be carried out by appropriately qualified and experienced tradesmen;
 - Be carried out under the supervision of a competent foreman;

Pr9821 - Specification for Reservoir Design and Construction

- Result in a high standard of construction and leave a thoroughly efficient, robust, tidy and fully operational and safe installation.
- 6.2.2 Machining shall be concentric, square to line and true. All sharp edges and burrs shall be removed.
- 6.2.3 Bolt holes shall be drilled and spot faced for bolt head and nut. Mating parts shall be match-marked and dowelled.
- 6.2.4 Defective work shall not be repaired by welding, filling, plugging or any other process unless written permission is granted by the Superintendent.
- 6.2.5 The Contractor shall ensure only qualified and competent personnel carry out welding work and, where necessary to meet Australian Standards, carry out non-destructive testing. Any periodic non-destructive testing and its interval, deemed necessary during normal operation of the equipment shall be advised by the Contractor.

6.3. Guarantees/Warranties

- 6.3.1 Guarantees/Warranties shall be provided for the equipment offered as being of modern and correct design and capable of efficiently and satisfactorily performing all the duties as specified or implied in this Specification.
- 6.3.2 If, when tested in accordance with the Specification, the performance of any plant or equipment is outside the stated tolerance limits, the equipment/plant shall be replaced to the satisfaction of Unitywater.

6.4. Steelwork

- 6.4.1 All steel work shall comply with the relevant Australian Standards and the requirements of Unitywater's *Building and Structural Specification* (Pr9903).

6.5. Aluminium Works

- 6.5.1 All aluminium work shall comply with the relevant Australian Standards and the requirements specified in Unitywater's *Building and Structural Specification* (Pr9903).

6.6. Pipes and Fittings

- 6.6.1 Pipes and pipeline fittings shall comply with the relevant Australian Standards and the requirements of Unitywater's *Specification for Pressure Pipeline Construction* (Pr9904) and *Non-Pressure Pipeline Construction* (Pr9875).

6.7. Support Brackets

- 6.7.1 Adequate pipework support shall be provided as per the requirements of Unitywater's specifications for *Mechanical Installation* (Pr9693) and *Building and Structural Works* (Pr9903).

6.8. Thrust Restraint

- 6.8.1 In accordance with Unitywater's specification for *Mechanical Installation*, sufficient restraint shall be provided at all pipe penetrations to ensure forces are sufficiently restrained within the pipeline.

Pr9821 - Specification for Reservoir Design and Construction

6.9. Gaskets

- 6.9.1 Gaskets must be supplied and installed in accordance with Unitywater's Mechanical Installation Specification.

6.10. Bolts and Nuts, Washers and Masonry Anchors

- 6.10.1 Bolts, nuts, washers and masonry anchors shall comply with the requirements of Unitywater's Specification for Pressure Pipeline Construction (Pr9904) and Mechanical Installation (Pr9693).
- 6.10.2 All dissimilar metals shall be effectively insulated. Where dissimilar metals come into contact, the surfaces shall be kept from direct metal to metal contact by use of PTFE gaskets, high strength phenol washers or other approved method of isolation.
- 6.10.3 Aluminium shall be isolated from any wet concrete by a moisture-proof coating, lining or gasket.

7. Design

7.1. Design Scope

- 7.1.1 All equipment shall be of a sound and robust design, suitable for the specified capacity or the capacity necessary to achieve the performance requirements and provided with all minor and incidental items for proper functioning of the whole system.
- 7.1.2 Equipment and components shall be to the manufacturer's normal design for the service specified with readily available replacement parts.
- 7.1.3 The designer shall be responsible for assessing the specific operating and maintenance requirements and loadings for each individual piece of equipment or facility.
- 7.1.4 The scope of design shall include, but is not limited to, preparation of the following:
- Engineering Reports;
 - General Arrangement Drawings – to define each facility in general terms and to provide a basis for co-ordinating detail design engineering by other engineering disciplines;
 - Arrangement Drawings – to define and locate all equipment in relation to other equipment, piping and structures;
 - Assembly and Detail Design Drawings;
 - Standard drawings;
 - Technical specifications;
 - Standard specifications;
 - Design calculations;
 - Reliability analysis.

Pr9821 - Specification for Reservoir Design and Construction

- 7.1.5 The following factors as a minimum shall be considered for planning and design of a new reservoir:
- Operational site topographical, environmental and seismic characteristics and conditions;
 - Sufficient access for all construction activities;
 - Sufficient vehicular and personnel access for all maintenance activities;
 - Design capacity for continuous operation with minimum downtime to meet prescribed service levels and availability;
 - Surge conditions and extreme excursions from the design operating point;
 - Robustness, and necessary de-rating, of reservoir and equipment to meet off design conditions for extended periods;
 - Energy efficiency not only at the design point but across the anticipated operational range;
 - Starting of equipment under fully loaded conditions;
 - Failsafe modes of operation during power outages and safe re-starting modes;
 - Standardisation of assemblies and components selected to reduce spare parts inventory and improve inter-changeability;
 - Fit-for-purpose design characteristics:
 - Efficient receipt, storage and on-delivery of water;
 - Water quality maintenance;
 - Reliable, effective and automated operations (reservoir normally unattended);
 - Incorporation of site security measures;
 - Low maintenance character with standard maintenance practices;
 - Remote monitoring, control and telemetry alarms;
 - Regulatory requirements such as OH&S and environmental governance aspects;
 - Compliance with all current versions of the relevant Australian Standards and the SEQ WS&S D&C Code and Unitywater specifications;
 - Minimisation of adverse environmental and community impact (such as aesthetic aspects, noise);
 - Economy in capital and maintenance cost consistent with reliability and reasonable operating cost (minimising life cycle costs);
 - Adequate weather protection and stormwater management;
 - Sufficient ventilation and materials selection to minimise corrosion;
 - Minimisation of sediment accumulation.

Pr9821 - Specification for Reservoir Design and Construction

7.1.6 Full details of references, assumptions made and details of computer programs used for the design shall be submitted to the Superintendent for review.

7.2. Safety in Design

7.2.1 A design safety review shall be undertaken at the start of the detailed design phase.

7.2.2 'Zero harm' concept shall be considered in design.

7.2.3 All safety requirements for safe and easy access for operation and maintenance personnel shall be incorporated into the design and construction.

7.2.4 A safety in design process shall include all design assumptions, risk analysis/assessments and control measures and shall be submitted prior to design finalisation.

7.3. Design Requirements

7.3.1 The design of the reservoir shall be carried out and certified by a suitably qualified RPEQ Engineer who shall have had recent experience in the design of reservoirs and is employed by a Consulting Engineering practice having Quality Assurance Registration to AS/NZS ISO 9001.

7.3.2 The reservoir shall be structurally designed for a water level at the top of the reservoir wall.

7.3.3 All reservoir shall have reinforced or post-tensioned concrete floor and walls and comply with AS3735.

7.3.4 Design of a valve pit (including the valve pit lid and any void protection) or other restricted access area shall provide adequate room for personnel to safely access the structure and be able to dismantle equipment contained within them.

7.3.5 Roofs shall either be:

- An aluminium roof complying with AS/NZS1664 (beams and purlins) and AS1562.1 (cladding), or
- A concrete roof complying with the latest relevant Australian Standards.

7.3.6 Roofs comprising a combination of steel and aluminium components are not considered suitable for use on reservoir.

7.3.7 Design life of the reservoir structure shall be not less than:

- 80 years for the concrete walls and floor and roof; and
- 40 years for an aluminium roof structure.

7.3.8 The design life of mechanical and electrical equipment shall be in accordance with Unitywater's Mechanical and Electrical Specifications – 25 years for mechanical equipment and 20 years for electrical components.

7.3.9 Design and detailing of the reservoir and its finishes and /or coating shall take into account the chemistry of the water to be stored. An up-to-date water analysis may be carried out prior to the commencement of detailed design.

7.3.10 Design shall allow for the possibility of bushfire, earthquake and for all cyclonic wind load characteristics applicable to the site area of Queensland.

