



GUIDANCE DOCUMENT **DESIGN REQUIREMENTS FOR** **STORMWATER QUALITY TREATMENT DEVICES**

Design requirements for stormwater quality treatment devices

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Amendment history

This guidance document commenced on 15 June 2026. Amendments since this date are listed in the below table.

Version number	Amendment title	Summary of amendment	Effective date
1.0	Commencement.	Creation of this document.	Effective 1 July 2026

1 Introduction

1.1 Application

This guidance document has been created by Mackay Regional Council. It supports the development assessment process under the Mackay Region Planning Scheme (Planning Scheme) and *Planning Act 2016* by providing guidance to assist in the interpretation of terms, concepts or requirements within the Planning Scheme or a Planning Scheme Policy.

1.2 Relationship with planning scheme

This document is referenced in the following locations:

- (a) Planning Scheme Policy (PSP) – Healthy waters

1.3 Purpose

This document provides specific design requirements for different types of stormwater quality treatment device types. This document supports the PSP – healthy waters by providing more detailed design requirements to those included in section 2.5.2 of the PSP.

2 Design requirements for specific stormwater quality treatment devices

2.1 Gross pollutant traps (GPT)

Minimum design requirements

GENERAL

- Where a GPT is used as part of a treatment train to achieve compliance using MUSIC modelling, it can achieve varying degrees of treatment.
- Where a GPT is used for compliance approach (d) - alternative management measures, it must Capture >90% of all solid gross pollutants and must be a SQIDEP approved device.
- Achieve contaminant treatment performance as demonstrated in MUSIC.
- Designed to ensure there is no flood impact or actionable damage/nuisance outside the development.
- Designed to bypass above design operational flows.
- Prevent resuspension of captured contaminants when design operational flow is exceeded.
- Shall not be installed within a submerged stormwater system.
- Shall not be located near electrical equipment, beneath electrical services, or overhead wires
- Minimum 20-year lifespan with a minimum 50-year design life for major structural design and replaceable operational elements.

MAINTENANCE

- Device must be suitably located and accessible by vacuum truck or crane for cleanout and maintenance during all-weather events. Manual handling of collected pollutants is prohibited.
- Device must be able to be isolated for cleanout or maintenance and must be designed to ensure that floatable contaminant cannot overspill during cleanout operations.
- A 2.5m wide vehicle access track must be provided from the external site to the GPT. Track must withstand heavy plant up to 20 T, provide safe accessibility, and have an industrial crossover with rolled kerb at the road edge. The track must be designed to fit with aesthetics/function of the immediate area.
- A reinforced concrete vehicle hardstand must be provided adjacent to the device for cleanout and maintenance.
- A designated dewatering area will be required for proprietary products as advised by Council. The dewatering area is to be located within 25m of the device and located above the 10% AEP flood level. The nominated area to be no steeper than 1 in 20 and grassed.
- Lids to be constructed to resist anticipated loads and must be anti-slip/trip. Lids to be removable and fitted with lock fitting standard MRC key.

2.2 Sediment ponds

Minimum design requirements

STANDARD DRAWINGS AND REFERENCE DOCS

Sediment ponds (also commonly referred to as sediment basins) are to be designed generally in accordance with the following:

- IECA - Appendix B - Sediment Basin Design and Operation

GENERAL

- Capture 90% of coarse to medium sized sediment particles ($>0.125\text{mm}$) from the 63% AEP flow event with cleanout frequency of maximum 5 years.
- Achieve treatment performance as demonstrated in MUSIC.
- Sized according to the 63% AEP design operation flow.
- Maximum velocity for minor flood event (40% to 10% AEP) less than 0.5m/s .
- Maximum velocity for major flood event (2% to 1% AEP) less than 2.0m/s .
- Hydraulic efficiency to be greater than 0.5.
- All penetrations must be watertight (i.e., have an anti-seepage collar or similar and be appropriately backfilled and compacted).
- All unmortared rock armour is to be hand placed angular rock suitable for the flow conditions.
- Functional elements of the basin may be installed during construction phase to assist in erosion sediment control, with accumulated sediment removed prior to on- maintenance.
- All accumulated sediment removed and the system planted in accordance with the approved design at the completion of the three year temporary protective state treatment, if applied. Temporary fencing may be required in the interim for safety
- Services to not be located within the footprint of the basin unless approved by Council.
- Construction tolerance of $\pm 25\text{ mm}$ for hydraulic structures, $\pm 50\text{ mm}$ for earthworks and -25mm to $+50\text{mm}$ for embankments to be applied.
- Lined with a non-dispersive impermeable liner (i.e., prefer 300mm clay) with a permeability of $< 1 \times 10^{-9}\text{m/s}$

INLET

- Invert to be between 1.5m and 2m below development surface level and set at standing water level or partially submerged.
- Pipe grade to ensure adequate inflow velocity subject to detailed hydraulic design
- Inlet and outlet structures to be located at opposite ends and aligned to promote high hydraulic efficiency.
- Scour protection must be provided at the outfall of the inlet If velocities exceed 2.0m/s scour control/energy dissipaters will be required.
- Inflows energy dissipation and scour protection shall prevent mitigate scour during a major storm event and minimise resuspension of coarse sediment collected
- Headwall to be appropriately integrated into the aesthetics/function of the immediate area.

