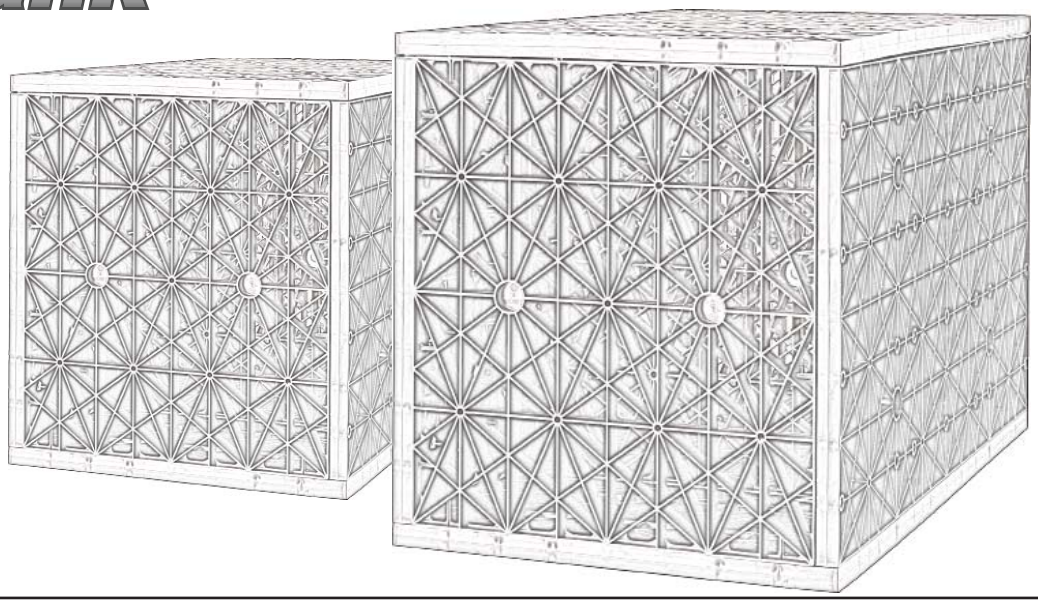
MODULAR UNDERGROUND WATER TANKS

Flo-Tank®



TECHNICAL SPECIFICATION - **2015**

Australia

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1. GENERAL

1.1 Scope

This Specification provides directions for the structural design and installation of Atlantis underground storm water run-off systems – inclusive of infiltration systems, harvesting and On-Site Detention (OSD) tanks. The system collects, stores and releases run-off at a reduced flow rate – through a flow control device – into an appropriate outfall and/or allows for infiltration of water into the ground. Construction must be carried out in accordance with the requirements of the relevant Statutory Authority.

The installation of the Atlantis system must be carefully planned and coordinated with concurrent work on the project such as; grading, excavation works, utilities installation, construction of access roads, site compaction and erosion management. The following documents must be submitted to the engineer: a geotechnical design report and all relevant design information; plans, sections and elevations, site photos and hydrological/hydraulic studies

1.2 References

This specification is defined in accordance with Australian Standards and Codes, supplemented by various relevant international standards.

Australian Standards and Codes:

Code	Standards Name
AS 4678	Earth-Retaining Structures
AS/NZS 2566.1	Buried Flexible Pipeline – Structural Design
AS/NZS 1170	Structural Design Actions
AS/NZS 3500	Plumbing and Drainage
AS 5100	Bridge Design
AS 3704	Geosynthetics
AS 3705	Geotextiles – Identification, marking and general data
AS 1289	Methods of testing soils for engineering purposes
AS 1141	Methods for sampling and testing aggregates
AUSTROADS	Bridge Design Code (1992)
AUSTROADS	Guide to pavement technology (2010)
Safe Work Australia, NSW	Excavation Work Code of Practice (2014)
Road and Maritime Services, NSW	QA Specification 3051.

International Standards:

Code	Standard Name
BS EN 1997-2004	Eurocode 7: Geotechnical design
BS 8002:1994	Code of Practice for Earth Retaining Structures
AASHTO	LRFD Bridge Design Specifications (2012)
ASTM E519/E519M – 10	Standard Test Method for Diagonal Tension (Shear) in Masonry Assemblages

International Guidelines:

Code	Standard Name
CIRIA C680	Structural Design of Modular Drainage Tanks
CIRIA C609	Sustainable Drainage Systems

1.3 Modular Tanks

The Atlantis single tank module consists of the following measurements:

- (W) 408mm x (H) 450mm x (L) 685 mm.
- 95% voids (small variations depend on internal plate configuration).