Pr9821 - Specification for Reservoir Design and Construction

- 7.3.11 Thermal expansion/contraction should be taken into account with the design and construction of the roof structure.
- 7.3.12 Roofing elements should be selected to eliminate condensate collecting and causing possible corrosion.
- 7.3.13 All points of contact between dissimilar materials shall be separated by isolating mediums.
- 7.3.14 In addition the design shall take into account the following minimum requirements:-
- AS 1170: Structural Design Actions;
 - AS 3735: 2001 Concrete Structures Retaining Liquids;
 - AS 3600; Concrete Structures ;
 - Occupational Health & Safety Regulations.

7.4. Whole-of-Life Costs

- 7.4.1 The selection of the materials and method of construction, pipework materials and arrangement will be determined by the most cost effective method which should be validated by a net present value analysis.
- 7.4.2 The factors that are required to be considered for this analysis are:
- Cost of reservoir structure;
 - Life and replacement cost of coatings, roof and ancillary items such as switchgear, telemetry, ventilation equipment, etc.;
 - Access and maintenance cost;
 - Where mixers are required, energy cost over the life of the reservoir;
 - Net present values of alternatives.

7.5. Design Report

- 7.5.1 Drawings and specification shall be sufficiently detailed to cover all aspects of construction and operation of the reservoir. The report shall be prepared and certified by the Designer Engineer.
- 7.5.2 As a minimum, the design report shall include:
- Construction methodology;
 - Report and recommendations by the Geotechnical Engineer (if applicable);
 - Detailed layout plan including access arrangements and pipe layout;
 - Detailed design of all components of the reservoir structure and roof, pipework, pits and vehicular access;
 - Design assumptions, risk analysis/assessments and control measures in relation to safety in design and design as a whole;
 - Commissioning plan.

Pr9821 - Specification for Reservoir Design and Construction

7.6. Design Documentation

- 7.6.1 The design documentation shall include the job specification and all civil, mechanical, structural and electrical drawings necessary to construct the reservoir and associated works. These documents shall fully describe the work required to complete the reservoir.
- 7.6.2 Design Documentation Drawings are to be supplied in PDF and AutoCAD format in accordance with the SEQ Codes Asset Information Specification.
- 7.6.3 The process for design review and acceptance of proposed design will be in accordance with Unitywater's quality procedures.
- 7.6.4 In addition to the above the design documentation shall include:
- Full details of all stressing operations including cable type and size, sheath type and size, concrete strength at transfer, number of jacks required, cable stressing method (one end or both ends), cable stressing order, stressing load, allowable draw in and calculated cable extensions should a post tensioned reservoir be required;
 - Full details of the grouting operations including materials, bleed control additive, mixing equipment, pumping equipment and grouting procedures;
 - Design calculations;
 - Agreement to easement rights;
 - Permit to enter land external to development; and
 - Where applicable approvals or letters of agreement from stakeholders/regulatory bodies.

8. Pipework

8.1. General

- 8.1.1 All pipes shall be supplied and installed in accordance with Unitywater's specification for Mechanical Installation, except where otherwise specified in this Specification.
- 8.1.2 All pipework shall be installed through the reservoir floor and not through the wall.
- 8.1.3 All pipes at penetrations shall be fitted with puddle flanges and a hydrophilic water seal such as 'Hydrotite' or an approved equivalent water sealing material.
- 8.1.4 All pipes shall be DICL and/ or MSCL 'Sintakote'. Polyethylene pipe maybe used only within the reservoir and should be connected to ductile iron penetrated through the floor. GRP pipe shall not be used at all.
- 8.1.5 Generally, pipework shall be kept sufficiently clear of the reservoir floor to facilitate ease of cleaning during maintenance activities.

8.2. Inlet Pipework

- 8.2.1 The inlet pipe diameter shall be sized by Unitywater.

Pr9821 - Specification for Reservoir Design and Construction

- 8.2.2 The inlet pipe shall be terminated at least 90 degree around the reservoir perimeter from the outlet pipe and shall be arranged so that the incoming water directed away from the outlet pipe.
- 8.2.3 The inlet pipe shall be fitted with a Unitywater approved mixing arrangement to promote effective mixing and promote efficient chlorine usage. The arrangement shall provide a safety screen for divers.

8.3. Outlet Pipework

- 8.3.1 The outlet pipe diameter shall be sized by Unitywater.
- 8.3.2 The outlet pipe shall be fitted with a bell-mouth and raised at least 100mm above the level of floor to minimise the risk of any accumulated sediment within the reservoir being disturbed and being discharged during reservoir operation.
- 8.2.4 The outlet pipe shall be covered by a grade 316 stainless steel or FRP screen/guard with opening of not more than 100 mm × 100 mm. The screen/guard shall be bolted to the floor using stainless steel anchor bolts.

8.4. Bypass Pipework

- 8.4.1 Pipework shall include a bypass between inlet and outlet for when the reservoir is out of service.
- 8.4.2 The bypass isolation valves shall be flanged gate valves.

8.5. Overflow Pipework

- 8.5.1 The reservoir overflow pipe shall be a vertical pipe inside the reservoir.
- 8.5.2 The overflow pipe shall be fitted with a bellmouth and be capable of discharging the design maximum inflow to the reservoir with a water level a maximum of 250 mm above top water level (TWL) and with minimum of 300 mm freeboard between top of bellmouth and underside of the lowest roof members, wall support brackets or bolted connections.
- 8.5.3 A risk based assessment of time for overflow shall be undertaken due to response times, telemetry back up, asset critically and location. Consideration needs to be given to instrumentation time delays, accuracy and sensor calibration when selecting operating level.
- 8.5.4 A visual overflow level mark shall be provided at the roof entry hatch near the internal access ladder.
- 8.5.5 Sluice/stop valves shall not be fitted on the overflow line to ensure the overflow is always operational.
- 8.5.6 Overflow pipework outlet shall include a non-return valve to restrict vermin from entering the pipeline.
- 8.5.7 Overflow pipe shall not directly be connected to a stormwater drain without a properly designed air-gap.
- 8.5.8 Discharge end pipes must be located inside a pit where they can be routinely inspected.

Pr9821 - Specification for Reservoir Design and Construction

8.6. Scour Pipework

- 8.6.1 The scour point is to be located as to optimise scour and cleaning activities.
- 8.6.2 A suitably sized scour pipe would extend from scour point to a pit or other approved location.
- 8.6.3 The scour pipe inlet shall be fitted with a bell-mouth and covered by a grade 316 stainless steel or FRP screen/guard with opening of not more than 100mm × 100mm.
- 8.6.4 The screen/guard shall be bolted to the floor using stainless steel anchor bolts.
- 8.6.5 The scour pipe shall be fitted with a flanged tee, a flanged gate valve downstream of tee to discharge to a pit and a flanged gate valve (hand wheel operated) with Camlock flanged coupler, end cap and 316 stainless steel chain to scour into a tanker in the case it cannot be discharged into the pit.

8.7. Under Floor Drainage (Slotted HDPE Pipe)

- 8.7.1 The reservoir is to be provided with a system of underfloor drainage to prevent the establishment of any hydraulic pressure under the reservoir floor, either from reservoir leakage, groundwater or pipe-work leakage near the reservoir.
- 8.7.2 The underfloor drainage shall be designed to collect all leakage, groundwater, etc. to a point at a collection drainage pit.
- 8.7.3 Underfloor drainage shall be DRAINCOIL® or similar approved product with a corrugated profile and uniform slot spacing, supplied with a filter sock, in accordance with Australian Standard AS 2439, Part 1.

8.8. Reinforced Concrete Stormwater/Overflow/Scour Drainage Pipes and Fittings

- 8.8.1 Precast, reinforced concrete pipes, rubber-ring-jointed (RRJ), suitable for stormwater drainage applications shall be used for drainage pipes. They shall be manufactured and factory tested for quality to AS/NZS 4058: 2007 *Precast concrete pipes (pressure and non-pressure)*, minimum Standard-Strength Class 3 Load or higher as per design requirements.
- 8.8.2 All stormwater drainage pipes shall be ensured that are designed with due consideration of AS/NZS 3725: 2007 *Design for Installation of Buried Concrete Pipes*.
- 8.8.3 The design loads shall be verified in consultation with Unitywater.