SEDIMENT POND

- Sized to match the settling velocity of target sediment size within a 63% AEP flow event.
- Storage volume must exceed the volume of accumulated sediment over 5 years.
- Concrete (minimum 150mm thick N32/20 with SL82 mesh) or keyed rock base extending 0.5m up batter. Clay lining to NWL or where directed by geotechnical report.
- Basin depth to be no less than 1.5 m below the NWL and have a length to width ratio of 1 to 3.
- Embankment slopes to be between 1 on 6 and 1 on 4 steep. Top of bank to be minimum 3.0m wide.
- Batter slopes above and immediately below NWL to graduate in slope from 1 on 5 to 1 on 8 and include a minimum 1.2m high vegetated 2.5m wide safety bench. Slope beyond 350mm below NWL to be no steeper than 1 on 3.
- Bund/embankment to be a minimum of 0.5m above the top of extended detention.
- Extended detention depth must be less than 0.3m above the NWL.
- Safety fencing, including temporary safety fencing, shall be provided generally in accordance with the requirements QUDM s12.4 Safety fencing. Where water is 250mm or deeper non-climbable safety fencing and/ or perimeter planting to control public access to the open body of water must be installed.

CONTROL OUTLET

- An overflow pit and pipe constructed in accordance with IPWEA standard drawings. Where basin discharges directly into a conveyance system, a control outlet will not be required.
- For sediment ponds to wetlands or bioretention systems box culverts will be considered by Council instead of pit to pipe outlet.
- Located maximum 2m away from the edge of the basin for maintenance access.
- Overflow pit lid must be designed to minimise trash build up and blockages. Council preference is a dome grate. Assume 50% grate blockage factor.
- Overflow pipe must be free draining and sized to convey a 63% AEP flow event.

SPILLWAY or HI FLOW BYPASS WEIR AND CHANNEL

- In accordance with IPWEA DS-076
- Sized to convey 40% to 10% AEP flow events where connected to minor drainage systems or 1% AEP flow event where connected to major drainage systems.
- Crest to be minimum 600mm thick reinforced concrete with rock mattress protection on both sides to end of batters and keyed into the embankments.
- Embankment crest height and freeboard above spillway to be in accordance with Queensland Urban Drainage Manual (IPWEA)
- Drop between crest and downstream finished surface level to be minimised.
- Channel must have sufficient scour protection for design flow velocity.
- Energy dissipators to be fitted to the end of spillway. Where hand placed rocks (grouted stone pitching) are used, the exposed elevation of the rock must be equivalent to the diameter of the inlet pipe and keyed in.

PLANTING

- A macrophyte planting zone is desirable between 200mm above and below NWL around the basin perimeter. Groundcover with high leaf surface density and fibrous roots are encouraged. Establishment of floating or submerged macrophytes discouraged.
- Batters and embankments can be vegetated and must be designed to manage weeds. Tree planting on embankments is not permitted
- Plant species, to be in accordance with MRC List of Plant Species. Planting density to achieve 90% coverage after 2 growing seasons (2 years).
- Plants are being grown in the container size specified in the planting plan. Plants must be at least 300mm high prior to delivery (or root mass equal to foliage mass for shorter species), 'hardened off' and healthy.
- 300mm thick topsoil required to line basin. Minimum topsoil depths for various plant applications include grass/turf (150mm), groundcover and small shrubs (300mm) and large shrubs (450mm)
- Topsoil must meet AS4419-2003: Soils for landscaping and garden use and meet basic agronomic requirements (salinity, pH, soil structure)
- Mulch must be applied to all batter plantings down to NWL and maintained at 50– 75mm deep until plants establish. Mulch between NWL and top of extended detention zone to be pinned down with an open weave organic mesh or mat.
- Mulch to be kept clear of plant stems by at least 50mm.
- Plants to be healthy and disease and pest free.

MAINTENANCE

- Device must be suitably located and accessible by standard Council equipment.
 - Device must be able to be drawn down or isolated for cleanout or maintenance.
 - A minimum 2.5m wide vehicle access track must be provided from the external site to the sediment pond. Track must withstand heavy plant (20 T excavator), provide accessibility (7m excavator arm reach) and have an industrial crossover with rolled kerb at the road edge. The track must be designed to fit with aesthetics/function of the immediate area and be safely traversable by the maintenance vehicle.
 - A reinforced concrete vehicle access ramp with a slope of 1 on 3 to 1 on 4 must be provided to a hardstand base for desilting.
 - A permanent depth marker to be installed within basin to indicate top of sediment storage zone
 - A designated dewatering area is to be located within 25m of the sediment pond and located above the 10% AEP flood level. The nominated area to be no steeper than 1 on 20 and grassed.
- Control outlet pit lids to be constructed to resist anticipated loads and must be anti-slip/trip. Lids to be removable and fitted with lock fitting standard MRC key.

