WATER SUPPLY RESERVOIRS

Queenstown Lakes District Council Land Development and Subdivision Code of Practice Addendum

Date: February 2022

QUEENSTOWN LAKES DISTRICT COUNCIL

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ABBREVIATIONS

ANSI	American National Standards Institute
AS	Australian Standard
ASME	American Society of Mechanical Engineers
ASNZS	Australian/New Zealand Standard
AWWA	American Water Works Association
BoD	Basis of Design
BWL	Bottom Water Level
CAD	Computer Aided Drafting
CCTV	Closed Circuit Television
CoP	(QLDC) Code of Practice 2020 including appendices
DWSNZ	Drinking Water Standards New Zealand
HAZOP	Hazard and Operability Assessment
NZBC	New Zealand Building Code
NZFS	New Zealand Fire Service
NZS	New Zealand Standard
NZSEE	New Zealand Society for Earthquake Engineering
ORC	Otago Regional Council
P&ID	Process (or piping) and Instrumentation diagram
QLDC	Queenstown Lakes District Council
TWL	Top Water Level
WSA03	Water Services Australia: Water Supply Code

GLOSSARY

Bottom Water Level	Level above datum at crest of outlet bell mouth – refer figure in Appendix D.
Datum	For QLDC projects the level datum shall be taken as: VD2016 (new national standard). This will replace current use of the Dunedin 1958 datum.
Dead Storage	Water stored below BWL – refer figure in Appendix D.
Designer	Suitably qualified and experienced professional design lead (as determined by Engineering New Zealand bearing a CPEng) for the reservoir facility. The Designer is responsible for the overall design of the reservoir facility including issue of instructions and specifications to the Tank Supplier. Where the tank is designed by a specialist supplier, the tank designer shall take on design responsibility for the components that they design.
Gross Capacity	Total capacity of the tank from floor level to Overflow weir.
Net capacity	Capacity between bottom water level and top water level.
Overflow Level	Level at the crest of the overflow weir, refer Appendix D.
Service Reservoir	DWSNZ terminology for drinking water storage associated with the water distribution system. For the purposes of this document shortened to reservoir or tank.
Tank Supplier	Designer and supplier of the steel tank and associated appurtenances to defined contractual limits.
Top water level	Refer figure in Appendix D. Same as High Operating Level, that is, the level at which pumps normally stop. Note that water levels can exceed this level if there is a system malfunction.

1.0. INTRODUCTION

1.1 SCOPE

This document records the QLDC requirements for the design of reservoir sites with bolted cylindrical steel tanks founded on cast in situ concrete bases.

1.2 RELEVANT APPLICABLE STANDARDS

The design shall be in accordance with the New Zealand Building Code and the following relevant standards:

The latest version of DWSNZ Guidelines Section 16.2.1 - design considerations for service reservoirs.

QLDC Code of Practice for Land Development and Subdivision

QLDC District Plan

QLDC AM3 Approved Materials

Drinking Water Standards NZ 2018

NZS3101	Concrete Structures
NZS3106	Concrete Structures for Storage of liquids
NZS3109	Concrete Construction
NZS3404	Steel Structures
NZS4219	Seismic performance of engineering systems
NZS4442	Welded Steel pipes and fittings for water
SNZ4509	NZFS Firefighting water supply CoP
NZSEE	Seismic Design for Storage Tanks (Red Book)
ASNZS1111/2	Nuts and Bolts
ASNZS1170	Structural Design Actions
ASNZS1252	High-strength Steel Bolts for structural engineering
ASNZS1319	Safety signage
ASNZS1477	uPVC Pipes
ASNZS1554	Structural Steel Welding
ASNZS1657	Platforms, walkways etc
ASNZS1664	Aluminium Structures
ASNZS1665	Welding of Aluminium Structures
ASNZS1768	Lightening Protection
ASNZS2280	Ductile Iron Pipes

ASNZS3894	Site testing of protective coatings
ASNZS4020	Products in Contact with Drinking Water
ASNZS4130	PE Pipes
ASNZS4600	Cold Formed steel
ASNZS4765	mPVC pipes
AS1252	SS Bolts
AS1275	Bolts Hot dip galvanised
AS1657	Ladders access and handrails
AS2239	Anodes for cathodic protection
AS2304	Fire Tanks
AS2129	Steel Flanges
AS4020	Drinking Water Products
AS4087	DI Pipe fittings and flanges
AS4100	Steel Structures
AS4158	Gibaults
AWWA D103-19	Factory Coated Carbon Steel Tanks for Water
ANSI/AWWA C652	Disinfection of water storage facilities
ANSI/AWWA D108	Aluminium Domed Roofs for Water Storage
ANSI/ASME B36.19	Stainless Steel pipe
API650/(NZSAPI)	Welded Steel Tanks
WSA-03	Water Supply Code of Australia
Water NZ	Hygiene practices to prevent water supply contamination
Building Act and code	Liquid retaining structures are buildings in terms of the Building Act 2004 and must therefore meet the performance requirements of the NZ Building Act and Code.

2.0. DESIGN CRITERIA

2.1 RESERVOIR USABLE STORAGE VOLUME CALCULATION

The minimum gross storage across each network shall be the greater of:
• 24 hours of average day demand • 12 hours of peak day demand • 6 hours of average day demand plus the greatest firefighting storage requirement for the network as defined by SNZ PSA 4509:2008

Flow rates for calculating the above shall be calculated by considering the current water demand usage with the consideration of water demand management over time. These are to be confirmed with QLDC.

2.2 DESIGN FOR DURABILITY

Component	Design Durability Life in Years	Comment
Tank steel walls, tank wall to concrete joint, tank roof	50	NB this relates only to durability and not return period for loading
Tank Concrete Foundations, Concrete valve pits, Concrete retaining structures	100	NZS 3101:2006 section 3 Durability
Site buildings	50	NZBC Clause B2 VM1 and NZS 3101:2006 section 3 Durability
Above and below ground pipelines including fittings	100	Relevant pipeline design standards
Mechanical components including valves	50	
Tank epoxy coatings	Design life 25 years Guaranteed life 2 years	All bolted tank plates must be factory epoxy coated in accordance with AWWA D103-19.
Tank sealants	Design life 25 years Guaranteed life 2 years	Joint sealant shall comply with the requirements of AWWA D103-19. Sealants shall be compatible with cathodic protection where fitted. Sealants shall be compatible with tank disinfection processes.
Cathodic protection (if required to provide design life of tank)	20	

Component	Design Durability Life in Years	Comment
Electrical assets	20	
Instrument and control assets	15	
Dissimilar metals	No situation where dissimilar metals may cause a galvanic cell to occur.	
Water quality testing	Designers must obtain an incoming water quality assessment to confirm the suitability of the tank proposed.	

2.3 DESIGN FOR ULTIMATE LIMIT STATE STRUCTURAL CAPACITY

Item	Design Life years	Importance Level	Standard
Tank superstructure and tank foundation	50	4	NZS 1170.0
Buildings, pits, and structures other than the tank	50	4	NZS 1170.0

Design working life	Importance level	Annual probability of exceedance for ultimate limit states		
		Wind	Snow	Earthquake
50 years	1	1/100	1/50	1/100
	2	1/500	1/150	1/500
	3	1/1000	1/250	1/1000
	4	1/2500	1/500	1/2500
100 years or more	1	1/250	1/150	1/250
	2	1/1000	1/250	1/1000
	3	1/2500	1/500	1/2500
	4	*	*	*

2.4 GENERAL REQUIREMENTS AND SERVICEABILITY

Element of Design	Requirement
Reservoir facility land status	Facilities shall be sited on freehold land vested to QLDC. Facilities within easements are acceptable but require approval from QLDC. Access roads and service/pipe alignments outside of the facility shall be within vested road reserve. Where this is impractical easements or vested freehold are acceptable alternatives. Leased land options are not acceptable.
Tank design standards - general	Bolted steel tanks to be designed to the *American Water Works Association Standard AWWA/ANSI D103-19: Factory Coated Bolted Steel Tanks for Water Storage*. Where applicable AS/NZS1170, NZS3101 and NZS 3404 must have precedence. Seismic design shall be in accordance with NZS 3106, and shall reference NZSEE Seismic Design of Tanks, 2009. The Designer shall refer to QLDC seismic design return period memo, refer to Appendix C. The design must consider the potential for wind and snow loading and ice formation in accordance with NZS 1170.2
Tank foundation and floor design standards.	The tanks shall be founded on an in-situ cast reinforced concrete floor designed in accordance with NZS 1170.0, NZS 3101, NZS 3106 and ANSI/AWWA D103-19, Section 13.4.6 Design of concrete structures for the storage of liquids. Use of post tensioned construction of the floor must be agreed with QLDC.
Underdrainage requirements	The concrete base of the tank shall have underfloor drains to assist with any leakage tracing. These drains shall be provided in at least 4 zones and shall discharge to a collection chamber where individual drain outlets can be identified – refer to figure in Appendix A. The drains shall be PVC of 50 mm diameter, set in no fines concrete and shall be configured to run within 1 m of any floor penetrations and otherwise equally spaced.
Liner forbidden	The tank must not have nor require a separate liner.
Minimise confined spaces	Facilities are to be designed to minimise or remove the need for any confined spaces.
Freeboard above top water level	Freeboard shall be sufficient for overflow to function and to contain sloshing caused by earthquake. If slosh mode contacts roof this is to be specifically identified in the design attributes report and to be allowed for in structural design.