8.9. Water Sample Points

- 8.9.1 Water sample points shall be installed on inlet pipe, outlet pipe and at three different levels within the reservoir; 1m below TWL, in the middle and 1m above BWL.
- 8.9.2 The water sample points from the reservoir shall be externally plumbed to the surface at 1.0m height for ease of access.
- 8.9.3 The reservoir sample point taps shall be accessible from ground level.
- 8.9.4 All sample points shall be enclosed within an aluminium lockable cabinet with each sample point clearly labelled. Refer to typical sample point arrangement shown on the Unitywater's reservoir standard drawings.

Pr9821 - Specification for Reservoir Design and Construction

- 8.9.5 Reservoirs with an internal diameter less than 30 m (in addition to sample points on inlet and outlet pipes) shall have two (2) sets of sample points, one at the inlet and the other diagonally opposite.
- 8.9.6 Reservoirs with a diameter greater than 30 m shall have (in addition to sample points on inlet and outlet pipes) three (3) sets of sample points equally spaced with one at the inlet.

9. Valve and Valve Pits

9.1. General Requirements

- 9.1.1 Valves shall comprise a complete operating unit incorporating all necessary supports and mechanical linkages and shall incorporate an actuator where necessary.
- 9.1.2 Valves shall comply with the requirements specified in the Unitywater's Specification for Mechanical Installation (Pr9693).

9.2. Gate Valves

- 9.2.1 Gate valves shall comply with the requirements of Unitywater's *Specification for Pressure Pipeline Construction* and the SEQ Code Infrastructure Product and Material List.
- 9.2.2 Aboveground valves shall be fitted with hand wheel. If the torque required to operate the valve exceeds specified amount, planet reduction gear boxes shall be provided.
- 9.2.3 Buried sluice valves shall be actuated by a valve key, constructed with an extension spindle.
- 9.2.4 Valves to be installed in below ground pipework shall be installed with cast iron surface boxes and precast concrete/plastic margin sets which shall be installed such that the margin set finishes 25 mm above finished ground level.

9.3. Ductile Iron Reflux/Check Valves

- 9.3.1 Ductile iron reflux/check valves in shall comply with the requirements of Unitywater's specifications for *Pressure Pipeline Construction* and *Mechanical Installation* and the SEQ Code Infrastructure Product and Material List unless otherwise specified in this Specification.
- 9.3.2 All check valves shall be Val-matic Flexi-check or similar approved (refer to SEQ Code Infrastructure Product and Material List), fitted with a disc position indicator and a SCADA compatible limit switch, entirely suitable for use in water or sewerage pressure mains.
- 9.3.3 The bolted cap shall feature a plugged pressure tapping.

9.4. Control Valve

- 9.4.1 Electronic control valves, with 2-way solenoid pilots that combine the advantages of a modulating, line-pressure driven, hydraulic control valve with the advantages of electronic control, thus suitable for flow and level control shall be utilised for reservoir design and construction.

Pr9821 - Specification for Reservoir Design and Construction

- 9.4.2 The control valve shall include a self-flushing filter for the pilot tubes. The control valve shall be linked with the telemetry system. The control valve shall be fitted with needle/speed regulators for actuation damping and a third normally closed 'Emergency close' solenoid valve. Refer to Unitywater general arrangement for control valves drawing.

9.5. Valve Pit and Access Cover over the Valve Pit

- 9.5.1 The designer shall place the inlet/outlet pipes and valves above-ground where there is sufficient space available to accommodate above-ground piping/valve without detrimentally impacting on access, traffic or maintenance activities.
- 9.5.2 Where the inlet/outlet/scour/overflow pipes and valves are installed underground, they shall be located inside a pit.
- 9.5.3 The inlet/outlet valve pit/s shall be fitted with Pierlite SDW236H lighting or similar approved lighting equipment a light switch and single phase powers outlets.
- 9.5.4 The pit/s shall be covered with materials suitable for the condition of the site (trafficable/non-trafficable) and complying with the local environmental requirements.
- 9.5.5 The covers/support beams shall be designed to be completely removed to enable removal of pipes and/or valves.
- 9.5.6 In areas with significant presence of trees, the valve pit shall be covered by aluminium solid chequer plate to prevent ingress of leaves into the pit.
- 9.5.7 The weight of any access cover shall be considered in the design.
- 9.5.8 The clear opening position and dimensions of access hatch are to be indicated in the project drawings.
- 9.5.9 A vertical ladder with retractable handgrip stanchions shall be installed inside the valve pit and shall be fabricated from fibre-reinforced plastic (FRP).
- 9.5.10 The cover shall include hinged and lockable access hatch and be designed for single man lift with ease of opening/ closing or removing. The access hatch shall be open flat on the ground.
- 9.5.11 The covers shall be non-slippery and have their top surfaces danger marked with yellow and black stripe.
- 9.5.12 Valve extension spindles shall be provided to the underside of covers with openings provided for valve operation by valve key.
- 9.5.13 A davit base complete with cap shall be provide inside the pit.
- 9.5.14 A safety grille is not required under the valve pit's access hatch.
- 9.5.15 Void protection post inserts ('rail safe' posts) shall be provided in positions that allow for safety protection of the void when the access hatch is fully open.

10. Reservoir Roof

10.1. Design Objective

- 10.1.1 The reservoir roof design objectives are to meet the following requirements:

Pr9821 - Specification for Reservoir Design and Construction

- Structural (safe, sustainable and fit for purpose design, watertight roof with adequate weather protection and storm water management);
- Designed and installed in accordance with manufacturers requirements to achieve the products' warranty;
- Operation and Maintenance (ease, reliable and safe operations and ease of maintenance);
- Access (sufficient access for inspection, maintenance and repair);
- Ventilation (sufficient ventilation to minimise corrosion, prevent of entering vermin and contaminants into the reservoir);
- Water Quality (no addition of any contaminant to the water);
- Security (comply with security requirements);
- WH&S (comply with Workplace Health and Safety requirements);
- Environmental requirements (minimal adverse environmental and community impact).

10.2. General Requirements

- 10.2.1 The roof shall be designed to fall to the wall with the sheeting projecting over the wall. Gutters and downpipes are not required, unless specified otherwise.
- 10.2.2 Internal gutter/box gutter are not allowed as the accumulation of leaves can permit entry of contaminants into the reservoir.
- 10.2.3 The roofing sheet and associated flashings shall be as directed in the design documents and installed in accordance with the manufacturer's technical data or instructions and in conjunction with plans, details and specification relating to the work.
- 10.2.4 The roof shall be particularly designed to cater for thermal effects, galvanic corrosion and corrosion due to coastal environmental conditions.
- 10.2.5 Provision shall be made for adequate fall arrest system for easy access by maintenance personnel.

10.3. Aluminium Roof

- 10.3.1 The roofing sheet and associated flashings shall be as directed in the design documents and installed in accordance with the manufacturer's technical data or instructions and in conjunction with plans, details and specification relating to the work.
- 10.3.2 Aluminium beams and purlins shall be roll formed from 5454 H34 alloy.
- 10.3.3 Purlins shall be used with down-turned bottom lips to prevent accumulation of moisture.
- 10.3.4 Bolts joining aluminium members shall be Bolts set into concrete shall be grade 316 stainless steel.
- 10.3.5 Bridging shall be 100mm channels from 6061-T6 alloy with welded cleats.

Pr9821 - Specification for Reservoir Design and Construction

- 10.3.6 Roof cladding shall be formed from marine grade aluminium alloy 5251 or 5052 sheet to AS/NZS1734 of not less than 1.2mm thickness.
- 10.3.7 The roof cladding shall be Permalite® Alspan Aluminium Roof Sheeting, or similar approved, and COLORBOND® both sides, white on the underside and Endurogreen® on the top side.
- 10.3.8 Fasteners shall be grade 316 stainless steel self-tapping screws, aluminium alloy 5251 formed washers and full size durable rubber sealing washers slotted to allow for expansion. All form washers shall be painted Endurogreen®.
- 10.3.9 Installation of the aluminium roof shall comply all strictly in accordance with the cladding manufacturer's instructions for coastal environments.
- 10.3.10 Thermal movement of the aluminium roof shall be designed into the roof beams and sheeting.
- 10.3.11 The design shall ensure minimal joints in roof to prevent the ingress of water; this also includes avoiding the creation of any unnecessary holes. The roof shall be completely watertight.
- 10.3.12 Cladding which is cut or trimmed to shape shall be left with a clean cut edge without jags and with no distortion of the profile or cross section.
- 10.3.13 All materials, finishings, flashings and fixings shall have protection from the effect of galvanic corrosion.
- 10.3.14 Vermin and contaminants proofing shall be provided to all sheeting edges/ends.

