Bioretention System Specification

1. Referenced documents.
   The following documents are incorporated into this specification by reference:
   1.1. Standards
      1.1.1. AS 1289 - Methods of Testing Soils for Engineering Purposes
      1.1.2. AS 1289.5.4.1-2007- Soil Compaction and Density Tests--Compaction Control Test--Dry Density Ratio, Moisture Variation and Moisture Ratio
      1.1.3. AS 1289.5.7.1-2006 - Soil Compaction and Density Tests--Compaction Control Test--Hilf Density Ratio and Hilf Moisture Variation (rapid method)
      1.1.4. AS 2758 - Aggregates and Rock for Engineering Purposes
      1.1.5. AS 4419 - Soils for Landscaping and Garden Use
      1.1.6. 1.1.6 AS 4454 - Composts, Soil Conditioners and Mulches
   1.2. Other publications
      1.2.1. Guidelines for Soil Filter Media in Bioretention Systems (FAWB) - the current version of the guideline can be found at http://www.monash.edu.au/FAWB/
      1.2.2. Construction and Establishment Guidelines - Swales, Bioretention systems and Wetlands (Water by Design) http://waterbydesign.com.au/ceguide/
      1.2.3. Transferring Ownership of Vegetated Stormwater Assets (Water by Design) http://waterbydesign.com.au/transferguide/
      1.2.4. Transferring Ownership of Vegetated Stormwater Assets (Water by Design) http://waterbydesign.com.au/transferguide/
      1.2.5. Bioretention Technical Design Guidelines (Water by Design) http://waterbydesign.com.au/techguide/
      1.2.6. Water Sensitive Urban Design Field Guide (Water by Design)
2. Abbreviations and definitions
   2.1. The bioretention system specification consists of the following abbreviations and definitions:
   2.2. Filter: soil layer which acts as a pollutant filter and supports plant growth.
   2.3. Impermeable liners: the liner that prevents water movement between the filter and the surrounding soils and defines the edge of the system.
   2.4. Transition layer: layer to separate filter layer from the drainage layer to avoid migration of soils from the filter to the drainage layer
   2.5. Drainage layer: relatively free draining layer to convey infiltrated water to the underdrainage.
   2.6. Under-drains: slotted drains collect treated stormwater from the drainage layer at the base of the bioretention system.
3. Test methods and standards
   3.1. The following test methods and standards are to be used as specified in the above guidelines when conducting tests associated with this specification:
   3.2. The hydraulic conductivity of potential filter media shall be measured using the ASTM F1815-11 method
   3.3. Particle size distribution: AS1289.3.6.1 - 1995
   3.4. Soils for landscaping and garden use: AS4419 - 2003.
4. Materials
   4.1. Materials shall meet the required specifications detailed in *Section 8 Filter media, Section 9 Transition layer, Section 10 Drainage layer, Section 11 Under drainage, Section 12 Permeable liner, Section 13 Impermeable liner and Section 14 Landscaping* of this document.
   4.2. All materials must be certified by the supplier with certification and delivery supply dockets shall be provided on request to certify the material delivered is the material tested.
5. Timing and erosion and sediment control
   5.1. The timing of civil and landscape works for bioretention systems must be carefully planned to ensure that both the bioretention system and the downstream waterways, are not impacted by stormwater and sediment (e.g. through best practice erosion and sediment control). In particular, the drainage layer, transition layer and filter media must not be placed until the risk of high sediment loading from upstream construction activities has been mitigated. The construction sequence must be approved by the superintendent.
   5.2. Erosion and sediment control during construction must be delivered in accordance with all legislative requirements including, where required, the preparation of site-specific ESC plan/s in accordance with current Best Practice Erosion and Sediment Control (e.g. IECA 2008, or later version).
6. Earthworks and hydraulic structures
   6.1. The construction of hydraulic structures must ensure the design levels are achieved. Bunds/ embankments surrounding the system shall be at correct levels. The below table summarises the construction tolerances for each element of a typical bioretention system.
   6.2. Bioretention systems tolerances

Bioretention element	Tolerance (unless specified otherwise)
Hydraulic structures	+ /- 25 mm (+/- 15 mm for streetscape systems)
Earthworks	+ /-50 mm
Under-drainage	+/- 25 mm
Drainage and transition layers	+ 25 mm
Surface level	+/- 25 mm +/- 40 mm for filter media >300 m² provided the average extended detention requirement is within 25 mm of the design requirement.
Embankments and bunds	-25 mm, + 50 mm

7. Maintenance access.
   Maintenance access is provided in accordance with the design drawings.

8. Filter media
   8.1. Materials
   A fundamental part of bioretention systems is the filter media. The main role of the filter media is to support vegetation and remove pollutants. Filter media should be loamy sand that has high permeability when compacted. It should not contain any rubbish or deleterious material. The loamy sand should contain some organic matter to improve water-holding capacity and plant health, but it should be low in nutrient content. The filter media must be compliant with AS4419 - Soils for Landscaping and Garden Use, and meet the following requirements:

Parameter	Test method in accordance with	Requirement
Saturated hydraulic conductivity	ASTM f1815-11	50 - 500 mm/hr (200 preferred)
pH	AS 4419	5.5 - 7.5
Electrical conductivity	AS 4419	<1.2 dS/m
Nitrogen content	AS 4419	<800 mg/kg
Phosphorus content	AS 4419	<40 mg/kg
Organic content	AS 4419	3% - 10%. Where organic content is below this threshold, the filter media may be ameliorated by adding 50 mm of compost and tining it into the top 150 mm of filter media.
Particle size distribution	AS 1289.3.6.1 - 1995	Clay & silt 3 - 6% (<0.05 mm) Very fine sand 5 - 30% (0.05 - 0.15 mm) Fine sand 10- 30% (0.15 - 0.25 mm) Medium to coarse sand 40- 60% (0.25 - 1.0 mm) Coarse sand 7 - 10% (1.0 - 2.0 mm) Fine gravel <3% (2.0 - 3.4%)

Source: Guidelines for Soil Filter Media in Bioretention Systems (FAWB) and Bioretention Technical Design Guidelines (Water by Design)

Filter media must be free of weeds and propagates. Other characteristics of the filter media required for plant growth should be confirmed with a soil analysis or confirmed with a horticulturist/landscape architect.

   8.2. Testing frequency
   Suitable filter media can be delivered to site or imported sand can be ameliorated to meet the above specification. In either case, the media shall be tested against the above parameters at one sample per 500 m3 of filter media. For soil supplied to site, testing must be undertaken on the actual material to be delivered to the bioretention system. The supplier and contractor will be responsible for ensuring the filter media meets the specification and the correct material is delivered to site prior to installation.
   8.3. Installation and compaction
   When installing, the following specifications shall be applied:
      8.3.1. Filter media shall be installed and compacted in two lifts for depths of over 500 mm. Compaction shall be light and even across the surface.
      8.3.2. The top surface of the drainage layer, transition layer and the filter media layer shall be level and free from localised depressions to ensure even distribution of stormwater flows across the surface and prevent localised ponding.
      8.3.3. Filter fabric must not be used between drainage layer, transition layer and the filter media layers or wrapped around the under-drainage

9. Transition layer
   9.1. Transition layers prevent filter media migrating into the drainage layer.
      9.1.1. Materials
         9.1.1.1. Transition layer shall be minimum thickness of 100 mm coarse sand unless otherwise specified (typically 1mm particle size diameter) with <2% fines.
         9.1.1.2. A particle size distribution for the sand shall be obtained to ensure that it meets the following criteria (VicRoads).
         9.1.1.3. D15 (transition layer) ≤ 5 x D85 (filter media)
   9.2. Testing
   A sample of the proposed transition layer is to be provided to the superintendent for approval prior to installation. The superintendent may require the transition layer to be tested to ensure its particle size.

10. Drainage layer
Drainage layers convey infiltrated water into the slotted under-drainage pipes.
   10.1. Materials
      10.1.1. Drainage layer shall be comprised of fine gravel (nominal 2-5 mm) with <2% fines and a minimum saturated hydraulic conductivity of 400 mm/hr. The depth of the drainage layer shall ensure at least 50 mm of aggregate cover over all perforated under-drainage pipes.
      10.1.2. A particle size distribution for the gravel shall be obtained to ensure that it meets the following bridging criteria (VicRoads): D15 (drainage layer) ≤ 5 x D85 (transition layer)
   10.2. Testing
   A sample of the proposed drainage layer is to be provided to the superintendent for approval prior to installation. The superintendent may require the drainage layer to be tested to ensure its particle size.

11. Under-drainage
   11.1. Materials
   Either slotted rigid pipe (HDPE or similar) or ag-pipe can be used for under-drainage as specified in the construction drawings. When installing, the following specifications shall be considered:
      11.1.1. Typically 100 mm-slotted HDPE pipe is the preferred type of rigid pipe.
      11.1.2. The slots in the pipe shall not allow the drainage layer aggregate to freely enter the pipe (under-drainage with slot width of 2 mm or smaller is preferred).
   11.1.3 Under-drainage pipes must not be surrounded by any geofabric or sock.
   11.2. Installation
      11.2.1. The maximum spacing of under-drains for bio-retention systems <100 m2 is 1.5 m from centre to centre. For bioretention systems >100 m2 the maximum spacing can be increased to 2.0 - 2.5 m if specified in the construction drawings.
      11.2.2. The under-drains shall be sloped towards the outlet pit (min. 0.5% longitudinal grade) and the base of filtration trench shall be free from localised depressions. For bioretention systems with a saturated zone a 0% pipe grade is acceptable.
      11.2.3. All junctions and connections shall be appropriately sealed.
      11.2.4. Under-drainage pipes shall be sealed into the overflow pit.
      11.2.5. All under drainage pipes to have raised clean out points constructed from non-slotted pipes which extend to 150 mm above filter media surface

12. Permeable liner (where specified)
   12.1. A permeable geotextile liner fabric must be used to line the outside of the bioretention system.
   12.2. The liner must extend at least 500 mm beyond the top of the sides and must be keyed into batter and covered by at least 200 mm of topsoil.
   12.3. The liner must be resistant to all soil acids and alkalis, resistant to microorganisms and comply with the requirements of AS3706.12 and AS3706.13.