2.3 Swales

Minimum design requirements

GENERAL

- Capture fine particulates (0.125mm-0.010mm) and attached pollutants and provide partial removal of heavy metals and bacteria from the 98.17% AEP flow event
- Achieve nutrient and contaminant treatment performance as demonstrated in MUSIC.
- Sized for contributing catchment less than 2ha.
- Maximum swale width (top) 4.5m.
- Minimum swale width (base) 1.0m.
- Maximum length 30m.
- Maximum depth 0.3m.
- Surface of side slope must be free draining with a grade between 1 on 4 and 1 on 10.
- Surface of longitudinal slope must be free draining with a slope between 1% and 4%.
- Inflow distribution must be uniform across full width.
- Energy dissipation required for concentrated inflows. Where hand placed rocks (grouted stone pitching) are used, the exposed elevation of the rock must be equivalent to the diameter of the inlet pipe and keyed in.
- Maximum velocity for minor flood event (40% - 10% AEP) less than 0.5m/s.
- Maximum velocity for major flood event (2% to 1% AEP) less than 2.0m/s.
- Depth x velocity (2% to 1% AEP) less than 0.4 m²/s.
- Manning's n (flow depths < vegetation height) 0.15 to 0.3.
- Manning's n (flow depths > vegetation height) 0.03 to 0.05.
- Design to discourage vehicle access/parking.
- Set down to be 60mm below edge of pavement level
- Underground services to not compromise the performance of the swale.
- Construction tolerance of +/- 25 mm for hydraulic structures (overflow pit crest and outlet pipe invert levels) and surface levels
- Swales may be installed during the construction to assist in erosion sediment control. Accumulated sediment must be removed at completion of construction phase OR 80% of allotment establishment and the swale reprofiled and planted in accordance with the approved design.

PLANTING

- Swales may be grassed or planted. Plant species, to be in accordance with MRC List of Plant Species. Groundcover with high leaf surface density encouraged and fibrous roots are encouraged. Planting densities to achieve 90% plant coverage after 2 growing seasons (2 years). Typical densities applied include groundcovers, sedges, rushes and macrophytes (min 6 plants/m²). Shrubs (1 plant/2-20m²) and trees (1 plant/20-100m²) depending on the species selected
- Planting to be uniformly distributed across and cover the full width of swale. Plants to be arranged in bands perpendicular to the inlet and same species to be clumped to facilitate propagation.
- Plants are being grown in the container size specified in the planting plan. Plants must be at least 300mm high prior to delivery, 'hardened off' and healthy.
- Minimum topsoil depths for various plant applications include grass/turf (150mm), groundcover and small shrubs (300mm), large shrubs (450mm) and trees (600 mm).
- Topsoil must meet AS4419-2003: Soils for landscaping and garden use and have basic agronomic requirements (salinity, pH, soil structure)
- Plants to be healthy and disease and pest free.

MAINTENANCE

- Device must be suitably located and accessible by heavy plant up to 20T.
- Heavy machinery for mowing/slashing to be avoided.

2.4 Bioretention Systems

Minimum design requirements

GENERAL

- All bioretention systems are to be 'saturated zone' type systems in accordance with IPWEA standard drawing DS-070 and requirements within this table.
- A primary treatment device must be fitted upstream of the device to remove gross pollutants
- Where the contributing catchment is less than 2ha, a rock apron and energy dissipation design in accordance with Queensland Urban Drainage Manual (IPWEA) will be required.
- Where the contributing catchment is greater than 2ha but less than 8ha, a sediment forebay is required to capture 75% of coarse to medium sized sediment (0.125mm) particles from the 98.17% AEP flow event with cleanout frequency of maximum 1- year.
- Where the contributing catchment is >8ha, a sediment pond is required to capture 75% of coarse to medium sized sediment (>0.125mm) particles from the 63% AEP flow event with cleanout frequency of maximum 5 years.
- The filter bed is designed to retain very fine/colloidal particles (0.010mm-0.0045mm), nutrients, heavy metals, and bacteria. When combined, the sediment forebay/basin and filter bed must achieve nutrient and contaminant treatment performance as demonstrated in MUSIC.
- Maximum width is 15m and maximum length is 40m.
- Maximum permissible size for the filter bed is 600m² before splitting into multiple cells.
- Large systems (>400m²) must have multiple inflow points to assist with flow distribution. Inflow must be uniformly distributed across the entire surface of sediment forebay/basin and bioretention basin.
- Grass embankment slopes to be between 1 on 6 and 1 on 4 steep where applicable. Top of bank to be minimum 3.0m wide.
- Extended detention depth of device must be no greater than 300mm.
- Maximum velocity for minor or major flood events must be less than 1m/s
- Above design operation flows must be bypassed where possible.
- All penetrations must be watertight (i.e., have an anti-seepage collar or similar and be appropriately backfilled and compacted).
- All unmortared rock armour is to be hand placed angular rock suitable for the flow conditions.
- Underground services to not compromise any component or function of the system.
- Construction tolerances of +/-25mm to hydraulic structures, underdrainage, and surface levels (where filter media <300m²), +25mm filter media (where >300m²), drainage and transition layers, +/- 50mm to earthworks and -25mm to +50mm embankments and bunds to be applied. Shape/slope tolerance of base and underdrainage to be 0% to max +0.5%, grade to be uniform.
- Functional elements (hydraulic structures, liner, and filter bed) to be installed with temporary protective measures (i.e., geofabric over with minimum 50mm topsoil and turf) at the end of development construction phase.
- Temporary protection measures to be removed along with all accumulated sediment and the system planted in accordance with the approved design at the completion of 80% of allotment building establishment.
- Safety fencing, including temporary safety fencing, shall be provided generally in accordance with the requirements QUDM s12.4 Safety fencing. Where water is 250mm or deeper non-climbable safety fencing and/ or perimeter planting to control public access to the open body of water must be installed.