10.4. Roof Flashings and Accessories

- 10.4.1 Flashings shall be designed to provide a tight seal against water penetration, to prevent build-up and entry of debris into the reservoir and to accommodate movement of the roof and/or wall elements.
- 10.4.2 All flashing shall also be durable, weather resistant and compatible with adjoining materials. The flashing material shall be the same material used for roof sheeting and have sufficient overlap to prevent water ingress.
- 10.4.3 Closed cell polyethylene foam closure strips matching the profile of the sheet cladding shall be fitted at eaves and similar locations as shown on the Drawings to seal against bird and vermin entry and dust emission.
- 10.4.4 Closure strips shall be permanently fixed in position.
 - 10.4.5 All flashing installed to ensure self-cleaning with no ponding of water on the roof.

10.5. Roof Sheeting Handling and Storage

- 10.5.1 Sheeting shall be kept dry in transit and on site to prevent water and/or condensation being trapped between adjacent surfaces. If stacked or bundled materials become wet, separate them and wipe them thoroughly with a clean cloth to dry.
- 10.5.2 Handle materials carefully to avoid damage, materials shall not be dragged over rough surfaces, each other, or have tools dragged across them. Protect materials from swarf.

Pr9821 - Specification for Reservoir Design and Construction

10.5.3 No stained or damaged sheeting shall be built into the finished work. Packs of sheet standing on site shall be stored clear of ground. Sheets shall be handled using clean dry gloves.

10.6. Concrete Roof

10.6.1 Concrete roofs shall be designed and constructed in a manner that ensures the structure is water tight.

10.6.2 Wherever applicable, all work carried out under this specification shall comply in all aspects (i.e. in design, construction, testing and performance) with the latest relevant Australian Standards listed in Section 4.2 and section 10 'Concrete Works' of this Technical Specification.

10.7. Roof Support Columns

10.7.1 Roof support columns shall be constructed from pre-tensioned concrete or 316 Stainless Steel Circular Hollow section. The number of internal column should be kept to a minimum.

10.8. Roof Stormwater and Overflow/Scour Management

10.8.1 The roof structure shall be designed to allow the rainwater flow-off from the roof to the hardstand area below around the reservoir and then be managed using a network of site drainage pits and pipes.

10.8.2 The hardstand shall be designed to avoid splashing, erosion and property damage due to rainwater and runoff.

10.8.3 The design shall ensure that all roof water drains away from the reservoir:

- Full length sheeting is to be used where practical and gaps of roof sheeting are to comply with manufacturer's recommendations (to be minimised);
- Roof sheeting shall project minimum 150 mm beyond the external face of reservoir wall to prevent roof water ingress;
- Roof edge gutters shall not be used as the accumulation of leaves can permit entry of containments into the reservoir;
- Box gutters running across roof shall not be used as they may lead to significant contamination of the reservoir;
- Roof access hatches shall be designed to prevent the ingress of water run-off;
- Roof penetrations shall be carefully designed and constructed to provide watertightness and to allow effective drainage of storm water around the penetrations without any ponding.

10.8.4 Site drainage shall be designed such that it provides adequate protection to the access road, reservoir and surrounds and also complies with Unitywater, local Council and other authorities' environmental management and OHS requirements.

10.8.5 Overflow and scour flows shall be addressed in relation to discharge to the existing stormwater drainage systems.

Pr9821 - Specification for Reservoir Design and Construction

10.9. Roof Sealant

10.9.1 Sealant shall also be used to prevent water ingress around items installed, e.g. fans, access hatches, etc. and shall meet the following requirements:

- Installed in accordance with roofing manufacturers requirements;
- Provide good adhesion to the roof surfaces;
- Resists extremes of both heat and cold;
- Resists to the damaging effects of sunlight (ultraviolet rays);
- Compatible with the performance of aluminium roof sheeting and flashing;
- Comply with the requirements of AS/NZS4020.

10.10. Roof Ventilation

10.10.1 Sufficient natural ventilation must be provided to minimise condensation of water within the roof structure, limit corrosion of the roof structure and components and assist in minimising WHS risks during confined space entry.

10.10.2 Ventilators shall be designed to allow for air to be discharged during reservoir filling and for sufficient air changes based on the air volume above the Top Water Level.

10.10.3 The roof space shall be ventilated using either:

- 450mm diameter Endurogreen COLORBOND® roof mounted rotary extraction ventilators, equally spaced throughout the roof, or
- Slope Mounted Roof Ventilators (1.3m² exhaust opening) installed at the highest practical elevation on the roof structure.

10.10.4 The roof ventilators shall be such weather, vermin and bird proof and shall be properly installed.

10.10.5 The minimum number of roof ventilators shall be as stated in the following table:

Table 1 – Number of Roof Ventilator

Area of Roof (m ²)	Number of Ventilators
< 100	1
100 – 250	3
250 – 500	4
500 – 1,000	6
1,000 – 2,000	8
➤ 2,000	1 for every 200m ² or part thereof

10.10.6 Roof ventilators shall be evenly distributed over the roof.

10.10.7 Roof ventilators shall be powder coated and comply with AS 4740 (2000). A minimum throat size of 500mm is preferred and suitably selected to prevent birds dropping into the reservoir from the top or washing/dripping down into the reservoir during rain

Pr9821 - Specification for Reservoir Design and Construction

event. Ventilators shall be rated and tested to resist rain and wind in accordance with AS 2428.1 and AS 2428.2.

10.10.8 Roof Ventilators shall be provided with removable marine grade aluminium or stainless steel wire mesh screens with a nominal aperture of 4 mm for protection against flying insect, vermin and windborne contaminants.

10.10.9 Cross ventilation of the reservoir shall be provided between the roof sheeting and the top of the reservoir wall.

The area of this air intake shall be at least twice the cross sectional area of the exhaust ventilators to provide satisfactory air turn over within the reservoir.

The air intake shall be evenly distributed around the perimeter of the reservoir and shall be made vermin, insect and bird proof using corrosion resistant mesh (stainless steel or marine grade aluminium) with nominal aperture size of 4 mm.

10.10.10 All shop detail drawings shall be supplied and cross-referenced to the relevant supplied drawings in the design documents.

11. Roof Access

11.1. Roof Access Platform

- 11.1.1 The reservoir roof access platform shall be located directly over the traffic accessible area in order to enable the maintenance operator to use the davit to pick up equipment from a vehicle below.
- 11.1.2 The platform and access hatch shall be designed in such a way to minimise the build-up of leaf and debris around the hatch to eliminate the accumulation of water around the hatch, so reducing its potential to enter the reservoir. This is critical to protect water quality of the reservoir.
- 11.1.3 The platform shall be constructed adjacent to and around the reservoir access hatch and be large enough to provide sufficient room for easy and safe access to anchorage points for fall arrest system, hatch cover, internal ladder and lifting davit especially when the access hatch cover is in open position.
- 11.1.4 The platform shall be finished as a constant level surface. The design, supply and fabrication of all platforms shall comply with AS1657.
- 11.1.5 Hand-railing/guard-railing shall be provided on the perimeter of access platform except at points of access from a stairway.
- 11.1.6 Guard-railing shall comply with the requirements of AS1657 and incorporating a toe-board.
- 11.1.7 A self-closing gate shall be provided in the hand rail to give access to the peak of the roof. The gate will be used for a person to access the roof walking to the centre where a central lanyard attachment will be located for the person to latch on to.
- 11.1.8 Handrails shall be fabricated from aluminium unless noted otherwise on the drawings.
- 11.1.9 Where dissimilar metals are to be clamped together, suitable neoprene or nylon shall be used to prevent galvanic action occurring.