This single tank can be expanded to variable heights by stacking and vertically connecting each module (customized for each project).

The tank modules consist of a fractal design and internal plate configurations that can be adjusted to meet specified loads requirements. The assembled tank modules must evenly distribute loads from all angles in a 360 degree range. The design features of the parts must incorporate a fractal shape of structural ribbing supports with angles including 30, 60, 90 and 180 degrees. The module must dissipate the loadings in an even manner to ensure that creep calculations for the design life are consistent for the design of the module under all angular loadings.

Refer to Flo-Tank Technical Package and CAD drawings for further details.

1.4 Materials

Material shall be plastic with composition of 85% recycled polypropylene and 15% Atlantis proprietary selected materials.

2. QUALITY ASSURANCE

2.1 Tests Performed

Requirement

Atlantis carries out a batch-testing regime to ensure the products delivered to the marketplace meet our technical specifications.

Program

A copy of the Atlantis quality assurance batch-test can be provided to the engineer as required.

Description:

Provide an Atlantis certificate to demonstrate that the product complies with Atlantis quality management system, with specific reference to the following:

- Material properties of moulded products
- Measurement of dimensions
- Assembly calibration checks for components
- Measurement of mass of unit
- Visual inspection for defects
- Drop test
- Short-term compression tests
- Impact test/falling weight

2.2 Independent Test Certificates

Compression, lateral, shear strength and flow capacity tests have been conducted at various independent universities and laboratories. Testing is done frequently and is continuously updated. Certificates can be sent upon request.

2.3 Delivery, Storage and Handling

Tank plates/assembled modules must be protected from damage during delivery and stored under a tarp for sunlight protection if the time from delivery to installation exceeds one week.

3. STRUCTURAL DESIGN

3.1 Ultimate Limit State

Permanent (Dead) Loads

Permanent loads must be determined using AS 4678.
The relevant sections are as follows:

- Section 4: Design Loads
  - 4.1: determines the vertical load as specified in AS1170.1
- Section 5: Material Design Factors
  - 5.2: determine the partial design factors (Table 5.1(A) & Table 5.2(B))

Imposed (Live) Loads

Traffic loading must be determined according to AS/NZS 2566.1. The relevant sections are as follows:

- Section 4.7: Design Loads – Superimposed Live Loads.
  - 4.72 – to determine live loads caused due to road vehicles (Equation 4.7.2(1) and 4.7.2(2), with reference to Figure 4.2).
  - Unless otherwise specified by the regulatory authority, road vehicle loads shall be taken as given in AS 5100 and AUSTROADS Bridge Design Code and Guide to pavement technology.
  - Guidelines to obtain vehicle data may be found in CIRIA C680.

According to AS1170.1 the minimum recommended value for imposed loads is a surcharge of 5kPa.

Load Combination for Permanent and Imposed Loads

Load Combinations must be determined using partial safety factors according to AS 4678 and AS1170.0, which classify different limit states based on stability and strength.

Lateral Loads

Lateral Loads must be determined according to AS 4678 . The partial design factors method is suggested, and the partial design factors are determined using Tables 5.1(1) and 5.1(B) in Section 5.2 for drained and undrained soils respectively. Lateral loads from nearby hills must be reviewed according to AS 4678-2002 and CIRIA C680.

Uplift Loads

According to AS 4678, hydrostatic pressures causing uplift on the base of retaining structures should be included in design calculations, unless positive means are adopted to ensure that they do not develop. Uplift is determined in accordance to BS EN 1997-1:2004 and CIRIA C680 - Section 4.5. During the geotechnical checks, if the site is near a body of water or coastline, it must also be checked if there is a tidal water table and/or seasonal water table.

Diagonal Loads

A combination of lateral and vertical loads is used to determine the diagonal force applied at the corners of the tanks. A finite element analysis may be used to determine the diagonal load applied along the side corner of the tank.

3.2 Serviceability Limit State

Refer to loads and steps stated in section 3.1. Partial safety factors used for the Serviceability Limit State are according to AS 4678, AS 1170, BS EN 1997-1:2004 and CIRIA C680.

3.3 Considering Creep Reduction

AS 4678 is used to determine the creep reduction factor.

The creep reduction factor is normally applied to compressive strength. According to CIRIA C680, creep due to lateral loads is not likely to be a significant issue for tanks up to 1.6m height and those located at a depth lower than 4m.