13. Impermeable liner (where specified)
   13.1. Materials
   Liner options include clay, geosynthetic bentonite clay liners or high-density poly ethylene (HDPE) liners. Refer to the project drawings for liner details.
   13.2. Installation
   Installation must be in accordance with manufacturers specifications and design drawings and achieve the following:
      13.2.1. The liners shall be keyed into the batters and to the embankments.
      13.2.2. Liners must be sealed around protrusions such as outlet pipes.
   13.2.3 Must achieve a maximum permeability of $1x10^{-9}$m/s

14. Landscaping
   14.0. Refer to landscape design drawings.
   14.1. Batter slopes must have min 200 mm topsoil which must be tested by a NATA-accredited laboratory in accordance with AS 4419.
   14.2. Subsoils to be cultivated to 150 mm prior to placing topsoil on batter slopes.
   14.3. Planting densities and species must be consistent with the landscape design drawings. No substitutions should be made unless approved by the superintendent.
   14.4. Plants supplied to site must:
      14.4.1. be grown in clean, weed- and pest-free conditions;
      14.4.2. be well developed, sun-hardened and contain a fully established root ball that does not crumble when removed from its container.
      14.4.3. be at least 200 mm high.
      14.4.4. show no sign of pest and disease
      14.4.5. show no signs of nutrient deficiency
      14.4.6. be free from weeds
      14.4.7. be clearly labelled
      14.4.8. be supplied in a container that is at least: 90 mm high x 50 mm wide
   14.5. Preparing Filter media: Unless specified otherwise, each plant must receive at least 10 g of slow-release native fertilizer in granular or tablet form. Pre-hydrated water crystals may be applied at 1-2% by weight.
   14.6. Mulch must be applied in accordance with the design drawings, be applied prior to planting, provide coverage of the soil and not exceed 75 mm thickness, and be kept 50 mm clear of plant stems. Unless otherwise specified, mulch should be fine sugar cane mulch secured in place by a loose weave jute net pinned at 500 mm centres.
   14.7. Filter media surface and plant stock are to be watered immediately prior to planting. Unless otherwise specified, plants should be planted in clumps of the same species, and large monocultures avoided.
   14.8. Plant method must minimise soil compaction and ensure that all roots are covered by at least 10 - 20 mm of soil, avoid covering plant crowns.
   14.9. Unless specified otherwise, the following irrigation schedule applies during plant establishment (at 2.5 - 5 L per plant per week)
      - Week 1-5 Five waterings per week
      - Week 6-10 Three waterings per week
      - Week 11-15 Two waterings per week
      - Thereafter As required to sustain plants until successful establishment
   14.10. Replanting must occur during the establishment period if less than 90% of plants survive.
   14.11. Successful plant establishment in bioretention systems is considered when the plants are robust and self-sustaining, and meet the following criteria.
      - Vegetation must cover at least 90% of the bioretention surface with mulch covering the remainder (< 10% mulch visible from above)
      - Average groundcover plant height must be greater than 500 mm.
      - Plants must be healthy and free from disease.
      - No weeds or litter to be present.

15. Certification and chain of custody
   15.1. The following certification and the chain of custody applies to bioretention media:
      15.1.1. The supplier and contractor are responsible for ensuring the bioretention media meets the specifications outlined in these guidelines and that the correct material is delivered to site. The supplier must arrange for testing of the filter media by a soil laboratory certified for the methods in accordance with the requirements listed above. On the basis of the testing, the soil laboratory and supplier must certify the material meets these specifications. The supplier must provide the certification and laboratory test results to the contractor with the supply docket.
      15.1.2. The contractor provides a copy of the supplier's certification, test results and supply docket to the site superintendent or bioretention designer for review.
      15.1.3. Following review of the certification, test results and the supply docket, the site superintendent or bioretention designer approves installation of the bioretention media.
      15.1.4. The relevant sections of the bioretention media sign-off form as per the Construction and Establishment Guidelines (Water by Design) should be completed and signed. This sign-off form is provided as part of the construction certification by the site superintendent or bioretention designer.

16. Hold points
   16.1. The following hold points must be observed in accordance with the most recent Water by Design construction checklists and superintendent approval is required for works to proceed:
      16.1.1. Prestart meeting
      16.1.2. Completion of hydraulic structures and under-drainage
   16.1.3 Prior to placing filter media
      16.1.4. After placement of filter media (prior to applying mulch and planting).

17. Compliance testing (for on-maintenance or off-maintenance)
   17.1. Compliance testing must be in accordance with chapter 5 of Transferring Ownership of Vegetated Stormwater Assets (Water by Design). Checklists must be completed and signed by the superintendent.

Rv.	DATE	REVISIONS
A	11/15	ORIGINAL ISSUE
	February, 2016	Original Issue

INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA
STANDARD DRAWINGS

BIORETENTION STANDARD NOTES

DS-078

Rv. A