Pr9821 - Specification for Reservoir Design and Construction

11.2. Roof Access Hatch

- 11.2.1 The reservoir roof shall be provided with a minimum one (1) access hatch.
- 11.2.2 The access hatch shall have a hinged cover which latches open in a vertical position. The hatch cover shall be fabricated from aluminium chequer plate. It shall consist of handle and lock.
- 11.2.3 The access hatch shall be sealed properly to prevent of water penetration through the lid.
- 11.2.4 The access hatch shall have a raised lip/edge around the hatch to protect against any direct drainage, ponding or debris build up.
- 11.2.5 The aluminium access cover needs to overlap the framed opening and extend around the frame.
- 11.2.6 Aluminium or FRP safety grille shall be provided below aluminium lid to prevent personnel from falling through an open lid while inspecting the reservoir. Grille shall be latched open in a vertical position at the same direction as access hatch lid.
- 11.2.7 Depending on the size of access opening and weight, the lid and safety grille may need to be fabricated in more than one piece.
- 11.2.8 Hand-railing including toe boards shall be provided on three sides of the access hatch. Handrails shall be designed and installed such a way to be removed when full access to hatch is required.
- 11.2.9 The access hatch shall be fitted with an approved limit switch to notify of unauthorised opening of the hatch. The contact switch shall be cabled and connected to the telemetry and SCADA facilities in accordance with the requirements of Unitywater's *Specification for Electrical Installation at Network Sites* (Pr9380).

11.3. Reservoir Roof Access by Stairs

- 11.3.1 Roof access shall be provided for all reservoir type:
 - This shall be done via a free standing fabricated stairs/platform structure;
 - Hand railing shall be provided on the sides of stairs;
 - Handrails shall be fabricated from aluminium unless noted otherwise on the drawings;
 - The design, supply and fabrication of stairs shall comply with AS1657.
- 11.3.2 A security enclosure shall be provided around perimeter of stair access:
 - The security enclosure shall consist of cladding or precast panel walls without roofing;
 - The enclosure shall be fitted with an access door and secured via padlock with cut protection or integrated deadlock configuration;
 - The security enclosure structure shall house the control panel and switchboard for the reservoir operation;
 - Sufficient clearance shall be provided between the stairs and the switchboard for personnel to safely undertake the maintenance activities.

Pr9821 - Specification for Reservoir Design and Construction

11.4. Internal Reservoir Access by Ladder

- 11.4.1 A vertical ladder with retractable handgrip stanchions shall be installed inside the reservoir and shall be fabricated from FRP:
- The ladder is not provided for (general) access purposes, but only emergency and hence, no cage or landing shall be installed.
- 11.4.2 The design, supply and fabrication of ladders shall comply with AS1657.

11.5. Fall Arrest Anchor

- 11.5.1 A single fall arrest anchor shall be suitably installed on the roof centre to enable maintenance personnel to attach lanyards and to work around the reservoir roof and wall.
- 11.5.2 The fall arrest anchor shall be high enough to allow lanyard clearance to the roof ventilation system.
- 11.5.3 A fixed length lanyard shall be supplied and stored inside a lockable box near the control panel inside the security enclosure located at the bottom of stairs.
- 11.5.4 An additional two (2) fall arrest anchors shall be suitably installed opposite the roof hatch opening for standby personnel lanyard attachment.
- 11.5.5 Where required, all load bearing components/attachments to be load tested as per AS1891.

11.6. Davit Arm

- 11.6.1 The davit arm shall be suitably designed, certified, supplied and installed. Design and testing of davit arm shall conform to AS1418-cranes (including hoists and winches).
- 11.6.2 The Davit arm shall also be designed to allow attachment of a fall arrest harness and/or lanyard.
- 11.6.3 The davit lifting point shall be located centrally over the opening associated with any hatch(es) in the reservoir roof.
- 11.6.4 The davit arm support structure shall be designed to meet the requirements of AS/NZS1891. A structural design certificate for the davit arm support structure shall be provided by the designer.
- 11.6.5 If the davit arm base is attached to the reservoir wall, then the reservoir wall where the davit arm base is to be mounted shall be designed to withstand all loads the davit arm and base may apply.
- 11.6.6 The davit arm shall be designed to be used for both Confined Space Entry (CES) and lifting or craneage activities (whether the lift is from the ground or from the access hatch work platform or from the work platform to the reservoir or from the reservoir to the work platform).
- 11.6.7 The davit arm shall also be designed to be used to transfer any item from outside the safety handrail to the work platform area and from the work platform to inside the reservoir or to outside the safety handrail.

Pr9821 - Specification for Reservoir Design and Construction

- 11.6.8 The davit shall be able to be moved and fixed in place so that the attachment point for a single person CSE outcome is placed centrally and directly over the open access hatch.
- 11.6.9 The davit arm shall be able to rotate through a maximum of 360 degrees of movement.
- 11.6.10 The davit shall have a minimum safe working load capacity of 1.5 tonnes.
- 11.6.11 The ground unloading point supporting the use of the davit arm shall be at least 600 mm away from objects (i.e. handrails, posts, roof and wall).
- 11.6.12 The davit shall have an eyebolt or similar device to enable easy detachment of the lifting gear. It shall have a handle or other device to facilitate slewing by hand.
- 11.6.13 The ground landing area shall be an unobstructed flat horizontal area of minimum horizontal dimensions 6000 mm by 2000 mm and shall be so positioned in relation to the reservoir wall in order to enable unloading at the approximate centre of the area.
- 11.6.14 The davit arm and associated support and mount shall be manufactured from mild steel and shall be hot dip galvanised in accordance with AS/NZS4680 and AS/NZS4792. Bolts joining galvanised members shall be galvanised in accordance with AS1214. Bolts set into concrete shall be 'grade 316' stainless steel.
- 11.6.15 The davit arm shall be installed with a certification plaque permanently fixed to the davit that states its compliance to the nominated Australian Standards. The installation shall be certified by a RPEQ. Also Safe Working Load (SWL) shall be displayed on a permanent notice plate in accordance with AS1418.
- 11.6.16 All facilities and equipment necessary for in-situ load testing of the davit arm installation shall be provided in accordance with AS1891 and manufacturer's recommendations. The testing shall be conducted by/or in the presence of a NATA accredited body. An individual report for each davit arm on completion of testing shall be provided.
- 11.6.17 Certification procedures for future annual certification purposes shall be provided. This shall include maintenance plan, requirements, certification and manuals.

12. Water Quality aspects

12.1. Mixing/Circulation Arrangement

- 12.1.1 The reservoir mixing/circulation shall be designed such a way to eliminate stagnated areas and promote efficient chlorine usage.
- 12.1.2 The arrangements which need to be considered include:
- Directing the inlet flow at an optimum angle to minimise stagnant areas;
 - Multiple inlets including Tideflex Mixing System (consisting of inlet nozzles discharging vertically upward and spaced along a horizontal manifold pipe and discharge tideflex check valves);
 - Water re-circulation system;

Pr9821 - Specification for Reservoir Design and Construction

- Using submersible mixers such as 'PAX' Water Mixer. In this arrangement, it is recommended to use a stainless steel chain to keep the PAX Mixer's cable on the floor of reservoir and to locate the cable inside a food plastic conduit to protect the cable; and
- A(ny) combination of above measures.

- 12.1.3 The design should avoid arrangements that are likely to disturb sediments on the reservoir floor.
- 12.1.4 The design shall not hinder a diver's access to the reservoir for cleaning purposes.
- 12.1.5 The designer shall consider an easy installation of mechanical equipment such as mixer via opening hatch.
- 12.1.6 Computational Fluid Dynamics (CFD) shall be used to design the inlet, outlet and mixing arrangements when directed by Unitywater. The CFD assessment shall be based on the different storage levels that the reservoir will move through from original provision to ultimate population.
- 12.1.7 Unitywater approval shall be obtained for the final design.

12.2. Re-Chlorination

- 12.2.1 If a site specific chlorination facility is required to boost disinfection levels within the system, then ensure that adequate land area is available for operation and maintenance of the facility. A submersible mixer will be required (see 12.1) if a chlorination facility is required for the site.

13. Concrete Works

13.1. General

- 13.1.1 Concrete works shall comply with Unitywater's *Specification for Building and Structural Works* (Pr9903).

13.2. Finishes to Formed Concrete Surfaces

- 13.2.1 The finish to all exposed formed concrete shall be off-form Class 2 finish to AS3610.
- 13.2.2 Particular care shall be taken to ensure a dense surface finish is attained on all internal surfaces of water retaining structures to minimise all surface irregularities which could retain sludge, silt, algae or other deleterious matter.
- 13.2.3 The minimum accepted surface finish to internal surfaces shall be Class 2 to AS3610 in regard to blow holes but Class 3 for tolerances.