4. INSTALLATION

Installation must be performed only by skilled and competent contractors with a satisfactory record of performance and quality on underground installations. Contractors must adhere to the Atlantis installation guidelines and engineering specifications. If the plans or drawings conflict with our installation guide, please notify the authorised engineer.

The geotechnical evaluation of the site to determine ground conditions must be accounted for; this would include seasonal, telluric conditions and soils that are prone to liquefaction. When considering the use of the Atlantis System in contaminated ground the authorized engineer must ensure substances that can cause deterioration of plastics are not present at excessive concentration levels

Installation may only proceed upon approval from the authorised engineer on existing ground conditions and engineer assurance of satisfactory performance. If existing conditions are found unsatisfactory, the authorised engineer must be contacted for further advice.

4.1 Minimum Setback – Distance from Existing Structures

Prior to excavating, soil types must be checked to determine the minimum distance of the excavation from existing structures. Table 1 below is according to Engineers Australia (2003-2006). An authorised engineer must check the required distance for which any excavation of poles, or any similar structure above or below ground must be kept. For safety guidelines, refer to Excavation Work Code of Practice (2014), Safe Work Australia. Underground storage tanks should be located externally to all buildings and structures.

The design of landscaping should be undertaken at the same time as the design of the tank so that the impact of tree roots or as-built overburden can be considered. Trees should not be located closer than the canopy width at mature height from the tank. Trees should not be planted directly over a tank or in such a position where maintenance work would require the removal of the tree.

Table 1: Minimum recommended setback (Engineers Australia)

Soil Type	*Typical Hydraulic Conductivity (cm/s)*	*Typical Hydraulic Conductivity (mm/hr)*	*Modification Factor (U)*	*Minimum Setback Distances from structures and boundaries (m)*
Sand	5.00E-03	180	0.5	1.0
Sandy Clay	1.00E-03 – 5.00E-03	36 – 180	1.0	2.0
Weathered or Fractured Rock	1.00E-04 – 1.00E-03	3.6 – 36	-	2.0
Medium Clay	1.00E-04 – 1.00E-03	3.6 – 36	2.0	4.0
Heavy Clay	1.00E-06 – 1.00E-04	0.036 – 3.6	2.0	5.0

4.2 Minimum Cover

Refer to Flo-Tank Technical Package for further details.

Minimum cover / top backfill must be determined according to AS 2566.1 and AS 3500.3. Table 2 shows the minimum recommended cover for Atlantis tanks, as according to the Australian Standards.

Table 2: Minimum recommended cover for Atlantis Tanks (AS2566.1 and AS3500.3)

Location	*Minimum recommended cover* (m)*
Not subject to vehicular loading (excluding fire services)	0.30
Fire services not subject to vehicular loading	0.60
Subject to vehicular loading -	
• not in roadways	0.45
• in sealed roadways	0.60
• under unsealed roadways	0.75
In embankment conditions or subject to construction equipment loading	0.75

* Subject to variation by the regulatory authority.

Heavy Trucks Loading

Based on AS 2566.1, a minimum top cover of 1m is recommended when there is presence of extra Heavy Trucks Loading. An authorised engineer must check design loads to ensure that strength and stability requirements are met.

Landscape

The minimum cover to the tank modules shall be as detailed below, unless the structural design check indicates that a greater depth of cover is required:

- Landscaped areas: We recommend a minimum between 300-500mm for top backfill.

4.3 Maximum Installation Depth and Cover

Refer to Flo-Tank Technical Package for further details.

A maximum top cover of 1600 mm is recommended. The authorised engineer must check design loads to ensure that strength and stability requirements are met.

If a greater installation depth is required, the overall stability and strength of the tank shall be assessed by a suitably qualified geotechnical engineer along with possible lateral load thrust relief solutions to allow modular units to withstand these loads at greater depths.

Installations in Cold Climatic Conditions

The tank should be installed below the frost line (depth to which the groundwater in soil is expected to freeze).

Detain and release systems should ensure the tank is kept at a reasonable temperature using insulation layers or adequate depth.

4.4 Site Grading

To minimise erosion and maintain sediment control, according to AS3500.3, surface grading of sites and the direction of stormwater flow paths through construction sites is necessary, including limits on slopes and lengthening of flow paths using barriers.

4.5 Foundation – Base Preparation

Materials used as founding material must comply with AS 1289, AS 1141 and RMS QA specification 3051.

The base construction must have sufficient strength to withstand the maximum bearing load likely to be applied, even in the wettest of conditions. Consideration should be given to the inherent drainage characteristics of the site.