Element of Design	Requirement
Number of reservoirs per site	Minimum two tanks and provision for at least one future tank. For sub-division reservoir facilities sufficient reservoir capacity must be delivered by the developer at the time the developer is seeking compliance for the sub-division. Determine the Total Gross Reservoir Storage required at each 10 year increment. Determine how delivery of the required storage can be staged. A minimum of 2 reservoirs are required at the 30 year primary design horizon. More than 2 reservoirs can be acceptable at the 50 year MPD horizon. Reservoirs to have a minimum of 6 m between each other. Reservoirs to have a minimum 4 m wide platform annulus around them. Above ground obstacles (excluding slopes) to be a minimum of 6 m from reservoirs. Where facilities do not meet the 6 m spacing, 4 m annulus or 6 m separation from obstacles must demonstrate appropriate constructability and long-term maintenance. The demonstration needs to include vehicle movements for maintenance and construction. Reservoir facilities that cannot demonstrate feasible long term constructability, and/or constrain the 3 Waters maintenance contractor to undertake regular or heavy maintenance are unacceptable.
Maximum tank height	Bottom water level to top water level shall not exceed 6 m.
Pipework arranged to allow for taking one tank offline	Pipework layout and valving to be arranged so that one of the tanks can be taken offline for maintenance and the other tank(s) are to be able to continue to function.
Flow shortcutting	Tank inflow and outflow to be designed to minimise the potential for shortcutting through the reservoir. This is normally achieved by having a high level inlet and low level outlet with at least 90° radial separation.
Protection of emergency and fire reserve	Reservoir systems must be designed to: • Prevent overflows. • Prevent drawdown of emergency/fire reserved storage except for those purposes.
Vermin and contaminant protection	Provide robust provision of screens to keep out birds, vermin, insects, and other pests from the tank. All permanent openings (not hatches) into the tanks including vents are to be protected

Element of Design	Requirement
	by 2 mm stainless steel insect mesh. No openings shall face upwards. Roof/wall joints shall be completely sealed to prevent dust, vermin, insects, rainwater penetration. The tanks shall be detailed to discourage any bird nesting.
Tank roof design	Provision of roof vents shall be compliant with AWWA D103-19.
Maximum valve and service chamber depth	Where chambers are required, they shall not be greater than 1.5 m deep. Control valves, flow meters and telemetry sensors shall be housed within in-ground chambers. However, the number of in-ground chambers needs to rationalised, made communal and wherever possible not needed to be trafficable, i.e. be at least 6 m from a reservoir. Above ground pipework or valves require specific approval. Trafficable chambers require specific approval.
Burst valves and earthquake, Altitude valve provisions	Burst valves, also known as earthquake isolation valves, shall be provided to preserve the tank contents in the event of an earthquake large enough to fracture the supply/falling main. It is essential that all reservoirs are able to withstand the design earthquake event without significant loss of stored water. • Each tank within the facility is to be fitted with its own EQ valve. • The designer is to consult QLDC to confirm manufacturer of the preferred burst valve. The burst valve shall be installed on the outlet main adjacent to the inside of the boundary fence. • Burst valve closure to be controlled by an overspeed function signal from each reservoir's outlet main high flow trigger set point or triggered by a seismic alarm. • Discuss with QLDC arrangements to get water from the tanks to road tankers in post-earthquake conditions. It may be required to provide an emergency hose connection or tap array at or near to the boundary fence. If required, this hose position should have an access road layout to facilitate road tanker manoeuvring. • In a multi-tank facility one of the tanks can be set to not automatically close its EQ valve, this ensures continued supply for LoS and firefighting with a false positive EQ, or where fighting a fire takes precedence over water loss. Non-auto EQ tank can be remotely

Element of Design	Requirement
	operated/isolated by operator, similarly auto EQ tanks can be remotely operated/opened by operator. A communal altitude valve provides protection from overflow for all reservoirs. The altitude valve shall be activated by pressure via a signal pressure pipe connected to the reservoir. The balance pipework may be used as a tapping point for the pressure signal pipe. A flow meter and flow control valve may be required on the inlet of some reservoir facilities to control their fill rate.
Plinth height	Mechanical plant to be mounted on plinths 200 mm high.
Cable trays/conduits	Cables are to be installed below ground in covered ducts/conduits or fixed above head height on cable trays, or in vertically mounted galvanised steel conduits attached to the tanks.
Barriers and fall protection	Provide handrails/chains around potential falling hazards.
Cathodic Protection	Provide suitable cathodic protection to appropriately protect integrity of steel tank structure.

2.5 PIPEWORK REQUIREMENTS

Design Element	Requirement (Refer to Appendix A for typical pipework arrangements)
Pipe materials	Below ground inlet and outlet pipework beyond the tank contractual limit shall be PE100 of a suitable pressure rating (PN16 minimum). PE pipe shall be suitably derated for fatigue and temperature as per PIPA guidance (POP0101). Above ground pipework within the tank shall be in accordance with QLDC AM3 approved materials document. All non-pressurised drainpipes shall be uPVC of a suitable class (minimum SN8). Flanges shall be to AS4087 of a suitable pressure class. Cast in concrete pipework shall be ductile iron or cement lined steel.
Internal pipework requirement	All above ground pipework shall be inside the tank and pass through the floor slab.

Design Element	Requirement (Refer to Appendix A for typical pipework arrangements)
Dedicated rising main	Reservoirs are to be supplied via a dedicated rising main unless specifically approved by QLDC. Some existing reservoir facilities have Rising / Falling mains and some future facilities may also require Rising / Falling main functionality. This is detailed further below.
Water Stops	All pipework passing into or out of the tank (through the concrete base slab) must be provided with suitable water stops/water bars and hydrophilic seals at all places where potential leakage paths exist.
Provision for differential movement	Pipework connecting structures with ground or other structures shall be designed to withstand differential movement. Suitable self-restraining flexible connections shall be provided within 1 m of the external face of the tank foundation and can comprise of either rocker pipes, PE pipe lengths, mechanical couplings, and/or bellows with EPDM flexible components.
Tank inlet	Inlets shall be high level bell mouths above normal operating level and the overflow outlet to provide an air gap. The inlet pipework shall be sized based on the design flow rates to the tank. Designer to confirm the design inlet flow rate with QLDC. Inlet pipes above ground (inside the tank) shall be ANSI/ASME B36.19 stainless steel 316L to a suitable pressure Schedule. Inlet pipes below ground shall be DI PN16 minimum or PE100 PN16 minimum.
Scour Pipes	An internal scour sump and scour outlet pipe shall be installed in the tank base to allow the tank to be fully drained. The internal scour sump shall be square in plan and twice the size of the outlet diameter with a minimum size of 500 x 500 mm. The scour pipe shall be connected to an external pump out chamber designed to allow sucker truck intervention if sediments are present. The required pump out chamber volume shall be equivalent to 10 mm of depth of water in the reservoir, however shall have a maximum volume no larger than a commonly available sucker truck, i.e. 6-8 m^3, and be no smaller than 1.5 m^3. The pump out chamber shall be combined with the overflow discharge chamber. The outlet of the pump out chamber shall have a normally closed valve prior to any piped connection to the calamity basin SW discharge system. The closed valve shall be openable to allow the tank to discharge direct to the SW discharge system if deemed acceptable by the

Design Element	Requirement (Refer to Appendix A for typical pipework arrangements)
	operator. However, the valve must normally be returned to a closed position.
Outlet Pipes	Outlet pipes shall be ductile iron or cement lined steel with bell mouth installed through the floor of the tank. They shall be sized to suit the maximum design outflow. Diameter may be locally reduced to allow an economical design of pipework, valve, and fittings. The outlet bell mouth shall be located within 2 m of the tank wall to minimise sub floor pipework. The outlet pipe arrangement must be arranged to ensure a minimum 100 mm dead zone above the tank floor to retain any accumulated sediment from being drawn into the outlet pipe. The Designer shall consider any requirement for an anti-vortex baffle.
Rising / Falling Main	If QLDC requires Rising / Falling main functionality then this must be achieved with separate inlet and outlet pipes as discussed above. A singular inlet / outlet pipe into a reservoir is not allowed. A non-return valve will be required to ensure turnover of the reservoir/s i.e. the reservoir is filled through the high-level inlet pipe and drained via the outlet pipe. A dedicated flow meter is still required on the outlet pipe to record flows and is linked to BCV operation. A flow meter is also required on the inlet pipe such that instantaneous demand can be deducted during reservoir filling. The inlet flow meter can be common to all reservoirs within the facility, similar to the installation of a common altitude valve. Although most flow meters have bi-directional capability they shall not be used where flow can be in both directions, i.e. on the Rising / Falling main, as this confuses processing of data provided by the meter.
Bypass valve between inlet and outlet	Some existing reservoir facilities have a by-pass pipe between inlet and outlet pipework. QLDC may require some future facilities to have this functionality The by-pass shall consist of a normally closed pipe, with a valve at each end and a means to purge the closed pipe from its end nearest the valve to the outlet pipe.
Internal overflow	The tank must be provided with an internal overflow pipe capable of taking maximum inflow without the water level reaching the roof structure. Maximum inflow to a single tank is calculated by dividing the maximum inflow into the reservoir facility divided by the

Design Element	Requirement (Refer to Appendix A for typical pipework arrangements)
	number of tanks less 1, i.e. total inflow divided by 1 for 2 tanks, and divided by 2 for 3 tanks. The overflow shall be conveyed to the scour pump out/overflow inground chamber. The overflow will initially bubble up from the chamber and be obvious to the operator. Any overflow beyond the capacity of the calamity basin's SW discharge system shall intentionally flood the calamity basin. The overflow pipe shall have a non-return valve installed at the exit point to prevent vermin from entering the pipe.
Balance pipework	To allow for any differential filling or decanting between individual tanks a smaller diameter balancing pipe is to be provided between tanks, or as a manifold where there are more than 2 tanks. Balance pipe work shall have an isolation valve no further than 1 m from each tank circumference.
Pipe routes	Within the reservoir facility the designer must ensure the configuration of inlet, outlet, overflow and drainage pipe work minimises the number of pipe crossings and the need for multiple vertical separations. Where possible the inlet and/or outlet pipes shall run in the verge adjacent to the access road.
Service duct routes	The Designer shall run ducts for control cables alongside the inlet and/or outlet mains where practical. Control cable ducts may be in the same trench as the pipelines provided code of practice separation is maintained.
Sample points	Sample points shall be provided on the outlet pipework as per the QLDC Standard detail B2-10, refer to Code of Practice, Section 6.
Freezing protection	Appropriate freezing protection to above ground pipelines is required. This is to be assessed on an individual basis. This may apply to smaller pressure 'signal' and water sampling pipework.
Pipe restraints	All fixings shall be by bolts, cast in fixings or chemical bolts. Corrosion and bi metal effects must be considered and mitigated. Clamping and bolting preferred to welding.