INLET

- Set down between headwall apron and forebay base to be free draining >10mm.
- Scour protection must be provided at the outfall of the inlet.
- If flow velocities exceed 2.0m/s scour control/energy dissipators will be required. Pipe grade to ensure adequate inflow velocity, subject to detailed hydraulic design.
- Inflows energy dissipation and scour protection shall prevent filter media, plantings and other basin elements from scour during a major storm event.
- Headwall to be appropriately integrated into the aesthetics/function of the immediate area.

SEDIMENT FOREBAY

- Used when catchment greater than 2ha, in lieu of sediment pond. For systems where catchment is less than 2ha, a rock apron and energy dissipation design in accordance with Queensland Urban Drainage Manual (IPWEA) will be required.

- Where catchment is greater than 8ha, a sediment pond must be employed.
- Be located at each entering stormwater inlet unless catchment is <5% of the total basin catchment.
- Edge to be provided with 50mm to 100mm wide vertical slots at 2m spacings.
- Forebay to align along the axis of the inlet.
- Nom. 100-150 dia. grouted rock pitching adjacent to vertical slots.
- Grouted rock pitching as per clause 34 of MRTS03, including use of sound rock which does not disintegrate in water, secure embedment into grout and cleaning.
- Velocities passing over the barrier to not exceed 0.5m/s during the minor event (63% AEP flow event).
- Storage volume must exceed the volume of accumulated sediment over 1-year. Required cleanout frequency to be no more than once per year.

SPILLWAY or HI FLOW BYPASS WEIR AND CHANNEL

- Incorporated into sediment pond and located near the inlet pipe.
- Sized to convey 40% to 10% AEP flow events where connected to minor drainage systems or 1% AEP flow event where connected to major drainage systems.
- Crest to be minimum 600mm thick reinforced concrete with rock mattress protection on both sides to end of batters and keyed into the embankments.
- Crest to be min 0.3m below the embankment crest. Prefer 0.2m freeboard in major flow to embankment.
- Drop between crest and downstream finished surface level to be minimised.
- Channel has sufficient scour protection for design velocity.
- Scour protection is required to be fitted to the end of spillway.

FILTER MEDIA

- Media to be between 400mm and 1000mm deep with minimum depth of 400mm required for groundcover planting and minimum 700mm depth required for trees and shrubs.
- Surface must be lightly compacted, flat, and free from localised depressions.
- Finished surface to be set ≤300mm below overflow pit crest and flat.
- To achieve hydraulic conductivity, water holding capacity, particle size distribution specifications outlined in Adoption guidelines for stormwater biofiltration systems – Appendix C: Guidelines for filter media in stormwater biofiltration systems (CRCWSC) the filter media requires at minimum:
- Clay and silt < 3% (<0.05mm); Very fine sand 5-30% (0.05 - 0.15mm); Fine sand 10 - 30% (0.15 - 0.25mm); Medium sand 40-60% (0.25 - 0.5mm); Coarse sand <25% (0.5 - 1.0mm); very coarse sand <10% (1.0 - 2.00mm); Fine gravel <3% (2.0 - 3.4mm)
- minimum 5% high quality organic matter from a long-term carbon source,
- saturated hydraulic conductivity of 200 mm/hr,
- low nutrient content (TN<800mg/kg and available phosphate <40mg/kg),
- pH 5.5-7.5 and
- EC less than 1200mS/m.
- Media shall be tested in situ at one sample per 500m³ in accordance with Adoption guidelines for stormwater biofiltration systems – Appendix C: Guidelines for filter media in stormwater biofiltration systems (CRCWSC) including ASTM F1815-11, ASTM F1632-03 and AS 4419 – 2003 where applicable.
- The media must be certified by the supplier that the material delivered to the development site for the specific bioretention system it meets the specifications above (i.e., development and WSUD ID must be mentioned).

TRANSITION LAYER

- Transition layer to comply with the specification in the Bioretention Technical Design Guidelines (Healthy Waterways) and Adoption guidelines for stormwater biofiltration systems – Appendix C: Guidelines for filter media in stormwater biofiltration systems (CRCWSC) including bridging criteria
- Generally, will be well graded coarse sand (0.7-1.0mm diameter) containing less than 2% fines.
- Layer thickness is minimum 100mm but varies dependant on required thickness of saturated zone. With a minimum saturated zone thickness/depth of 450mm and minimum drainage layer of 200mm, the transition layer will be 300mm thick in order for the standing water level in the saturated zone to sit 50mm below the base of the filter media.
- The Transition Layer must be certified by the supplier that the material delivered to the development site for the specific bioretention system it meets the specifications above (i.e., development and WSUD ID must be mentioned) including the bridging criteria. To be assessed to against 'bridging criteria' requirement in accordance with Queensland Urban Drainage Manual (IPWEA) with results provided to council for approval.