13.3. Materials and Coatings

- 13.3.1 The reservoir structure is intended to be constructed of concrete with no external coating.

13.4. Construction

- 13.4.1 No access hole in the wall of the concrete structure will be permitted.

Pr9821 - Specification for Reservoir Design and Construction

13.4.2 Construction of concrete structures shall conform to AS3735, and AS3600.

14. Painting and Corrosion Protection

14.1. General

- 14.1.1 Corrosion protection and painting shall be undertaken in accordance with the requirements outlined in Unitywater's *Specification for Mechanical Installation* (Pr9693).
- 14.1.2 Surface protection and protective coatings for all surfaces shall be designed for 15 years' service life without the need for replacement and shall comply with the latest revision of the relevant Australian Standards (in particular those relevant Australian Standards stated in Section 2.5 of this document), together with the requirements of competent Statutory Authorities having jurisdiction over all or part of the manufacture, installation and operation of the plant.

14.2. Pipework Protective Coatings

- 14.2.1 All above ground pipe and fittings shall be coated internally and externally with Rilsan 'Nylon 11' (or similar).
- 14.2.2 Loose polyethylene sleeves, as recommended by the manufacturer, shall be fitted over all ductile iron pipework and fittings laid below ground level to provide additional protection to the pipes and fittings. Sleeves shall be fitted in accordance with the manufacturer's instructions and specifications.

15. Electrical/Telemetry

15.1. General Requirements

- 15.1.1 Reservoir design and construction shall include electrical and telemetry equipment as specified in the contract documentation, this Specification, Unitywater's specification for Electrical Installations at Network Sites and Unitywater's standard electrical drawings. All equipment shall be supplied from the Unitywater Accepted Electrical Equipment List.
- 15.1.2 The electrical components of a reservoir installation shall comprise of at least:
- Incoming power supply;
 - Switchboard containing metering, main distribution section, PLC and telemetry equipment;
 - Instruments for reservoir level etc.;
 - Area lighting and power;
 - Security system; and
 - Lightning protection system.

Pr9821 - Specification for Reservoir Design and Construction

15.2. Power supply

- 15.2.1 All reservoir sites will be supplied from the local electrical distribution network. Generally a single phase 230V 50Hz supply will be sufficient except for sites with three phase supplied valve actuators.
- 15.2.2 The Electricity Distributor needs to be consulted as the earliest possible stage in order to make provision for such a connection.
- 15.2.3 Off-grid/ solar supplier shall not be accepted due to their low levels of reliability and the critical nature of these assets.

15.3. Switchboard

- 15.3.1 The switchboard is to be located inside the security enclosure and constructed with the requirements for outdoor type switchboards as per Unitywater's specification for Electrical Installations at Network Sites.
- 15.3.2 The latest Unitywater's drawings shall be obtained at the commencement of project.

15.4. Telemetry and Instrumentation Cubicle

- 15.4.1 A telemetry and instrumentation cubicle shall be established to house the telemetry equipment, control power supplies, GPO for technician's use and field wiring terminals.
- 15.4.2 The power supply for the telemetry equipment shall have battery backup.
- 15.4.3 The telemetry equipment shall include remote/radio telemetry unit (RTU) that is connected to a digital radio and an aerial.
- 15.4.4 The RTU forwards and receives radio signals to and from a base station which is connected to the Unitywater SCADA system.
- 15.4.5 This system shall allow for remote monitoring and control of the reservoir.

15.5. Radio Path Survey

- 15.5.1 On completion of the concept design, the designer shall engage and pay a Unitywater approved supplier to undertake a radio survey and form this to nominate a base station, transmit and receive frequencies and remote terminal unit number along with antenna direction/ bearing to base, antenna mounting height and antenna size.
- 15.5.2 The designer shall obtain Unitywater approval for the engagement of the appropriate contractor to undertake the activities in the above section.

15.6. Site Lighting

- 15.6.1 Sufficient lighting facilities shall be provided within the reservoir security structure (Pierlite SDW236H lighting or similar approved) and for the reservoir roof access stairways and platform (Pierlite Contempo RVS 250 or similar approved).
- 15.6.2 Light fitting shall be mounted inside the switchboard as per Unitywater's *Specification for Electrical Installations at Network Sites* (Pr9380).

Pr9821 - Specification for Reservoir Design and Construction

- 15.6.3 Internal lighting shall comply with the requirements of AS/NZS1680. Road way lighting shall comply with the requirements of AS/NZS1158.
- 15.6.4 External lighting will be operated by a switch on the Distribution section of the site switchboard.

15.7. Site GPOs

- 15.7.1 The following 240V general purpose outlets (GPOs) will be provided as per Unitywater's *Specification for Electrical Installations at Network Sites* (Pr9380), with each GPO supplied from a separate earth leakage circuit breaker:
- 15.7.2 One 15 amp breaker on the internal door of the distribution section of the main switchboard; and
- 15.7.3 One 10 amp breaker inside the PLC/Telemetry/Instrumentation Panel for the technician's use.
- 15.7.4 Also a single phase power outlet (10 amps) shall be fitted inside the inlet/outlet valve pit/s.

15.8. Lightning Protection

- 15.8.1 Lightning protection shall be provided in accordance with Unitywater's specification for Electrical Installations at Network Sites.

16. Instrumentation

16.1. Level Sensor

- 16.1.1 The reservoir shall be provided with a radar type level transmitter, VEGAPULS 61 (compact, high frequency K-band sensors) with the following specifications:
- Measuring range up to 35 m;
 - Process fitting - G1½A, mounting strap or flange;
 - With encapsulated horn antenna ø40mm / PVDF / -40..80°C;
 - Process temperature between - 40 and + 80°C;
 - Process pressure between – 100 kPa and + 200 kPa;
 - Measuring precision of +/- 2mm, and;
 - Transmitting frequency - K band.
- 16.1.2 The level reading shall be relayed through to the SCADA and RTU for remote continuous level measurement and raise SACAD/RTU alarms when the level reaches a level alarm high (overflow level) and a level alarm low (empty level).
- 16.1.3 The equipment shall include all the necessary documentation, fittings, antenna, housing, cables, and electrical connections required to complete the installation.

Pr9821 - Specification for Reservoir Design and Construction

- 16.1.4 The signal cables supplying the radar from the main Switchboard/RTU shall be terminated in a glanded IP66 stainless steel/marine grade aluminium junction box adjacent to the radar head similar to the B&R Connector TE junction box series.
- 16.1.5 Any cables connecting back to the main switchboard which supply the radar shall be shielded twisted pair.
- 16.1.6 The equipment shall be mounted away from any internal reservoir walls stairs or other obstructions which may impede the radar signal. The antenna shall be mounted according to the instructions provided by the supplier with all clearances as recommended.
- 16.1.7 Commissioning of the measuring device shall be undertaken by Unitywater however the contractor shall assist Unitywater to commission the device and address any operational/defects issues raised by Unitywater technicians during commissioning. The radar shall be commissioned on an empty/low level reservoir to allow any obstruction to be filtered out. The construction program shall make allowance for this.
- 16.1.8 All cables and cores shall be uniquely and clearly labelled to match the electrical drawings in accordance with Unitywater's *Specification for Electrical Installations at Network Sites* (Pr9380).
- 16.1.9 Installation shall be strictly in accordance with the manufacturer's specifications.
- 16.1.10 All level sensors shall be installed in a location to allow ease of access for maintenance and shall be connected to the telemetry system.

16.2. Level Floats

- 16.2.1 Two Flygt ball level floats shall be supplied, connected and commissioned for the purposes of alarming during high and low level conditions.
- 16.2.2 The high level float shall be positioned 500 mm below the overflow level of the reservoir and be 'normally closed'.
- 16.2.3 The low level float shall be positioned 500 mm above the floor of the reservoir and be 'normally open'. The alarms shall be sent to telemetry and SCADA.
- 16.2.4 The preferred equipment is the Flygt Xylem ENM-10 Level regulator.
- 16.2.5 Level floats shall be terminated in a stainless steel/marine grade aluminium IP66 junction box adjacent to the manhole entry for the reservoir as per the radar.
- 16.2.6 All cables and cores shall be uniquely and clearly labelled to match the electrical drawings in accordance with Unitywater's *Specification for Electrical Installations at Network Sites* (Pr9380).
- 16.2.7 Labels shall be affixed to each ball float cable leaving the junction box before entering the reservoir with "High Float" and "Low Float" to allow for rapid identification during replacement/maintenance.
- 16.2.8 In addition to overflow switch, it is recommended to mark the overflow level on the wall inside the reservoir near the internal access ladder.