2.6 POWER, CONTROL AND INSTRUMENTATION SYSTEM REQUIREMENTS

Element of Design	Requirement
Level sensors	Reservoir level is to be measured by dual transducers operating in a duty/standby configuration. Hydrostatic pressure transmitters installed via small bore penetrations at the tank base are preferred. The penetration shall include an isolation valve to allow for the safe removal of the level instrument while the tank is in service. Suitable mechanical protection shall be provided to protect the devices from damage. The duty level sensor shall be utilised to control the filling of the reservoir. The duty service device shall be selected by the operator and shall change automatically to the standby device in the event the duty instrument fails. Alarms shall be configured for Low, Low-Low, High, and High-High levels. In addition, an alarm shall be raised if the measured level on the two level sensors shows a difference exceeding 10%. The instrument make/model shall be confirmed with QLDC in advance of detailed design, refer to Appendix B.
Level Switches	A secondary level device is to be provided in the form of high and low float switches. Float switch positions are shown in Appendix D. Float switches to be installed close to main hatch for easy access. The instrument make/model shall be confirmed with QLDC in advance of detailed design, refer to Appendix B.
Flow Meters	An Electromagnetic flow meter is required to measure the flow leaving the reservoir site. The meter shall be mounted in a suitable lidded flow meter pit with good all-weather access and drainage. If the site includes multiple falling mains an individual flow meter shall be provided on each main. The flow meter make/model shall be confirmed with QLDC in advance of detailed design, refer to Appendix B.
Telemetry and SCADA	A Swampfox RTU shall be provided to enable communication and control through the QLDC SCADA system. Where practical, communications with the pump station filling the reservoir shall be via a hard-wired connection (copper, Ethernet, or fibre).
Electricity Requirements	Where practical all reservoir sites shall be provided with mains electricity. Where practical the electricity supply shall be brought to site underground and within the access road corridor. Where the

Element of Design	Requirement
	access road corridor is switchback or convoluted, a more direct route can be arranged. Where the provision of a mains connection is not possible or practical a solar array with suitably sized battery pack shall be provided.
Lightning Protection	Lightning protection risk assessment to AS/NZS 3000 shall be provided by the Designer.
Lighting	For sites with a mains power supply external security lighting with passive infra-red sensor shall be provided. The designer shall consider the requirements for task lighting provisions, to be agreed with QLDC on a site by site basis. All lighting shall be LED.
Security	Hatches and portholes shall be fitted with position switches to be linked to SCADA for monitoring and alarming.
Local Switchboard	A local Switchboard shall be provided and shall incorporate circuit breakers, level and flow monitoring transmitters and telemetry equipment. The board shall be constructed from stainless steel and rated for external conditions. The Designer shall confirm with QLDC their requirements for kiosks or small buildings to house the equipment.
Backup power generation	Electrically actuated burst control or EQ valves will require a sufficiently sized UPS allowing for a minimum of 2 actuations for each valve at the facility. The Designer shall discuss any requirement for a back-up generator or provision for a mobile generator with QLDC. Where a lift pump station is included at the facility to supply water to an upper pressure zone, it is likely that an on-site back-up generator will be required.

2.7 CIVIL AND SITE REQUIREMENTS

Element of Design	Requirement
Site signage	The site shall include the following signage: • Access gate sign showing name of site, QLDC contact details etc.

Element of Design	Requirement
	• H&S signs (chlorination related, no smoking, confined space, electricity, speed limit, hearing protection, visitor instructions, etc) refer to AS/NZS 1319. • Security Notices. • Face plate on each tank giving tank manufacturer, reservoir name, volume TWL and BWL.
Calamity basin	The designer must consider the consequences of a catastrophic failure of one of the tanks and incorporate mitigation strategies (such as a safe overland flow path or a calamity basin) into their design. A calamity basin shall comprise a bund surrounding the tanks with a volume capable of retaining the volume of one full tank. The bund shall be at least 4 m from the tank base and shall have a cross section with 1 in 3 slopes and a 1 m wide crest. The bund will be continuous apart from where the reservoir facility vehicle access track crosses the bund. The track forms an overflow weir and determines the TWL of the calamity basin. For clarity the volume of calamity basin is calculated by multiplying the area of the basin, less the footprint of intact tanks by the depth of water in calamity basin. Where the access track crosses the bund it shall have 1 in 5 ramps with suitable vertical curves to allow vehicles to transit over the crest. The calamity basin is to have a SW drainage system connected to a suitable watercourse or stormwater system. In the event of an overflow or tank rupture the discharge from the calamity basin will be intentionally and specifically limited to the capacity of the basin's SW drainage system and receiving environment. Should an overflow continue without intervention, or more than one tank rupture, then an overflow from the calamity basin may occur over the access track and be conveyed in a controlled manner as overland flow. It is unacceptable to have no designated overland flow path from the reservoir facility in the event of an overflow or tank rupture. Calamity basin reservoir depths to overflow exceeding 0.50 m, and facilities with lift pump stations and other electrical equipment within the basin, will require specific approval. Electrical switchgear shall be kept above the calamity basin TWL. Calamity basin reservoir depths to overflow exceeding 1.3 m are not acceptable.
Stormwater drainage	Reservoir site stormwater drainage shall be configured to prevent any standing water accumulating in a 10 year ARI storm event. The designer shall not create a large catchment for the calamity basin. Storm events in excess of a 10 year ARI may cause standing water within the calamity basin, but the designer must ensure that any

Element of Design	Requirement
	standing water up to a 250 ARI event will drain away in less than 8 hours. The designer shall also ensure that the maximum design volume of water in the calamity basin will drain completely within 12 hours. The stormwater discharge system shall connect to an appropriate receiving environment. Design of the facility platform (the invert of the calamity basin) should avoid excessive change in platform level, i.e. +/-250 mm maximum.

Access road	The access road shall provide for the following:
	• All roading shall be in accordance with the QLDC District Plan Decisions Document April 2021, Section 29.
	• The access road shall be compliant with the QLDC Code of Practice Section 3. The access road shall be minimum 4m wide and shall have a pavement design suitable for construction and maintenance traffic.
	• Maximum gradient shall be as follows:
	  o Maximum extended grade 14% for straight lengths, hardfill surfacing as a minimum.
	  o Maximum localised grade 16% (20m max extension) for straight lengths, concrete surfacing as a minimum.
	  o Maximum grade for tight corners (>90 degrees) 12.5%, hardfill surfacing as a minimum.
	• Curve radii shall be sufficient to allow for construction and operational traffic. Refer to curve/turning circle figures in the above referenced document. A turning circle should always be achievable with a 4m wide annulus provided around each tank, unless the tanks are very small diameter. Utes should be able to turn around tanks larger than 6.0m diameter and 8.8m medium rigid vehicles should be able to turn around reservoirs larger than 12.0m diameter. At QLDC's discretion smaller reservoir facilities may not need a contiguous annulus around each tank, and a hammerhead design maybe acceptable, at QLDC's discretion.
	• The access road must have a safe flat section for vehicles to park while the driver unlocks the gates to the facility. This is to mitigate the risk of 'roll-back' events. The flat section should comfortably accommodate a Ute and allow for swinging of the gates. Flat sections for parking less than 8m long and/or with a gradient in any direction greater than 1v:33h (3%) will need specific approval.

Element of Design	Requirement
	• Road design shall provide for access in bad weather and shall have stormwater system designed to contain a 1 in 10-year event. • The access road shall be provided with signage. • A minimum 4 m wide unsealed annulus around each tank is required for access by ute, 8.8m medium rigid vehicle, or elevated work platforms (EWPs).
Access hatches	Permanent personnel access facilities to the roof are required. At a minimum the access facilities will comprise a platform beside the tank with a handrail at the tank gutter height. The platform is intended for accessing the roof top inspection hatch/s and is not intended for access on to the roof itself. Depending on the height of the tank wall above ground level (AGL) a lower intermediate platform may be required. Any fixed ladders shall not extend below 3.6 m AGL, or will require an infallible mechanism to prevent use by unapproved persons. Removable ladders shall extend no more than 6 m AGL and will require a proprietary ladder attachment system to ensure safe use. One access hatch on the roof is required to allow for monitoring, instrumentation, and drone access. This hatch shall have a clear opening of 600x600 mm. Two diametrically opposite access ces (porthole type), minimum 1000 mm clear diameter in the tank shell, just above floor level are required for internal tank inspections when the tank is empty. Portholes shall be hinged so they swing open and do not need to be lifted. Portholes shall be fully sealed, leak free and lockable.
Security, fencing and gates	The reservoir platform shall be surrounded by a security fence with chain link mesh a minimum of 2.2 m high with single barbed wire top line and additional rabbit proof fencing buried to 300 mm. Fences should be a minimum of 8 m horizontally from tanks to allow the operation of plant. Fences can be placed on slopes with a gradient in any direction not exceeding 1v:2h. The designer shall avoid having fences on top of berms or in other visually dominant areas. Compound access gates shall be double leaf with a minimum 4 m wide opening and a single barbed wire top line. Gates shall be the same height as the security fence and shall be provided with standard QLDC padlocks.