DRAINAGE LAYER

- Drainage layer to comply with the specification in the Bioretention Technical Design Guidelines (Healthy Waterways) and Adoption guidelines for stormwater biofiltration systems – Appendix C: Guidelines for filter media in stormwater biofiltration systems (CRCWSC) including bridging criteria
- Generally, will be washed, well graded fine aggregate (2-5mm diameter) containing less than 2% fines. Scoria is not permitted.
- Layer thickness to be minimum 200mm with flat base. Greater thickness required if pipe diameter exceeds 100mm and is to achieve minimum 50mm pipe cover
- The drainage Layer must be certified by the supplier that the material delivered to the development site for the specific bioretention system it meets the specifications above (i.e., development and WSUD ID must be mentioned) including the bridging criteria. To be assessed to against 'bridging criteria' requirement in accordance with Queensland Urban Drainage Manual (IPWEA) with results provided to council for approval.

SATURATED ZONE (incorporated within transition and drainage layers)

- Minimum depth 478mm.
- Provided with impermeable liner (to extend full depth of filter media and 500mm up batter) with permeability no greater than 1×10^{-9} m/s
- Top of saturation zone must be contained within the transition zone and be greater than 100mm below base of filter media.

UNDERDRAIN

- Minimum 100mm diameter AS 2439.1 compliant PVC slotted pipe. Pipes must not be socked or to be wrapped in geofabric.
- Slotted pipe must be a proprietary manufactured product (not slotted on site) with slots sized to pass maximum infiltration rate.
- Slotted pipe to be spaced at 1.5m in systems less than 100m² increasing to 3m in systems greater than 100m².
- Slotted pipes to be laid flat where a saturated zone is created.
- Slotted pipe capacity must be greater than the maximum infiltration capacity of filter media. Assume 50% blockage factor.
- Y connections (45° angle) to be used on all underdrain pipe connections.

CLEANOUT PIPE

- Unperforated vertical sections of the underdrain pipe raised to the surface of filter media at maximum 20m intervals. Top of vertical pipes to be capped and set at least 150mm above the surface of the filter media. Top of riser pipes to be fitted with a secured cap or lid.
- All pipe junctions and connections must be sealed and penetrations watertight
- 135° angle bends to be used on all cleanout pipe connections.

CONTROL OUTLET

- An overflow pit and pipe constructed generally in accordance with IPWEA standard drawings DS-070. Where basin discharges directly into a conveyance system, a control outlet will not be required
- Located maximum 2m away from the edge of the basin for maintenance access
- Overflow pit lid must be a raised 'letterbox' grate for bioretention systems <200m² and dome grate for bioretention systems >200m² and designed to minimise trash build up and blockages. Assume 50% grate blockage factor.
- Maximum grate opening width of 100mm
- Overflow pit must be free draining to receiving drainage or waterway base level
- Pipes must be sealed into the overflow pit.
- Invert of outlet pipe (upstream end) equal or below base of drainage layer.
- Overflow pipe must be free draining and sized to convey a 63% AEP flow event.

LINER

- Compacted clay (minimum 300mm thick) or synthetic liner (high-density polyethylene (HDPE) or bentonite) to be used to line the base and sides of saturated and sealed systems. Hydraulic conductivity of the liner or clay to be less than 1×10^{-9} m/s. Synthetic liners must be installed and sealed in accordance with manufacturer's specification. In-situ materials can be used if they are tested and meet the requirements and test results are provided to Council.
- Liners to be keyed into earthen or rock battered systems at least 500mm beyond the edge of the filter media

and pinned and covered with 200mm topsoils.

- Liner to extend over the embankment of embankment bound systems.

PLANTING

- Plant species to be in accordance with MRC List of Plant Species. Groundcover with high leaf surface density and fibrous roots are encouraged. Typical densities applied include groundcovers, sedges, rushes and macrophytes (min 6 plants/m²). Shrubs (1 plant/2-20m²) and trees (1 plant/20-100m²) depending on the species selected. Planting density to achieve 90% vegetation cover after 2 growing seasons (2 years).
- Minimum species applied to filter media area: 2 species (basin >100m²), four species (basin between 100-400m²), six species (basin > 400m²).
- Slopes steeper than 1 on 5 must be vegetated.
- Turf is not considered suitable vegetation for a bioretention basin.
- Deciduous species are not permitted and nitrogen fixing species to be avoided (e.g., legumes from Fabaceae and Casuarinaceae)
- Plants are being grown in the container size specified in the planting plan. Plants must be at least 300mm high prior to delivery, 'hardened off' and healthy.
- Planting to be uniformly distributed across and cover the full width of basin. Plants to be arranged in bands perpendicular to basin inlet and same species to be clumped to facilitate propagation.
- Forest and rock mulch are not permitted. Organic sterilised mulch to be applied at a depth of up to 75mm to assist plant establishment of batters and sugar cane mulch to depth of 50-75mm applied to filter surface.
- Mulch of surface and to top of extended detention (TED) to be pinned down with an open weave organic mesh.
- Mulch to be kept clear of plant stems by at least 50mm.
- Plants to disease and pest free.

