

METAL RECYCLING FACILITY DEVELOPMENT

LOT 3 DP251779

88 MURRAYS FLAT ROAD

TOWRANG. NSW. 2580

WATER CYCLE MANAGEMENT STUDY



Prepared by SOWDES
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This report is accompanied by a *MUSIC* model titled Metal Recycling Facility (.sqz file)



WATER CYCLE MANAGEMENT & OVERLAND FLOW STUDY

Introduction.

SOWDES has been commissioned by the proponent of a metal recycling facility development to be undertaken on a parcel of land identified as Lot 3 DP251779 which is located at 88 Murrays Flat Road, Towrang to undertake a Water Cycle Management Study which will include an assessment of potential water quality issues. For the stormwater quality assessment component software modelling using the 'MUSIC' program will be undertaken to identify the type and source of possible pollutants and to prepare a chain of treatment measures to overcome any of the identified water quality issues. Where appropriate the scope also includes undertaking a conceptual design of the stormwater drainage system to ensure that the proposed collection, conveyance, and treatment measures can adequately fit within the confines of the development area and suitably drain to downstream receiving systems. The proposed development is classified as a Development Class 'T' – 'Module Group 5' within the Water NSW development classification system and therefore must be referred to Water NSW for concurrence.

This report and its recommendations have been compiled with reference to and consideration of the Goulburn Mulwaree Council Development Control Plan (as amended), 'Developments in the Drinking Water Catchment – Water Quality Information Requirements' (WaterNSW, February 2023), the publication from Water NSW titled "Neutral or beneficial Effect on Water Quality Assessment Guideline (October 2022), all relevant Australian and industry standards, existing stormwater drainage infrastructure, neighbouring developments, and all existing site conditions. Where practical and appropriate, the recommendations, constraints and conditions from the above listed reports and documents have taken precedence in the modelling and design process such that any water quality issues, environmental concerns, and matters pertaining to public amenity have been addressed. Preparation of the *Water Cycle Management Study* addresses the following specific information requirements:

- NSW Department of Planning and Environment – Planning Secretaries Environmental Assessment Requirements (SEARS: 1819); seventh and eighth items listed under the category of 'soil and water'.
- Goulburn Mulwaree Council – Minutes of Pre-lodgement Meeting (Ref: FWA/0042/2122); Part 13.2 'Water NSW' – item 13.2.1.

The basis of this report and its recommendations are derived from information obtained by the requesting and/or developing party. Changes pertaining to location, orientation, size and/or design may render the contents of this report inappropriate and hence invalid. Any such occurrence is beyond the control of the author and hence responsibility for accuracy and validity is passed. Further, data and input parameter values associated with any modelling program are understood to be current and valid at the time of compiling the report, hence any changes to these protocols are beyond the reasonable control of the author and with such, the recommendations contained in this report are construed in good faith.

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1. DEVELOPMENT PROPOSAL		
#	DESCRIPTION	DETAIL
1.1	Property details	The development site is located on the northeastern outskirts of the city of Goulburn in an area that is not serviced by Council utilities or infrastructure and is identified as Lot 3 DP251779 – 88 Murrays Flat Road, Towrang. NSW. 2580
1.2	Land zoning and area	The development property is zoned 'E4 – General Industrial' (Goulburn Local Environmental Plan 2009 – Land Zone Maps LZN_001G) and comprises approximately 32.26 hectares.
1.3	Development details	The proposed development is for the establishment of a metal recycling facility that will process up to 30,000 tonnes of ferrous and non-ferrous metals per year.
1.4		The overall recycling facility will occupy an area of 6.50 hectares along the western boundary of the property within grass paddocks and include an existing dwelling and curtilage.
1.5		The recycling facility component will be contained within a defined precinct that will occupy an area of approximately 4.733 hectares and include dedicated entrance and exit provisions with inter-connecting roadways; sorting bays to separate the different types of incoming metals; a de-pollution shed to manage dismantling of vehicles and similar end-of-life machinery; pre-shredding bays and storage areas; shredding, cutting, and hammermill processing facilities; post-shredding storage and sorting areas; and ancillary structures and facilities.
1.6		Materials being processed at the recycling facility will be sourced predominantly from the larger metropolitan areas of Sydney, Canberra, and the south coast, and regional areas such as the southern highlands and Goulburn.
1.7		Processed materials will be stored in separate stockpiles of 'like' metals for transport offsite to other facilities and businesses for further processing, recycling, and re-purposing.
1.8		Once operational the facility will employ 10 full-time persons with the potential for an additional 15 persons on a transient and intermittent basis associated with inward and outward truck movements, service contractors, and occasional visitors.
1.9		The business trading hours will be Monday to Friday 7:00am to 6:pm, Saturday 7:00am to 4:30pm, and after hours and Sundays will be used to undertake machinery and vehicle maintenance.
1.10		The existing dwelling will be converted into an administration building with combined staff amenities, and between the southern aspect of the building and the recycling precinct a staff and visitor parking area will be established.