Element of Design	Requirement
Cut and fill batters	Cut batter slopes not exceeding 1v:2h are acceptable, however still need to be covered by the geotechnical advice for the site. The design shall contemplate the long-term erosion protection and general stability of the slope. 3 Waters maintenance contractors require landscaping to be low maintenance and should avoid lawns, or other plants needing seasonal maintenance. The maximum gradient for grass planting requiring mowing is 1v:3h. Slopes with a gradient in excess of 1v:3h require mass planting with shrubs/tussocks or a mechanical means to avoid erosion. Cut batter slopes with a gradient in excess of 1v:2h require a specific geotechnical assessment. Slopes with a gradient in excess of 1v:1h require alternate means to stabilise and/or promote fibrous plant stabilisation and also required specific approval. Cut-off drains above cut batter slopes may be required to mitigate the risk of erosion. Any cut slope requiring mechanical stabilisation will require specific approval. Any cut batter slope that offers a risk of falls to itinerate users of the land (approved access or otherwise) is unacceptable. Any cut batter slope that does not contemplate long term maintenance and erosion control is unacceptable. Fill batter slopes not exceeding 1v:2h are generally acceptable, however need to be covered by the geotechnical advice for the site. The design shall contemplate the long term erosion protection and general stability of the slope. Fill batter slopes with a gradient in excess of 1v:2h require a specific geotechnical assessment. Any fill area requiring mechanical stabilisation will require specific approval. Any fill batter slope that offers a risk of falls to itinerate users of the land (approved access or otherwise) is unacceptable. Any fill batter slope that does not contemplate long term maintenance and erosion control is unacceptable.
Rockfall protection	A formal assessment of the site is required by the designer in order to confirm the necessity, or otherwise, for rock fall or other

Element of Design	Requirement
	protection. If required, an appropriately qualified designer shall design the system.
Vehicle and foundation loading on pipes	All external below ground pipework shall be designed for at least HN loading. The Designer shall consider structural loading to AS/NZS 2566 where required but especially at road crossings and under any foundations.
Bollard protection	Valve groups and other non trafficable chambers shall be protected from traffic by bollards.
Landscape Design	A specific landscape design is required. Trees which may threaten the infrastructure are not to be included. Trees and planting shall be native species suitable for local conditions. Trees shall be planted on the outside faces of the calamity basin and not within the security fencing of the facility. The 3 Waters maintenance contractor will not accept maintenance of plantings. There may be situations where plantings within the security fencing of the facility are appropriate, this will need to be agreed with QLDC.

3.0. DESIGN DOCUMENTATION

3.1 PRELIMINARY PROJECT REQUIREMENTS AND CONSTRAINTS MEMO

The consultant shall prepare a preliminary Project Requirements and Constraints memo. The purpose of the memo is to specifically, clearly, and succinctly record the project requirements and constraints that the design will be prepared to address. Designer shall liaise with QLDC to confirm and specifically record the aspects below in a formal memo addressed to the QLDC project manager:

- Purpose of storage, e.g., potable water, raw water, or recycled water.
- Requirement for designations and designation boundary.
- Easement requirements.
- Land availability including legal boundaries.
- Any pre-existing ground/foundation information.
- Access road requirements, both for operation, maintenance and construction.
- Tank volume calculation.
- Tank operating levels.
- Location of existing rising and falling mains and connection to network.
- Water supply demand forecast.
- Relationship with, and operational requirements of, associated water treatment facilities.
- Details of consents and designations obtained and requirements for any new consents.
- Site specific planting and landscaping requirements.
- Specific requirements for electricity supply and back up generation.
- Any special security requirements.
- Any special hygiene, office, or other accommodation requirements.

3.2 CONCEPT DESIGN REPORT

To record how the design approach to address the project requirements and constraints recorded in the Preliminary Project Requirements Memo the designer shall develop a Concept Design Report.

The specifics of the design and the method of achieving the project requirements are to be recorded in this document. The purpose of the document is to agree the form of the solution prior to proceeding with detailed design and finalisation of the drawings and specification. As a minimum the document is to clearly identify the following items

- Site layout including topographic data, land boundaries, existing services and other land issues
- Consent constraints that may occur including stormwater discharge, resource consents etc
- Pipe layout including connection to the network and pipe layout within the site

- Tank layout and tank geometry and provision for future tanks
- Preliminary landscape layout
- Stormwater control within the site and stormwater from adjacent sites
- Requirement for retaining structures and earthworks
- Geotechnical information and geotechnical interpretation supporting the layout developed
- Site access layout
- Design requirements as listed in section 2 of this document

3.3 DETAILED DESIGN REPORT

To accompany the completed design documents (specification, drawings and other documents) the Designer shall prepare a Detailed Design Report. The purpose of the Detailed Design Report is to record the design inputs and solutions and the decisions and assumptions made. The Detailed Design Report is intended as the mechanism to record for future reference the design assumptions and design decisions and the intended operation of the facility. It is intended that the Detailed Design Report elaborate and expand on the items in the Concept Design Report and also record subsequent changes in assumptions or scope.

3.4 COMMISSIONING AND TESTING PLAN

The Designer shall prepare a Commissioning Plan for QLDC approval detailing how the filling, testing, cleaning and disinfection and commissioning of the tanks will be carried out.

The commissioning plan shall include for testing of alarms and super-chlorination as part of the commissioning.

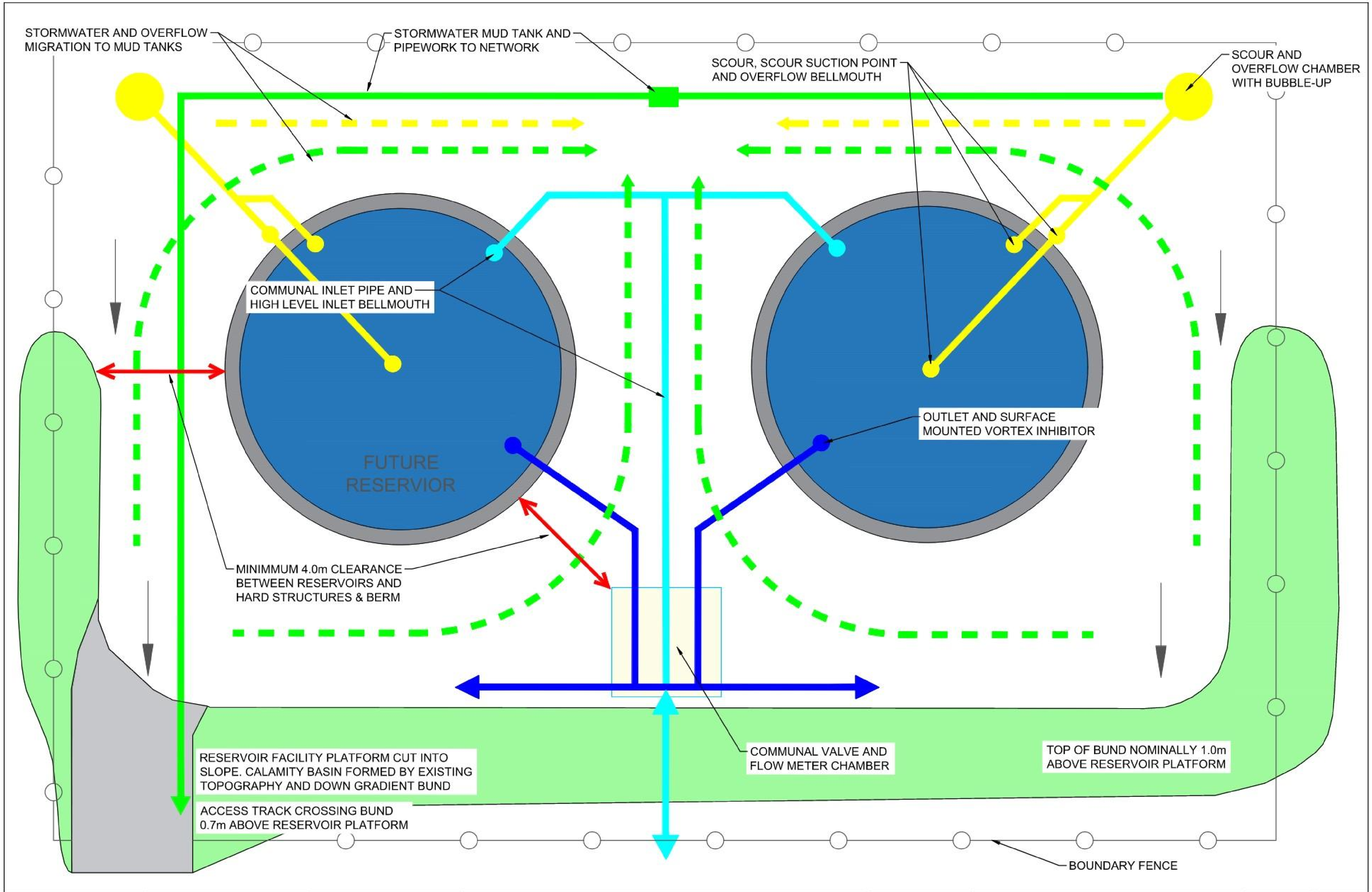
Minimum requirements shall include.

- Stabilisation period and level monitoring requirements
- Leak testing of the roof shall be carried out in accordance with Section 13.9 in AWWA D103. This testing shall be carried out in the presence of QLDC staff or nominee.
- Test procedure to test the tank overflow operation
- Test procedure for scour operation
- Cleaning and disinfection requirements. Disinfection shall be to the Water New Zealand Good Practice Guide 'Hygiene Practices to Prevent Water Supply Contamination, December 2019,' The adopted disinfection method is to be discussed and agreed with QLDC operations staff.
- Bacteriological testing. Samples shall be taken and tested in line with the Water New Zealand Good Practice Guide and the Drinking-water Standards for New Zealand 2005 (Revised 2018) to demonstrate a successful disinfection procedure.
- Transducer testing. The pressure transducer and associated float switches shall be configured to stop the rising main pumps to prevent overflows. Switch levels and alarms

shall be provided as shown in Figure SK4 (Appendix D). Switch and alarm signals shall be tested as part of the commissioning plan.

- Holiday conductivity testing of all panels shall be completed in accordance with AWWA D103-19.