MAINTENANCE

- Device must be suitably located and accessible by heavy plant up to 20T.
- Device must be able to be drawn down or isolated for cleanout or maintenance.
- A minimum 2.5m wide vehicle access track must be provided from the external site to the sediment forebay. Track must withstand heavy plant (20 T), provide accessibility (7m excavator arm reach) and have an industrial crossover with rolled kerb at the road edge (WCC). The track must provide access to 40% of the perimeter of bioretention system. At a minimum the access must be well-compacted gravel but should be and be designed to fit with aesthetics/function of the immediate area
- A reinforced concrete vehicle access ramp with a slope of 1 on 3 to 1 on 4 must be provided to a hardstand base for desilting.
- A permanent depth marker to be installed within sediment pond (where applied) to indicate top of sediment storage zone.
- A designated dewatering area is to be located within 25m of the sediment pond
- (where applied) and located above the 10% AEP flood level. The nominated area to be no steeper than 1 on 20 and grassed.
- Control outlet pit lids to be constructed to resist anticipated loads and must be anti-slip/trip. Lids to be removable and fitted with lock fitting standard MRC key.
- Include provision for turning and stockpiling of material as required.

2.5 Constructed wetland

Minimum design requirements

GENERAL

- A primary treatment device must be fitted upstream of the device to remove gross pollutants.
- Sediment pond to capture 80-90% of coarse to medium sized sediment (0.125mm) particles from the 63% flow event with cleanout frequency of maximum 5 years. Wetland to retain very fine/colloidal particles (0.010mm-0.0045mm) and achieve nutrient and contaminant treatment performance as demonstrated in MUSIC.
- Must be provided with inlet pond and high-flow bypass
- Extended detention depth of the macrophyte zone must range between 0.25m to 0.5m for up to 48hrs.
- Maximum velocity for minor flood event (40% to 10%) less than 0.5m/s.
- Maximum velocity for major flood event (2% to 1% AEP) less than 1.0m/s
- Embankment slopes to be between 1 on 6 and 1 on 4 steep. Top of bank to be minimum 3.0m wide.
- Wet season groundwater level to be at least 300mm lower than the base of the constructed wetland, or impermeable liner provided.
- Above design operation flows must be bypassed.
- All penetrations must be watertight (i.e., have an anti-seepage collar or the like and be appropriately backfilled and compacted).
- Services to not be located in the proposed footprint of the constructed wetland unless approved by Council. If services are approved, detection tape and kerb markers must be used to show service locations.
- A full hydraulic assessment to be undertaken where the constructed wetland is greater than 50ha, or when it includes structures such as fences and boardwalks.
- Construction tolerances of +/-25mm to hydraulic structures and surface levels, +/- 50mm to earthworks and -25mm to +50mm embankments and bunds to be applied.
- Macrophyte zone to be disconnected from sediment pond during allotment building phase and flow redirected to the high-flow bypass. Macrophyte zone can be planted in accordance with the approved design and reconnected to sediment pond for short periods for watering. Provision must be made to drain the macrophyte zone during the plant establishment phase.
- Temporary protection measures to be removed along with all accumulated sediment at the completion of 80% of allotment establishment. Connection between the sediment pond and macrophyte zone to be reinstated at the required rate to facilitate plant growth.

INLET

- Inverts to be set as close as possible to the NWL of the sediment forebay.
- Pipe grade to ensure adequate inflow velocity, subject to detailed hydraulic design.
- Inlet and outlet structures to be located at opposite ends and aligned to promote high hydraulic efficiency.
- Velocities must not exceed 1.0m/s during a 1% AEP event.
- Scour protection must be provided at the outfall of the inlet. Scour protection to be 3 pipe diameter lengths from the face of the outlet if velocities 1.0m/s. If velocities exceed 2.0m/s scour control/energy dissipaters will be required.
- Inflows energy dissipation and scour protection shall prevent mitigate scour during a major storm event and minimise resuspension of coarse sediment collected
- Headwall to be appropriately integrated into the aesthetics/function of the immediate area
- Safety fencing, including temporary safety fencing, shall be provided generally in accordance with the requirements QUDM s12.4 Safety fencing. Where water is 250mm or deeper non-climbable safety fencing and/ or perimeter planting to control public access to the open body of water must be installed.

SEDIMENT POND/INLET POND

- Sized to match the settling velocity of target sediment size within a 63% AEP flow event
- Storage volume must exceed the volume of accumulated sediment over 5 years.
- The number of sediment ponds used within a wetland system must be less than two.
- Hydraulic efficiency to be greater than 0.5.
- Concrete (minimum 200mm thick with SL82 mesh) or keyed rock base extending 0.5m up batter. Clay lining to NWL or where directed by Geotechnical report.
- Basin depth to be no less than 1.5m below the NWL and have a length to width ratio of 1 to 3.
- Bund/embankment to be a minimum of 0.3m above the top of extended detention.

- Crest of overflow pit must be set at NWL which is 0.2m higher than the NWL in the macrophyte zone and 0.3m below the crest of the high-flow bypass weir
- Extended detention depth must be less than or equal to 0.3m above the NWL.
- Embankment slopes to be between 1 on 6 and 1 on 4 steep. Top of bank to be minimum 3.0m wide.
- Batter slopes above and immediately below NWL to graduate in slope from 1 on 5 to 1 on 8 and include a minimum 1.2m-high vegetated 2.5m wide safety bench. Slope beyond 350mm below NWL to be no steeper than 1 on 3.
- Inlet and outlet structures to be located at opposite ends and be aligned to promote a high hydraulic efficiency.