The ground foundation must achieve a minimum CBR of 3-5% in accordance with AS 1289.6.1.1 unless noted otherwise by the authorised engineer. The base of the excavation shall have a sand or gravel sub-grade layer. The depth and compaction of the sand will be determined based on the bearing capacity and exsettlements, which must be approved by either the authorised engineer, or a qualified geotechnical engineer. Compaction should be at 95-98% Standard Proctor.

4.6 Excavation

Suitability of the base must be ensured prior to excavation. Excavation shall be in accordance with AS 4678 and Excavation Work Code of Practice (2014), Safe Work Australia, or as directed by the authorised Engineer. The excavation for Atlantis tank modules consist of the following parameters:

- Excavation Depth = Base Fill + Tank Height + Specified Backfill Height
- Excavation Area = Tank Footprint + Minimum Side Backfill

4.7 Backfill

Refer to Flo-Tank Technical Package for further details.

Backfill Thicknesses

Top backfill is as the minimum cover determined in Section 4.2. The minimum recommended base and side fill are as shown on Table 3 below. In regards to base fill, a suitably qualified engineer must check for sufficient structural support. Refer also to section 4.5.

For installations in reactive soils or clay a minimum of 500mm side backfill is recommended.

Table 3: Minimum recommended side and base backfill requirements

Fill	*Pedestrian Traffic*	*Vehicle Traffic*
Base Fill	100mm	100mm
Side backfill	200mm – 500mm	200mm – 500mm

Backfilling Material and Process

Materials must comply with AS 1289, AS 1141 and RMS QA specification 3051. Backfilling must be placed in such a manner so as to avoid uneven loading or damage. Spread material using a lightweight powered mechanical compactor or roller (if a large scale project, use a Posi Track). After having placed and compacted the first 300mm of backfill, the remaining top backfill added must be placed and compacted in 150mm lifts. Compaction should be at 95-98% Standard Proctor.

The filter material is determined according to AS/NZS 3500.3 – in which Section 2.13 states that the material used must be:

- Coarse washed sand with less than 5% fines passing 75micron sieve.
- Aggregate of angular material up to 19mm (3/4").

4.8 Geotextile

Refer to AS 3704-2005 and AS 3705-2012. For all applications the geotextile should be hydrophilic, so as to allow the absorption of water. It should be noted that geotextiles that are hydrophobic repel water due to the molecular structure and are not suitable for use with Atlantis products. Enough overlap must be available to fold over the top of the tank (300-500mm recommended).

The recommended geotextile for use with Atlantis products are the following:

- Infiltration: 125g/m2 (4 oz/yd2) of hydrophilic nonwoven needle-punched material
- Onsite Detention Tank: 250 g/m2 (8 oz/ yd2)

The authorised engineer must ensure the suitability for individual cases and determine if other select liners may be used.

4.9 Impermeable Liner

Liner is not required for infiltration tanks. The recommended geo-membrane is as follows:

- 0.75mm (0.03") HDPE (Suitable for welding)
- 1mm (0.04") HDPP (Suitable for welding)

The authorized engineer must ensure the suitability for individual cases.

4.10 Infiltration Systems Considerations

Infiltration systems receive stormwater and allow it to soak safely into the ground. Stormwater disposal systems are recommended to be at least 1m above impervious layers or groundwater levels in order to prevent groundwater pollution.

4.11 Piping

Refer to Flo-Tank Technical Package for further details.

Inlet and Outlet

Refer to AS/NZS 3500. A Pre-Filtration system is required to ensure that the system is free of gross pollutants, silts, litter, grit, sediments, oils and associated aromatic chemicals that can cause deterioration of the system. The following chemicals: Polyaromatic Hydrocarbons (PAH), Benzene and derivatives, Acenaphthene Benzo-perylene, Carbon, Tetrachloride, Heptane, Kerosene Mineral Oil (White), Nitric Acid, Sulphuric Acid and Toluene chemicals are not recommended for polypropylene.

For bed and haunch zones granular material graded to AS 1141 should be provided. Non-corrosive hose clamp or tape is to be used to fasten fabric to pipes to prevent backfill from entering structure. Maximum recommended pipes diameter is 225mm. Greater pipes must not penetrate the structure.

Overflow

In regard to overflow, refer to AS NZS 3500.1:2003 – Section 8.