APPENDIX A TYPICAL SITE LAYOUT AND PIPEWORK DRAWINGS



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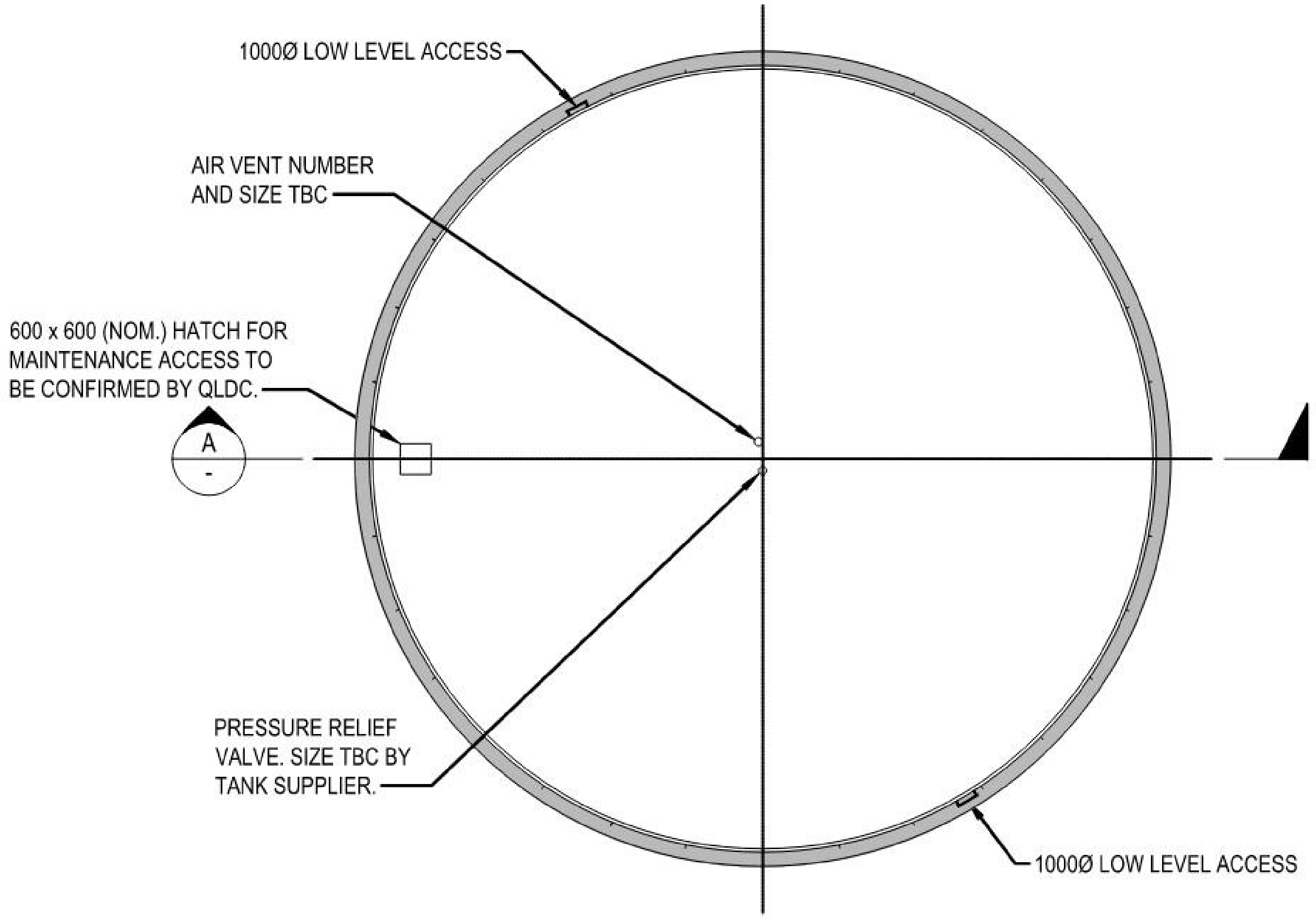
QUEENSTOWN LAKES DISTRICT COUNCIL

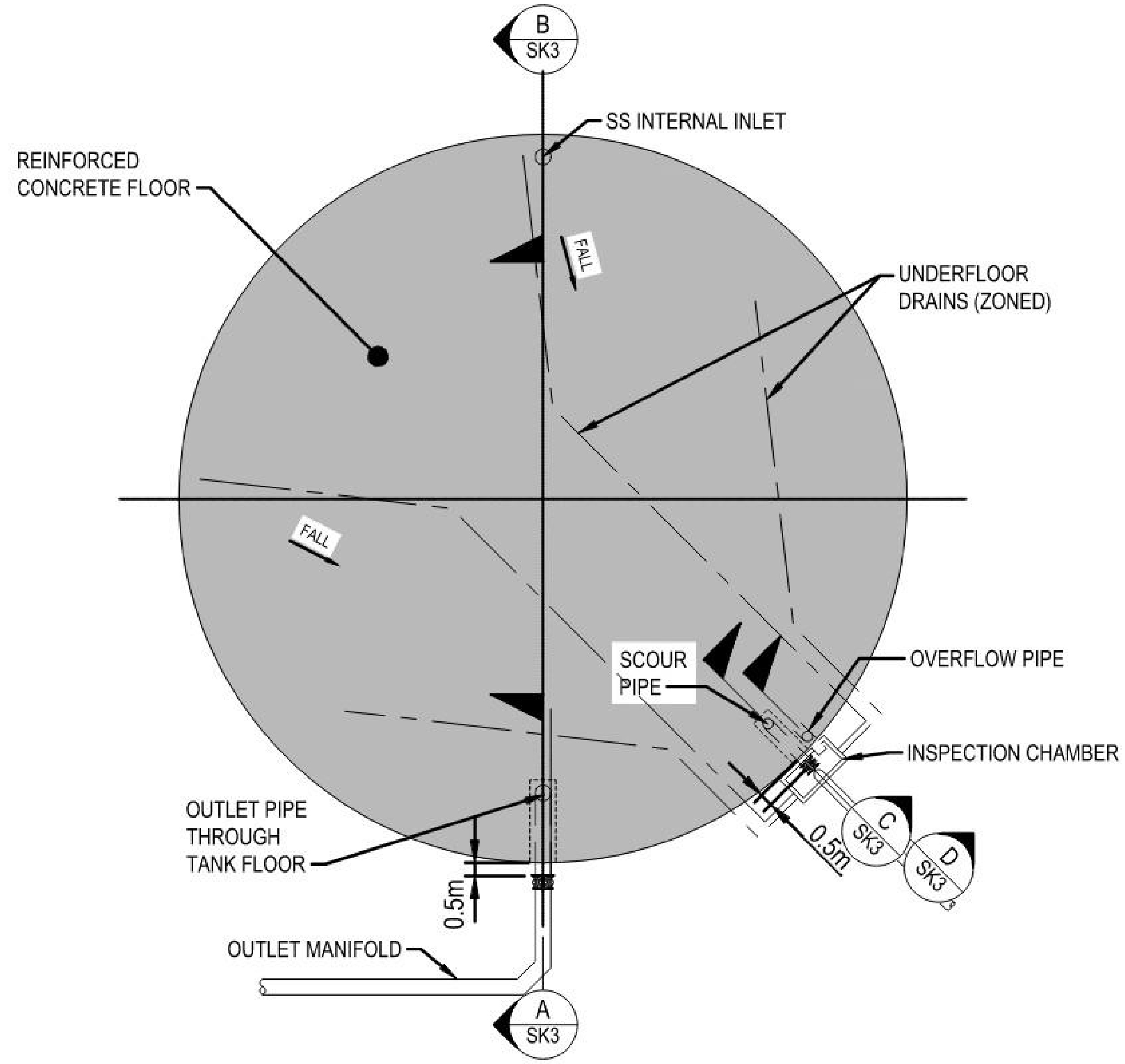
QLDC Wanaka Water Trunk Main
Engineering Design
Typical Reservoir Facility

DESIGN	JS				2-0343.01	FOR APPROVAL
DRAWN	BS				DWG No.	
APRVD	JS					
PROJECT #: 2-0343		A	Initial design	21/01/2022	N.T.S	A
		REV	DETAILS	DATE	SCALE	REVISION



RESERVOIR ROOF PLAN

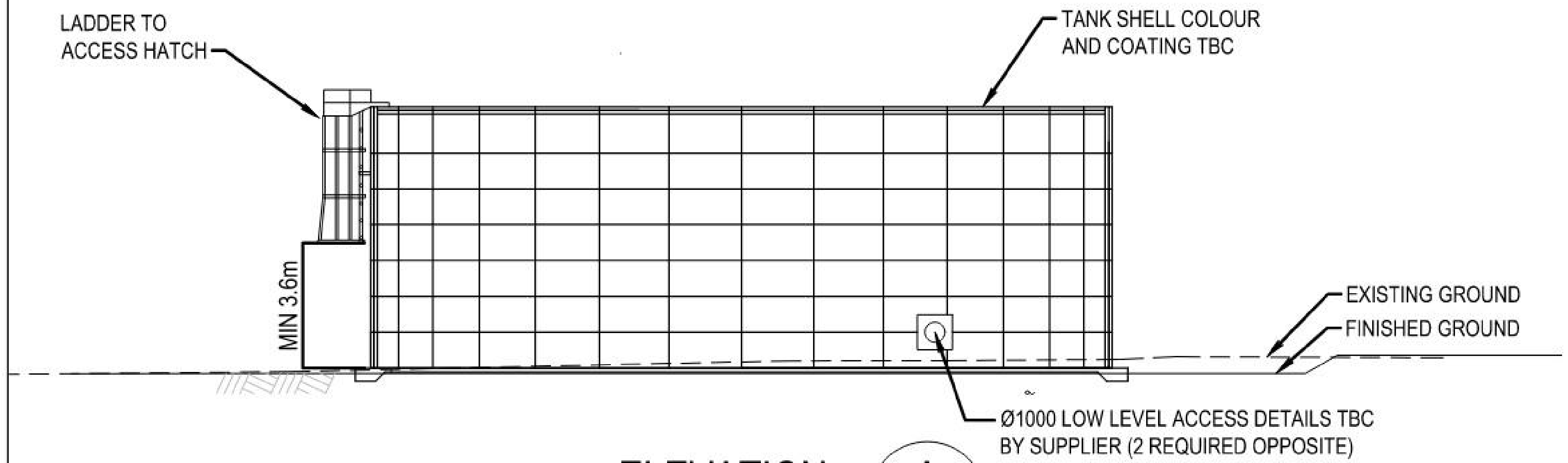
(TYPICAL)



RESERVOIR FLOOR PLAN

(TYPICAL)

REFER SK3 FOR PIPEWORK DETAILS.