INLET POND CONTROL OUTLET

- An overflow pit and pipe constructed in accordance with IPWEA standard drawing DS-070.
- Located towards the side of the basin for maintenance access.
- Overflow pit lid must be a raised grate and designed to minimise trash build up and blockages. Assume 50% grate blockage factor.
- Crest height must be set at or maximum 0.2m above the NWL of the macrophyte zone.
- Designed to allow for isolation of the macrophyte zone for maintenance.
- Pipes leading from control outlet must be sealed into the overflow pit.
- Scour protection must be provided at the outfall of the overflow pipe. Scour protection to be 3 pipe diameter lengths from the face of the outlet if velocities 2.0m/s. If velocities exceed 2.0m/s scour control/energy dissipaters will be required.

MACROPHYTE ZONE (WETLAND)

- Four depth zones must be provided perpendicular to the flow path. Vegetated zones must cover at least 80% of the macrophyte zone surface area and include: ephemeral marsh (+0.2m to NWL), shallow marsh (NWL to -0.2m), deep marsh (- 0.2m to -0.4m).
- Open water zone must be between 1.2m and 1.5m deep, support submerged marsh vegetation and cover up to 20% of the surface area.
- All marsh zones to be connected to the open water zone. Islands are not permitted.
- Embankment vegetation to be planted above the macrophyte zone.
- Bund/embankment to be a minimum of 0.5m above the top of extended detention and be consistent around entire wetland.
- Maximum water level to not exceed more than 0.3m above the top of extended detention level.
- Extended detention depth equal to or less than 0.5m for no more than 48hrs, 90% of time.
- Velocities to be less than 0.1m/s through the wetland.
- Minimum length to width ratio of 4 (L) to 1 (W). Width to not exceed 10m in width due to likelihood of hydrodynamic mixing.
- Hydraulic efficiency to be greater than 0.5, with inlet and outlet structures to be located at opposite ends and be aligned to promote a high hydraulic efficiency.
- Outlet to be located as close as possible to the point of discharge into the receiving environment.
- Batter slopes above and immediately below NWL to graduate in slope from 1 on 5 to 1 on 8 and include a minimum 1.2m high vegetated 2.5m wide safety bench. Slope beyond 350mm below NWL to be no steeper than 1 on 3.
- Longitudinal grade to be 1 in 150 or greater. Flat benches are not permitted.
- Free from localized depressions and low points resulting from earthworks.
- Sharp bends to be avoided.
- Peak 4.88% AEP inundation depth to be no more than 1.2m deep in accordance with Queensland Urban Drainage Manual (IPWEA).
- Riser outlet and maintenance drainage pipe to be included within the wetland.
- Batters and embankments (i.e., +0.2m) to be between 1 on 8 and 1 on 3 grades, densely vegetated and mulched to manage weed. Groundcover coverage of 90% is recommended for all batters.
- Temporary safety fence (1.2m high silt fence or parawebbing) required around edge until vegetation has established.

SPILLWAY or HIGH FLOW BYPASS WEIR AND CHANNEL

- Incorporated into sediment pond and located near the inlet pipe.
- Designed to convey the maximum overflow from the sediment pond (typically >63% AEP).
- Crest to be min 0.3m below the embankment crest or ensure 0.2m freeboard to embankment in major storm

- Crest to be minimum 500mm thick reinforced concrete with rock mattress protection on both sides to end of batters keyed into the embankments.
- Drop between crest and downstream finished surface level to be minimised.
- Channel has sufficient scour protection for design velocity.
- Length and capacity must be sufficient to convey above design flow.
- Passes velocity check of 0.1m/s within macrophyte zone when water is at the top of extended detention level and the riser is operating at design capacity.
- Energy dissipators are required to be fitted to the end of spillway. Where iceberg rocks are used, the exposed elevation of the rock must be equivalent to the diameter of the inlet pipe and keyed in.

RISER OUTLET (in macrophyte zone) PIT

- Pipe grade to be at least 0.3%.
- Pipe invert to be a minimum of 0.3m below the NWL and 0.3m higher than pipe outlet.
- Outfall pit to be accessible from the edge of the wetland.
- Outfall pit to have a hinged grate or gridded lid to enable visual inspection of the sidewinding penstock and open the gate valve from the surface.
- Submerged offtake pit connecting into the outfall pit to be set 300mm off the invert of the deepest part of the outlet pool and be fitted with a water level gauge.
- Riser water level control to be provided by orifice plate in preference to PVC riser pipes
- Orifice size and height to match design notional detention time (max 48 hours)
- Include measures to trap debris to prevent clogging.

MAINTENANCE DRAINAGE PIPE

- Sized to draw down the permanent pool within 12 hours.
- Connects the low points in the macrophyte zone to the riser outlet.
- Fitted with a valve within the riser outlet pit to allow for manual operation.
- Minimum 300mm diameter with invert less than 100mm above the base of the macrophyte zone and fitted with a submerged offtake pit.