Types of pipes and Fittings

The recommended pipes and the corresponding Australian Standards are as follows:

Table 4: Recommended pipes and fittings to be used in the design

Pipe/Fitting	*Corresponding Australian Standard*
Glass-reinforced polyester (GRP)	AS 3571.1.
Polyvinyl chloride (PVC)	AS/NZS 1254, AS/NZS 1260 or AS 1273, as appropriate
Polyethylene (PE)	AS/NZS 4129, AS/NZS 4130 or AS/NZS 2033, as appropriate
Plastic pipe for subsoil drainage	AS 2439.1
Rubber ring joints/elastomeric seals	AS 1646

5. MAINTENANCE

Maintenance and use shall be in accordance with local standards and the regulatory authority. Refer to AS/NZS 3500.

Regular inspection and maintenance is required to ensure the effective long-term operation of below ground modular storage systems. Tanks must be installed with a suitable pre-treatment system (see Section 4.11) and therefore, most maintenance efforts should be primarily directed at the pre-treatment structure. The Atlantis tank systems are designed to be free of sedimentes, debris and contaminants.

Maintenance plans and schedules must be developed during the design phase by the authorized engineer. Specific maintenance needs of the system must be identified and maintenance schedules adjusted and approved by the authorized engineer to suit requirements. Atlantis recommends that maintenance operations of pre-filtration systems take place monthly, yearly and after storm events (please refer to Flo-Tank Technical Package) upon approval of the authorized Engineer.

5.1 Inspection / Vent / Flushing Ports

Refer to Flo-Tank Technical Package for further details.

Typically made from PVC pipes, these ports provide ventilation and vertical access for visual inspection, vacuuming and/or flushing. They allow access for remote CCTV, jetting equipment and gauges to measure the depth of the stored water.

Ports should be long enough to sit on the bottom of the Tank System, rising to the finished surface where they are capped. These pipes should be perforated into the tank structure, normally at the bottom.

Vent Ports

Adequate venting must be provided to the structure, as according to AS/NZS 3500. Atlantis tanks must be vented to prevent a vacuum from forming in the tank. Typically these are 100mm-150mm diameter pipes capped with a PVC tank breather vent cap and/or slotted cover. Vent ports may be connected as a perforated pipe through the stone.

Spacing: A minimum of one vent port should be provided for every 7500m2 of impermeable catchment area to be drained to the tank. Ports should be at least 10m apart.

Inpsection Ports

Typically these are 100mm-150mm diameter pipes.

Spacing: Inspection ports are recommended within the first 1.5m of an inlet pipe (not required when there is a catch basin/pit) and 10m-15m spacing throughout the system.

Inpsection / Flushing Ports (Optional)

Flushing should be performed when sediment reaches a pre-determined depth or when storage volume is reduced to an unacceptable level. The diameter of the port is determined by a number of factors including the rate at which water will be pumped into the system, the number of flushing ports incorporated and the possible requirement of vacuuming through the port.

Spacing: These ports for general maintenance are recommended within the first 3m-4.5m of an inlet pipe or catch basin/pit and 10m-15m spacing throughout the system.

5. INSTALLATION PROCEDURE

The steps below summarise the recommended installation procedure for Atlantis tanks:

1. Ensure a temporary perimeter fence is erected before excavation.
2. Excavate according to the required depth and area alloted. Check for presence of soft soils and high groundwater table.
3. Prepare the base/foundation, including surface grading if required.
4. (Not for infiltration tanks) Lay the impermeable plastic liner along the base and up the walls.
5. Place geotextile to wrap the tank. 300-500mm of geotextile is recommended to be available on the ends to wrap over the tank system.
6. Install the tank modules.
7. Install venting, inspection and/or maintenance ports.
8. Wrap tank in geotextile. There should be a minimum of 300-500mm overlap at the joints and seams.
9. (Not for infiltration tanks) Seal system with liner overlapping edges by 1m and install pipe boots.
10. Put utility tape on all corners for determining sub-surface location in the future.
11. Connect inlet/outlet/overflow pipes. Use non-corrosive hose clamp or tape to fasten fabric to the pipes to prevent backfill from entering structure.
12. Backfill sides compacting in 150mm lifts.
13. Backfill top compacting in 150mm lifts. If specified by the Design Engineer, place geogrid.
14. Perform final cleaning of the site.
15. Place required surface materials such as ground covers, shrubs or paving materials.
16. Do not take down perimeter fencing (restricts heavy traffic above the tank system) until construction of the site is complete.
17. When necessary install permanent signs that display maximum loads allowable over the tank.