ELEVATION A -

SCALE 1 : 250

INDICATIVE ONLY - REFER TO PRINCIPALS REQUIREMENTS

Pinnacles Civil
Design | Build | Asset Management

QUEENSTOWN LAKES DISTRICT COUNCIL

QLDC Wanaka Water Trunk Main
Engineering Design
Reservoir (Typical) Plan and Elevation

DESIGN	JS
DRAWN	BS
APRVD	JS

PROJECT #: 2-0343

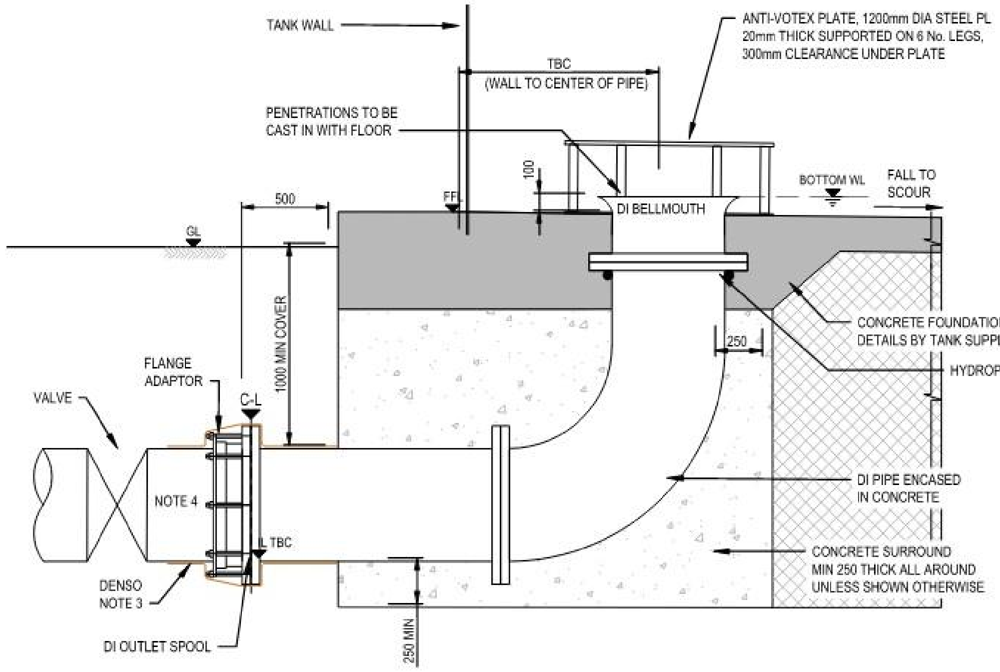
REV	DETAILS	DATE
A	Initial design	23/08/2021

DWG No.	SCALE	REVISION
2-0343.01	N.T.S	A

FOR APPROVAL

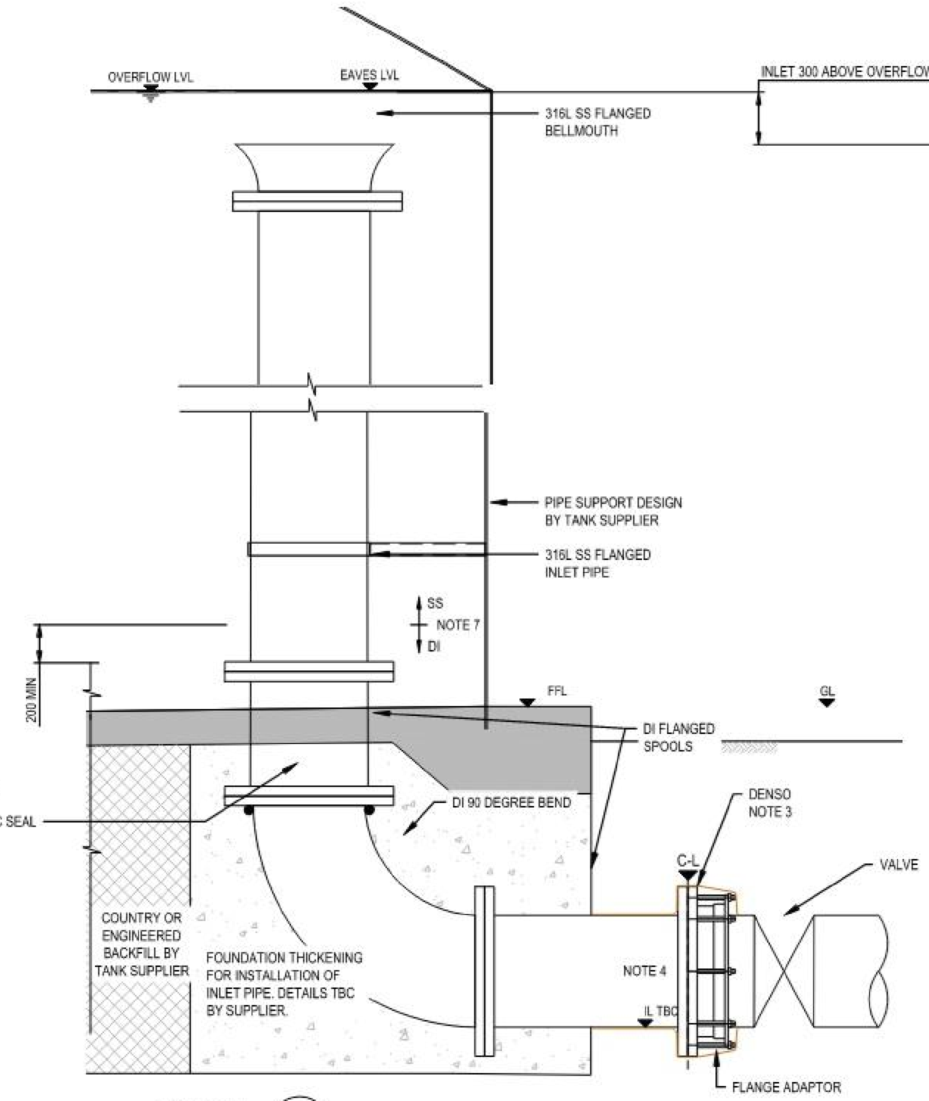
RESERVOIR CONNECTION NOTES

1. REFER TO QLDC DOCUMENT 'RESERVOIR PRINCIPALS REQUIREMENTS'.
2. ALL STAINLESS STEEL PIPE TO BE 316L STAINLESS
3. ALL MILD STEEL AND DUCTILE IRON BOLTED CONNECTIONS ARE TO BE WRAPPED USING FULL DENSO SYSTEM PRIMER, MASTIC FILL, PETROLEUM TAPE AND MPHD OUTER WRAP WHEN NOT CAST INTO CONCRETE.
4. PIPES TO BE CONNECTED TO A ROCKER PIPES TO TAKE ANGULAR DISPLACEMENTS OF AT LEAST 5 DEGREES.
5. BLANK FLANGES TO BE PROVIDED AT CONTRACTUAL LIMITS.
6. C-L = CONTRACTUAL LIMITS (TO BE CONFIRMED)
7. DESIGNER TO APPLY GALVANIC ACTION PREVENTION AT DISSIMILAR METAL INTERFACE.
8. INLET INVERT TO BE MINIMUM 100mm ABOVE TOP WATER LEVEL.
9. SIMPLE BELLMOUTH OR OVERFLOW SHOWN. DESIGNER TO CONSIDER WEIR TYPE OVERFLOW TO MINIMISE TANK HEIGHT.
10. DESIGNER TO CONSIDER REQUIREMENTS FOR THRUST BLOCKS.