Pr9821 - Specification for Reservoir Design and Construction

16.3. Electromagnetic Flow Meters

- 16.2.1 Bi-directional magnetic flow meters shall be ABB Watermaster, Endress & Hauser (Pro Mag 50W) or Emerson (refer to SEQ Accepted Products and Materials List for Electrical Installations) with a minimum conductivity of $\geq 5 \mu\text{S/cm}$ and meet at least the following requirements:
- Flow meter shall be installed entirely as per the manufacturer's instructions with particular attention to minimum straight distance before and after the flow meter relative to tees, bend and other obstruction;
 - The flowmeter shall not be direct buried and shall not be installed in pits without adequate drainage. Unitywater's preference is to have all electrical equipment above ground level and accessible to technicians where possible.
 - Flow meters shall be entirely suitable for accurate and reliable measuring of the process liquid under pressure over the entire expected flow range;
 - The transmitter/sensor is to be remote mounted;
 - The lining of the flowmeter is to be elastomer;
 - The electrodes shall be Grade 316L stainless steel;
 - Potential equalising fluid contact rings shall be used for metal pipe connections;
 - The flow meter shall comprise an electromagnetic detector, power supply and converter providing an overall system accuracy of $\pm 1\%$. The flow meter shall utilise bi-polar pulse technology and shall have a configurable pulse output pre-set to 100 L/pulse, and;
 - The detector shall have a stainless steel metering tube suitably lined (Neoprene or EPDM) to resist wear and corrosion. Where negative pressure (i.e. vacuum) is possible, the lining shall be omitted.

17. Site Security Requirements

17.1. Perimeter Fencing

- 17.1.1 Fencing shall be erected around the perimeter of the reservoir to restrict unauthorised access to the site.
- 17.1.2 The reservoir shall be protected using 2100 mm high 3.15mm heavy gauge chain wire mesh fencing with fixed bottom rail and topped with three strands of barbed wire set on a 45 degree outward crank. Coastal fringe and corrosion prone environments, Black PVC coated heavy gauge wire is to be used with all posts and rails powder coated black to match.

17.2. Perimeter Fencing Entry Points

- 17.2.1 The entry point shall be secured via gate of construction to match fence type. Gate shall be secured via chain and padlock arrangement. Chain welded to gate frame and 10mm chain to be used.

Pr9821 - Specification for Reservoir Design and Construction

17.3. Security Signage

- 17.3.1 The security signage shall be installed at 30 m intervals along perimeter fencing facing a public road and at 50 m intervals along other boundaries.

17.4. External Security Lighting

- 17.3.2 Lighting shall be provided to site entry gate and reservoir access points.

17.5. Intruder Alarm System (IAS)

- 17.5.1 Proximity (Reed) switch shall be installed on the reservoir's roof access hatch/s to monitor access to the hatch and to the entry door of the security enclosure to the stairway roof access.
- 17.5.2 An alarm shall be raised when an unauthorized person open the access hatch/s or enclosure entry door.
- 17.5.3 An alarm panel shall be provided with off-site monitoring of Intruder Alarm System via PSTN connection. IAS will be consistent with Unitywater enterprise IAS platform.

17.6. Key System

- 17.6.1 All mechanical locking shall be keyed to Unitywater registered Master Key system.

17.7. Locking

- 17.7.1 All mechanical locking shall where practical be deadbolt style locking integrated into the door/ access point build.
- 17.7.2 All padlock applications including pit applications shall incorporate lock shroud protection to provide protection against cutting. Locking recess pits or shrouds must allow water to freely drain away, so as to prevent padlocks from becoming submerged.

18. Signage and Labelling

18.1. Safety Signage

- 18.1.1 All mandatory, caution, prohibition, danger, security and safety signage (e.g. confined space entry) shall be supplied and installed as required by current legislation.

18.2. Labelling

- 18.2.1 All equipment shall have the identification number affixed to the equipment to facilitate easy identification for operation and maintenance purposes.
- 18.2.2 All instruments shall be identified with tags mounted adjacent to but not directly on the instrument.
- 18.2.3 All tags and labels shall be of stainless steel construction with engraved numbering and lettering and shall comply with the requirements of Unitywater's *Specification for Drawing, Document and Equipment Tag Numbering* (Pr8843).
- 18.2.4 Tags and labels shall be fixed in a prominent location by use of stainless steel pins.

Pr9821 - Specification for Reservoir Design and Construction

18.3. Piping Identification

- 18.3.1 Above ground and in-pit pipework shall be provided with identification markers indicating contents and direction of flow in accordance with AS1345-1995 (Identification of the contents of pipes, conduits and ducts) and Unitywater's *Specification for Drawing, Document and Equipment Tag Numbering* (Pr8843). Markers shall be approved self-adhesive labels.

19. Site Workmanship

- 19.1.1 Site workmanship and aspects related to earthworks are outlined in Unitywater's *Specification for Civil and Earth Works* (Pr9902).

20. Testing, Commissioning and Post Construction Documentation

20.1. Hydrostatic Pressure Testing

- 20.1.1 Hydrostatic Pressure Testing shall be carried out in accordance with the requirements stipulated in Unitywater's specification for Mechanical Installation, including:
- Management of drained test water in accordance with Water Services Association of Australia (WSAA) Guideline: Dechlorination of Drinking Water to Discharged Waterways, National Guidance for the Urban Water Industry 2019;
 - Disposal of flushing water in accordance with Unitywater's *Pr9183 - Emptying and Cleaning of Reservoir Work Instruction* and Water Services Association of Australia (WSAA) Guideline: Dechlorination of Drinking Water to Discharged Waterways, National Guidance for the Urban Water Industry 2019; and
 - Determining acceptability of all new mains associated with the reservoir construction in accordance with Unitywater's *Pr9032 - Procedure for Determination of Acceptance of New Mains*.

20.2. Commissioning

- 20.2.1 A detailed program of commissioning procedures shall be submitted for approval prior to the commencement of any commissioning activities.
- 20.2.2 A minimum of ten (10) business days prior to commencement of any commissioning activities, the following are required:
- A final walkover and inspection by Unitywater stakeholders shall be completed;
 - All electrical and control (SCADA) works shall be completed such that control valves, flowmeters, air valves, etc. can be monitored remotely during the filling and testing process;
 - All "As Constructed" information shall be provided;
 - A completed "Asset Template" shall be provided;

Pr9821 - Specification for Reservoir Design and Construction

- The inlet main shall be checked for chlorine residual and flushed as required until a free chlorine residual is obtained.
- 20.2.3 A network intervention application shall be submitted to Unitywater Network Engineering with a minimum five (5) business day notification of the commencement of commissioning activities.
- 20.2.4 Prior to filling of the reservoir, the inside surfaces of the reservoir must be washed down to remove dirt and dust using high pressure equipment and water containing a minimum 5mg/L chlorine for disinfection.
- 20.2.5 The wash down water shall be disposed of through the scour outlet and into the on-site stormwater pipework in accordance with Unitywater's Pr9183 - Emptying and Cleaning of Reservoir Work Instruction and Water Services Association of Australia (WSAA) Guideline: Dechlorination of Drinking Water to Discharged Waterways, National Guidance for the Urban Water Industry 2019.
- 20.2.6 During filling of the reservoir, sufficient sodium hypochlorite solution (10% available chlorine) shall be added into the incoming water to ensure that approximately 3 mg/L of free chlorine is retained in the water body after the filling.
- Consideration must also be made to ensure the added 10% sodium hypochlorite is adequately mixed throughout the water body.
- 20.2.7 Unitywater will provide water for cleaning purposes and filling at no cost to the Contractor.
- 20.2.8 The testing shall be in accordance with AS 3735 Supp 1 2001 *Concrete Structures Retaining Fluids* comprise the following:-
- Filling the reservoir shall be at a uniform rate not exceeding 2m maximum per day and a rate of no greater than 200mm per hour;
 - The reservoir shall be filled to the design TWL and allowed to stabilise for a minimum 7 day period. During this period the Contractor shall monitor the water level on a daily basis to confirm that absorption and autogenous healing process are proceeding as expected. If the reservoir has to be emptied or the water level drops more than 300 below TWL for longer than 24 hours, the stabilisation period must recommence from Day 1;
 - On completion of the stabilisation period, the water tightness testing of the reservoir over a 7 day period shall be commenced in accordance with AS 3735 2001 *Concrete Structures Retaining Fluids*. The reservoir shall be considered fit for purpose if the net drop in water level does not exceed 10 mm over the 7 day test period;
 - If, however, the reservoir fails the water tightness test, and the reservoir has to be drained or emptied, the Contractor shall be solely responsible for its disposal. The disposal of water shall be done in accordance with the Unitywater's Document No. 05525 Dewatering-Construction/ Commissioning/ Reservoir Work Instruction and Unitywater's Document No. 05526 Dewatering High Chlorinated Water Work Instruction. Upon refilling the Contractor shall pay Unitywater the current water rate;