DISCHARGE OR OUTLET PIPE

- Sized to match the higher of the two discharges; maximum discharge from the riser outlet or the maximum discharge from the maintenance drain.
- Pipe to be free draining with a 0.5% to 1% grade.
- Outlet to be located within a well-defined natural depression and angled 45 to 60 degrees towards the main channel flow.
- Outlets to be recessed into the banks of any watercourse, 3 times the bank height from the toe of the bank or 10 (single cell outlet) to 13 (multi cell outlet) times the equivalent pipe diameter, whichever is greater. Headwall be appropriately integrated into the aesthetics/function of the immediate area.
- Outlet to be located away from highly mobile or erodible stream banks, or the outside of channel bends.
- Where transition to a waterway includes a vertical drop of greater than 400mm, major grade control and scour protection is required. This is to include the design of the toe apron to prevent instability.
- Scour protection must be provided at the outfall of the overflow pipe. Scour protection to be 3 pipe diameter lengths from the face of the outlet if velocities <2.0m/s into a watercourse. If velocities exceed 2.0m/s scour control/energy dissipaters will be required.

LINER

- Not required if the hydraulic conductivity of in-situ soils is certified as suitable by a geotechnical report
- A liner must be installed if interaction with groundwater or saline or acid sulfate soils is likely. Clay liners must be 300mm thick and must cover the entire sediment pond and up to the extended detention depth of the macrophyte zone or where directed by a geotechnical report. Clay material must have hydraulic conductivity less than 1×10^{-9} m/s, be compacted to have a density ratio of 95% standard compaction, be free of organic material and rubble, contain greater than 40% clay and silt fines, less than 10% gravel (>2.36mm), have a liquid limit between 25% to 60% and a plasticity index between 15% to 45% when tested in accordance with AS1289.
- Synthetic liners to be high-density polyethylene (HDPE) (minimum 1mm thick) or bentonite geosynthetic clay liner with hydraulic conductivity less than 1×10^{-9} m/s and must be installed and sealed in accordance with manufacturer's specification. Liner must cover the entire sediment pond and up to the extended detention depth of the macrophyte zone or where directed by a geotechnical report. Liner to be keyed at

least 500mm beyond the edge of the basin and wetland and pinned and covered with 200mm topsoils.

PLANTING

- Plant species, in accordance with MRC List of Plant Species and be compatible with the surrounding open space.
- Plants are being grown in the container size specified in the planting plan. Plants must be at least 300 mm high prior to delivery, 'hardened off', and healthy; free of pest, disease and weed.
- A planting zone is required between 200mm above and below NWL around the sediment pond perimeter. Batters and embankments to be vegetated and mulched to manage weed. Tree planting on embankments is not permitted. Establishment of floating or submerged macrophytes discouraged within the sediment pond.
- Macrophyte zone (<350mm deep) must be planted minimum of 80 % (aerial cover at NWL) at 6 plants per m² (minimum) in clumps of 5-10 plants and deep areas to be planted to be 2 plants per m² (minimum). Equal amounts of shallow marsh (100- 150mm deep) and deep marsh (150-350 mm deep) to be planted in the macrophyte zone.
- Open water (20 %) is to be planted with submerged species at 1 plant per m² (minimum).
- Groundcover coverage of 90% recommended for all batters at 6 plants per m²
- Plants to be arranged in bands perpendicular to basin inlet and same species to be clumped to facilitate propagation.
- Minimum topsoil 200mm to be provided as macrophyte substrate. Wetland design levels to be inclusive of topsoil. 300mm thick topsoil required to line sediment pond.
- Topsoil must meet AS4419-2003: Soils for landscaping and garden use and have basic agronomic requirements (salinity, pH, soil structure).
- Mulch must be applied to all batter plantings down to NWL and maintained at 50– 70mm deep until plants establish. Mulch between NWL and top of extended detention (TED) to be pinned down with an open weave organic mesh or mat. Organic matting to be installed below the 1% AEP level rather than mulch.
- Mulch to be kept clear of plant stems by at least 50mm
- Minimum 90% planted vegetation cover after 2 growing seasons (2 years). Plants to be healthy and disease and pest free.
- Control measures and warning measures (e.g., signage) must be adopted around identified hazards (over 0.5 m high) where deemed appropriate by the designer following appropriate safety in design/risk assessment.

MAINTENANCE

- Device must be suitably located and accessible by standard Council equipment.
- Device must be able to be drawn down or isolated for cleanout or maintenance.
- A minimum 2.5m wide vehicle access track must be provided from the external site to the sediment pond/inlet pond. Track must withstand heavy plant (20 T excavator), provide accessibility (7m excavator arm reach) and have an industrial crossover with rolled kerb at the road edge (WCC). The track must provide full access to the perimeter of wetland. At a minimum the access must be well-compacted gravel but should be and be designed to fit with aesthetics/function of the immediate area.
- A reinforced concrete vehicle access ramp with 1 on 3 to 1 on 4 must be provided to the hardstand base of the sediment pond for desilting.
- A designated dewatering area is to be located within 25m of the sediment pond and located above the 10% AEP flood level. The nominated area to be no steeper than 1 on 20 and grassed.
- Permanent depth marker to be installed within the sediment pond indicating top of sediment storage zone.
- A designated dewatering area is to be located within 25m of the sediment pond and located above the 10% AEP flood level. The nominated area to be no steeper than 1 on 20 and grassed.
- Permanent depth marker to be installed within the macrophyte zone indicating the water level relative to normal water level.
- Control outlet pit lids to be constructed to resist anticipated loads and must be anti- slip/trip. Lids to be removable and fitted with lock fitting standard MRC key.
- Include provision for turning and stockpiling of material as required.