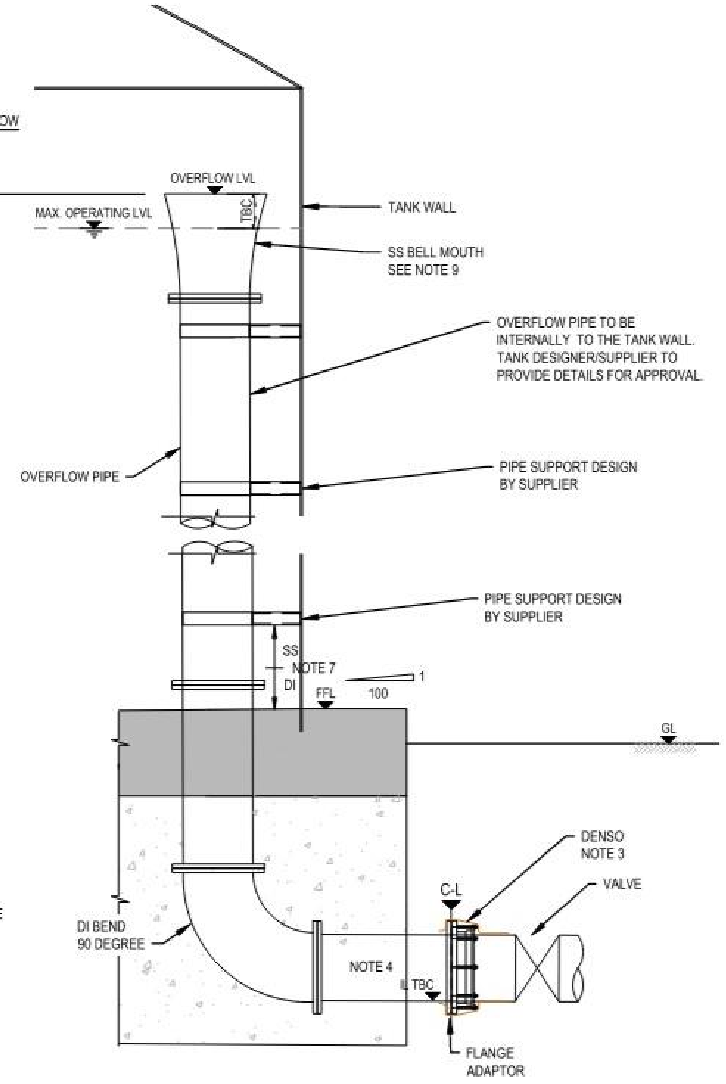


TYPICAL RESERVOIR OUTLET CONNECTION

SECTION A SK2
NOT TO SCALE

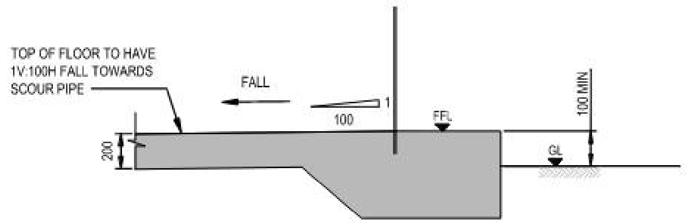


SECTION B SK2
NOT TO SCALE
RESERVOIR INLET CONNECTION

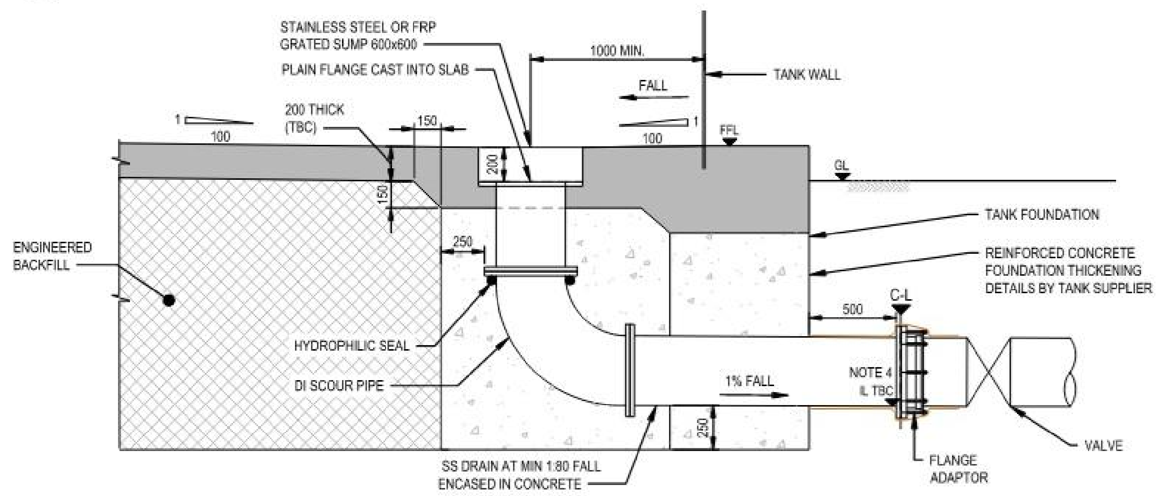


RESERVOIR DRAINAGE AND OVERFLOW (NOTE 4)

SECTION D SK2
NOT TO SCALE



TYPICAL FOUNDATION DETAIL
SCALE 1 : 20



SECTION C SK2
NOT TO SCALE
TYPICAL SCOUR PIPE OUTLET

NOTE:- ORIGINAL SIZE A1

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QUEENSTOWN LAKES DISTRICT COUNCIL

QLDC Wanaka Water Trunk Main
Engineering Design
Reservoir Pipework Detials

DESIGN	JS				2-0343.01	FOR APPROVAL
DRAWN	BS				DWG No.	
APRVD	JS					
PROJECT #: 2-0343		A	Initial design	23/08/2021	1:200 A3	A
		REV	DETAILS	DATE	SCALE	REVISION

APPENDIX B QLDC PREFERRED INSTRUMENTATION

Preferred instrumentation for the reservoir facility is as noted below:

Pressure Transducer	Endress and Hauser FMX21
Float Switch	Flygt ENM-10

APPENDIX C SEISMIC DESIGN MEMORANDUM

Memorandum

22 May 2019

To	QLDC		
Copy to			
From	Amy Williams	Tel	04 495 5833
Subject	Seismic Return Period Requirements - Water supply reservoir	Job no.	12506856//

1 Background

The following memo outlines the design philosophies used in determining design seismic loads for new freshwater reservoirs and how these are applied to QLDC.

The RFP documentation provided by QLDC outlines that the reservoirs are designed to Importance level 4 with a 100 yr design life.

The combination of a very high importance level and longer than 50 year design life puts the design seismic loading outside of the parameters typically set by the loading standard 1170.0 .

The following outlines the factors considered in determining the return period of design seismic loads. The combined effect of these factors can require a utility to be subject to a hazard analysis. The design recommendation are then considered in the context of other utilities throughout New Zealand and in the wider context of American Lifelines guidance.

2 Design Working Life

The concepts of "Design Working Life" used in determining loading and "Specified Intended Life" used when determining durability requirements. While they have separate meanings, both of these terms are often referred to as Design Life. AS/NZS 1170 outlines the design working life, in relation to determining design loads in commentary CL C3.3 below:

"The 'design working life' is a reference time period expressed in years. It is a concept used to select the probability of exceedance of different actions. This does not mean that when the design working life is reached the structure will fail; nor does it mean that the design working life has to correspond exactly with the intended useful life the designer has in mind or with the durability of the construction materials."

3 Importance Level

The importance level of a structure is related to the risk that its's loss of service poses to the community.

If the reservoir is the sole source serving an importance level 4 facility, such as fire services or emergency surgeries, the reservoir must also be treated as IL4.

GHD Limited
Level 2 Grant Thornton House 215 Lambton Quay Wellington 6011 PO Box 1746 Wellington 6140 New Zealand
T 64 4 495 5800 **F** 64 4 472 0833 **E** wgtnmail@ghd.com **W** www.ghd.com

Outside of this requirement, reservoirs typically fall between Importance level 3 (IL3) and importance level 4 (IL4). The distinction between the two levels can be effected by the levels of redundancy in the supply network or its requirement to provide service to post disaster services.

On this basis, the selection of IL4 as a design basis allows emergency services to rely on these facilities for post emergency functions.

4 Seismic Design Return Period

The importance level and design working life affect the magnitude of the seismic loading to be applied in the design (through the selection of Design Return Period).

Reprinted below is Table 4.1 from the NZS 1170. This table gives guidance on the appropriate return period to select based on the various design parameters, i.e. IL, design working life, and probability of exceedance.

QLDC has specified that all reservoirs be to be considered IL4 structures – appropriate for structures required for Post-Disaster functions. This requirement is set out in their RFP documents.

The importance level informs both the ultimate limit state (ULS) return period and the serviceability limit state (SLS) return period. For a standard 50 year design working life structure (Building Code), the required return periods for an IL4 structure will be 1/2500 and 1/500 respectively. However, because QLDC require the design life to be extended to 100 years, there is a need to review both the SLS and the ULS return periods.

Figure 1: Extract from AS/NZS1170

TABLE 3.3

ANNUAL PROBABILITY OF EXCEEDANCE

Design working life	Importance level	Annual probability of exceedance for ultimate limit states			Annual probability of exceedance for serviceability limit states	
		Wind	Snow	Earthquake	SLS1	SLS2 Importance level 4 only
Construction equipment, e.g., props, scaffolding, braces and similar	2	1/100	1/50	1/100	1/25	
Less than 6 months	1	1/25	1/25	1/25	—	
	2	1/100	1/50	1/100	1/25	
	3	1/250	1/100	1/250	1/25	
	4	1/1000	1/250	1/1000	1/25	
5 years	1	1/25	1/25	1/25	—	—
	2	1/250	1/50	1/250	1/25	—
	3	1/500	1/100	1/500	1/25	—
	4	1/1000	1/250	1/1000	1/25	1/250
25 years	1	1/50	1/25	1/50	—	—
	2	1/250	1/50	1/250	1/25	—
	3	1/500	1/100	1/500	1/25	—
	4	1/1000	1/250	1/1000	1/25	1/250
50 years	1	1/100	1/50	1/100	—	—
	2	1/500	1/150	1/500	1/25	—
	3	1/1000	1/250	1/1000	1/25	—
	4	1/2500	1/500	1/2500	1/25	1/500
100 years or more	1	1/250	1/150	1/250	—	—
	2	1/1000	1/250	1/1000	1/25	—
	3	1/2500	1/500	1/2500	1/25	—
	4	*	*	*	1/25	*

* For importance level 4 structures with a design working life of 100 years or more, the design events are determined by a hazard analysis but need to have probabilities less than or equal to those for importance level 3.

Design events for importance level 5 structures should be determined on a case by case basis.

QLDC'c requirement for water reservoirs (IL4 structures) is that at ULS the structure is to be designed for a 1/2500 year return period earthquake and that at SLS2 the structure is to be designed for a 1/500 year event. This requirement is appropriate for structures that must function following a major event where they must provide the necessities of life. The loading code requires hazard analysis for such structures, when the design working life is extended beyond 50 years, but notes that loadings must not be less than for IL3 structures with a 100 year design life.

5 Hazard Analysis

A hazard analysis is required for the combination of IL4 and 100 year Design working life in order to determine the seismic loading. This type of analysis is highly specialised and typically only delivered by GNS. Preliminary discussions with GNS indicate that these studies can take month with a cost of 50-70K per site. Current indications are that they do not have the capacity to commence any new studies until August 2019.

6 Context of return periods

GHD have looked at the design decisions in the context of the decisions made in the design of similar facilities

6.1 New Zealand Context – return periods

We have found the combination of IL4 and 50 Year Design Working life to be adopted in the following situations:

Wellington Water Limited – New Reservoir Design

Wairoa District Council – Wairoa Reservoir

WaterCare Auckland – design of new Hunua pipe lines & supply reservoirs

QLDC – Glenorchy Reservoir

6.2 International Context – return periods

Further to this, the 1/2500 return period for ultimate limit state design is in line with the American Life lines guidance documents.

7 Required Clarification

We propose to design the reservoirs to seismic loads based on the following criteria:

Table 1: Seismic Loading Cases for IL4 Structures

Load Case	Performance Requirement	Annual Exceedance Probability (AEP)
Serviceability Limit State 2 (SLS2)	No loss of service (operational continuity). Repairable damage. Interpreted: No loss of water-tightness / tolerable water ingress permitted.	1/1000
Ultimate Limit State (ULS)	No loss of life, no collapse. Damage may be uneconomic to repair. May lose water-tightness.	1/2500
Maximum Considered Earthquake (MCE)	No collapse. Damage likely to be uneconomic to repair.	N/A

The return periods above are based on and IL4 structure with a 50 year Design Working Life. As outlined previously, this approach is in line with the return periods used in other parts of New Zealand and also agrees with the American Life lines guidance documents.