Pr9821 - Specification for Reservoir Design and Construction

- The load/settlement behaviour of the foundations shall be carefully monitored during the water testing phase by accurate survey compared to baseline survey prior to filling;
 - If the total settlement at any control point exceeds 10 mm or the differential settlement between any two adjacent control points on the perimeter exceeds 5 mm, then filling shall be immediately terminated and the testing procedure shall be modified or abandoned;
 - All survey work associated with testing shall be carried out by an independent registered surveyor, with a report summary of results presented to Unitywater on completion.
- 20.2.9 The Contractor shall be responsible for maintaining the water quality, in accordance with the acceptable range detailed below, until the reservoir has been completely commissioned and handed over to the Principal, i.e. Practical Completion.
- 20.2.10 Further, the Contractor shall commission all plant and equipment, in accordance with the contract requirements, including the reservoir, pipework, valves, instruments, etc. Commissioning tests shall demonstrate compliance with the contract requirements and shall be completed to the approval of the Superintendent's Representative.
- 20.2.11 Final commissioning and handover shall include all activities required to fill the reservoir, satisfy all testing requirements and make the new reservoir operational.

20.3. Water Quality Testing

- 20.3.1 Testing for final water quality to demonstrate the water is safe to send to consumers shall occur no less than three (3) days after the commencement of hydrostatic testing and prior to the water within the reservoir being released into the network and available for consumption.
- 20.3.2 Samples for final water quality testing must be collected no earlier than 24 hours after filling has been completed and the sodium hypochlorite has been added and mixed.
- 20.3.3 The final water quality 'certificate' will only be valid up to ten (10) days post the date the sample was collected and if there has been no further entry into the reservoir after the date the water sample was collected for microbiological testing. Note the exception with regard to BTEX and metals testing outlined in 20.3.5 below.
- If it is unlikely the reservoir will be able to go 'live' within this period, arrangements to maintain water quality and turnover shall be made. Additionally, retesting for final water quality acceptability shall be undertaken.
- 20.3.4 The water in the reservoir shall be sampled and tested by a NATA registered laboratory approved by the Superintendent (this service can be provided by Unitywater's Scientific Services or an external laboratory). Tests shall be considered satisfactory when they fall within the water quality limits specified below.

Table 2 – Water Quality Acceptance Criteria

Analysts	Unit	Required Result Range
pH		6.5 – 8.5
Apparent Colour	PCU	< 15

Pr9821 - Specification for Reservoir Design and Construction

Analysts	Unit	Required Result Range
Turbidity	NTU	<5
EC	(μ S/cm)	< 1250
Free chlorine residual	mg/L	> 0.5
Total chlorine residual	mg/L	> 0.5
Total Coliforms	mpn/100mL	<1
<i>E.coli</i>	mpn/100mL	<1
Heterotrophic Plate Count	cfu/mL	<100
THMs	μ g/L	<250 individually and also as a sum
Chlorate	mg/L	<0.8
Metal Scan (mercury, lead, nickel, aluminium, copper and manganese)		The results must not exceed health or aesthetic values stated in the Australian Drinking Water Guidelines, for the tested analyte.
BTEX		The results must not exceed health or aesthetic values stated in the Australian Drinking Water Guidelines, for the tested analyte.

20.3.5 Both metal scan and BTEX tests may take up to 14 days so this should be considered prior to final testing outlined in table above. These results are not subject to the 10 day acceptance criteria outlined above. *The following is a suggested protocol that may assist in meeting the above requirements.*

- *Late week 1 – fill/dose reservoir*
- *Monday week 2 – BTEX & metals sampling*
- *Monday week 3 – bacteriological & physical /chemical sampling (results back Thurs/Fri of week 3)*
- *Monday week 4 – BTEX and metals results available (assuming they take the full 2 weeks).*
- *Bring reservoir online if all results pass testing.*

Note this means that water needs to be dosed to a sufficient level for chlorine decay and to provide a residual after 2.5 weeks. 3mg/L as outlined earlier should be sufficient if free chlorine.

20.3.6 The samples collected must be representative of the body of water within the reservoir. As a minimum, samples are to be collected at three different levels within the reservoir; near the surface, in the middle and near the bottom. Dependent on the diameter of the reservoir, consideration should also be made with respect to adequate representation spatially across the reservoir.

20.3.7 Should any of the microbiological analyses not comply with the water quality limits shown above, the reservoir shall be resterilised and re- tested for all analytes, except

Pr9821 - Specification for Reservoir Design and Construction

Metal Scan and BTEX (where they have been demonstrated to meet the specifications in table 2) until the test results are satisfactory.

- 20.3.8 Should any of the chemical or physical analytes not comply with the water quality limits shown above, the water will be considered unsuitable for potable use and the Contractor shall develop an action plan for approval by the Superintendent's Representative. The Contractor shall be solely responsible for implementation of the approved action plan.

20.4. Post Construction Documentation and Practical Completion

- 20.4.1 A Certificate of Practical Completion will be awarded upon successful commissioning and handover of the reservoir.
- 20.4.2 Post Construction documentation shall be provided to Unitywater no later than twenty (20) business days following the successful commissioning and handover of the reservoir.
- 20.4.3 As a minimum the post construction documentation shall include:
- A Certificate of Compliance certifying that the structure has been constructed in accordance with the design documentation, and is structurally adequate for the intended purpose;
 - A Certificate of Compliance certifying that the structure/site complies with Unitywater's Occupational Health and Safety Policy;
 - Records of any additional geotechnical work carried out during construction;
 - Records of all concrete control testing;
 - Records of all post-tensioning activities;
 - Water tightness test results;
 - Pressure test results;
 - Results of water quality testing;
 - All Factory Acceptance Test (FAT) for each item of equipment;
 - All pre-site and Site Acceptance Test (SAT) for each item of equipment;
 - Commissioning report;
 - P&I Diagram;
 - O&M manuals for all electrical and mechanical equipment;
 - Post construction survey report (carried out by registered surveyor);
 - Description of all telemetry monitoring and control functions including a listing of all I.O.'s;
 - A full set of As-Constructed drawings certified by RPEQ, in hard copy and electronic formats; the As-Constructed drawings and asset manuals shall be prepared in accordance with 'SEQ WS & S D & C Code Asset Information Specification';

Pr9821 - Specification for Reservoir Design and Construction

- ADAC and asset management forms;
- Restoration completed to the satisfaction of Unitywater; and
- Rectification of all defects, excluding any during the defects liability period.

20.5. As Constructed Information

- 20.5.1 The As Constructed drawings shall be prepared and supplied in accordance with the 'SEQ WS & S D & C Code Asset Information Specification'
<http://www.seqcode.com.au/standards/>.
- 20.5.2 Asset information data shall be recorded on the 'As-Constructed Asset Record for Water Supply Assets' spreadsheet will be provided by Unitywater. This asset data shall include full asset details including installed value of all items.

20.6. Asset Manuals

- 20.6.1 Asset manuals shall be prepared and provided in accordance with the SEQ WS & S D & C Code Asset Information Specification.