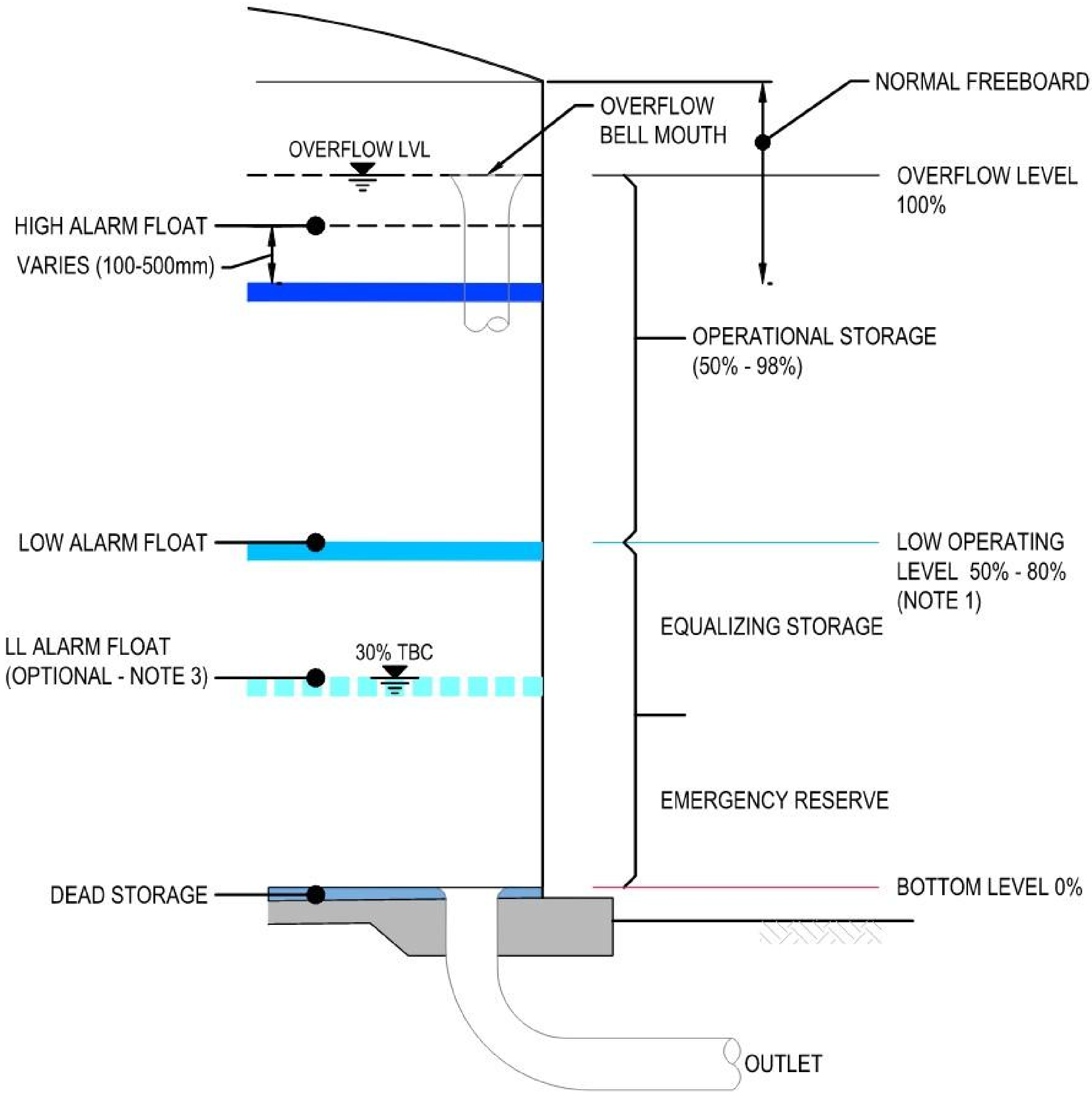
The alternative, is to instigate a 100 year Design Working Life, and commission site specific seismic hazard study. This will have significant impacts on both the programme and budget of this project.

Please advise if QLDC agree with the recommendation to adopt the return periods in Table 1.

Regards

Amy Williams
Structural Team Leader

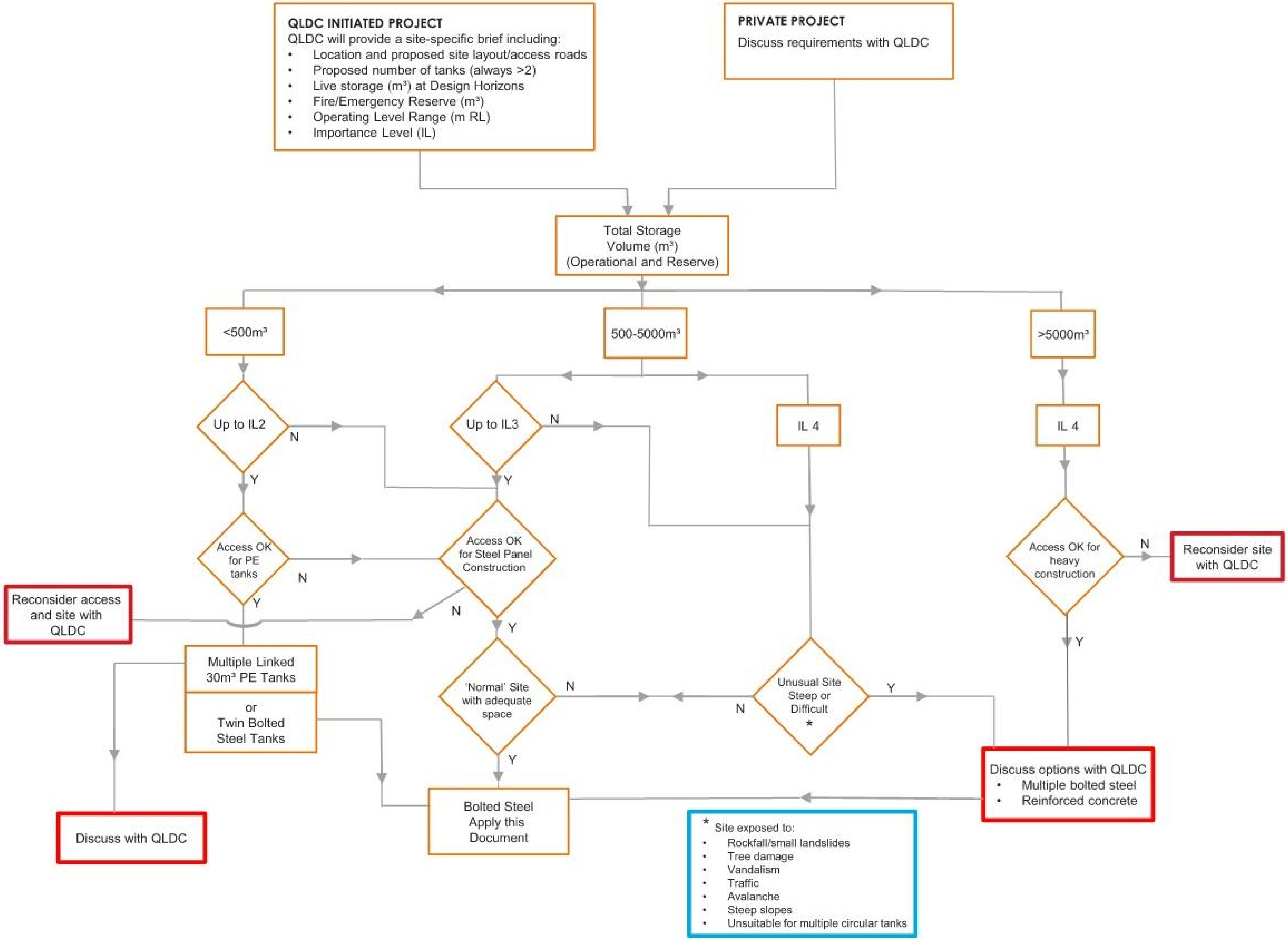
APPENDIX D RESERVOIR LEVELS



NOTES

1. LOW OPERATING LEVEL IN A RANGE FROM 50% TO 80% DEPENDING ON LOCATION / OTHER TANKS / REMOTENESS / SEASON.
2. SCADA ANALOGUE FROM HYDROSTATIC-PRESSURE LEVEL TRANSDUCER. TO BE MOUNTED WITH GUIDE/ OR STILLING WELL.
3. LL ALARM DESIRABLE - POSITION DEPENDS ON SAME CRITERIA AS NOTE 1 ABOVE.
4. OPERATING LEVELS CAN CHANGE SEASONALLY.

APPENDIX E TANK FLOW CHART


QLDC INITIATED PROJECT
QLDC will provide a site-specific brief including:
• Location and proposed site layout/access roads
• Proposed number of tanks (always >2)
• Live storage (m³) at Design Horizons
• Fire/Emergency Reserve (m³)
• Operating Level Range (m RL)
• Importance Level (IL)
PRIVATE PROJECT
Discuss requirements with QLDC
Total Storage Volume (m³) (Operational and Reserve)
<500m³
500-5000m³
>5000m³
Up to IL2
N
Y
Up to IL3
N
Y
IL 4
IL 4
Access OK for PE tanks
N
Y
Access OK for Steel Panel Construction
N
Y
Access OK for heavy construction
N
Y
Reconsider site with QLDC
Reconsider access and site with QLDC
Multiple Linked 30m³ PE Tanks
or
Twin Bolted Steel Tanks
'Normal' Site with adequate space
N
Y
Unusual Site Steep or Difficult *
N
Y
Discuss options with QLDC
• Multiple bolted steel
• Reinforced concrete
Discuss with QLDC
Bolted Steel Apply this Document
* Site exposed to:
• Rockfall/small landslides
• Tree damage
• Vandalism
• Traffic
• Avalanche
• Steep slopes
• Unsuitable for multiple circular tanks