Figure 1. Recent aerial image showing the proposed metal recycling development precinct to be located along the western boundary of the property inside the area bounded by the light blue coloured line – an area of approximately 6.50 hectares.



2. EXISTING SITE CONDITIONS

#	DESCRIPTION	DETAIL
2.1	Land area	The development property comprises approximately 32.26 hectares and is irregular in shape being somewhat rectangular except that from a point approximately midway along the southern boundary there is a kick in the boundary alignment to the southwest that makes the western boundary significantly longer than the eastern boundary.
2.2	Access	The development site is accessed from the Murrays Flat Road which lies adjacent to the western boundary with three separate entrances off the roadway into the site.
2.3		The first entrance is located in the southwestern corner and is clearly identified with an access gate however to date it is not used regularly.
2.4		The second entrance is located approximately 390 metres further north along Murrays Flat Road from the southwestern corner and it is the main entrance to the property with a gravel carriageway that leads up to an existing dwelling and curtilage.
2.5		The third entrance is located near to the northwest corner of the property, approximately 80 metres north of the main entrance, and it is just aligned with a 20-metre-wide Right of Carriageway within the property that runs parallel to the northern boundary and is assumed to benefit the adjoining land holding to the immediate east of the site.
2.6		The existing internal access carriageway is formed as a loop commencing from the main entrance and sweeping along the front aspect of the dwelling and then heading to the northwest to exit at the gateway associated with the Right of Carriageway.
2.7	Slope / topography	The development property is divided into two distinct topographical regimes with the majority of the site to east of the nominated development precinct having a general fall from the southeast to the northwest at an average grade of 3.3% (~2°) with subtle changes in surface micro-relief around several drainage depressions and farm dams.
2.8		The western quarter of the site where the proposed development will be located has a general fall from the southwest to the north-northeast at similar grades and variations
2.9		The two topographical regimes converge at a defined drainage depression that runs through the site in a south to north alignment.



2.10	Site stormwater drainage	The development site is burdened by several defined drainage depressions and farm dams, some of which have been purposely designed and constructed in what appears to be soil and water protection measures.
2.11		The most significant of the drainage systems is the main corridor that essentially runs parallel to the Murrays Flat Road traffic corridor in a south to north alignment through the site and is approximately 200 metres to the east of the western boundary.
2.12		This system is highlighted by a moderately sized dam in the northern third of its alignment through the property and receives most of the incoming flows from a catchment that begins on the southern side of the Hume Highway traffic corridor and includes the adjoining property to the immediate south.
2.13		A second drainage corridor traverses the eastern portion of the property in a southeast to northwest pattern and includes a series of small dams that cascade from one to the other over a short distance.
2.14		The outlet from the dam in the main drainage corridor and the last dam in the secondary drainage system both discharge into a small dam just to the south of the Right of Carriageway along the northern boundary with the combined outflows eventually draining into the Wollondilly River approximately 800 metres to the north of the property.
2.15		There are a few other smaller dams within the property, some of which in the eastern portion have diversion berms running parallel to the contours of the terrain to direct upslope flows into them, and others in and around the nominated development precinct which would have been used for stock drinking water in separated fenced paddocks are relatively small and have a limited contributing catchment area.
2.16		Rainwater runoff from the roof of an existing dwelling is collected in an 80,000-litre metal water tank that is located to the north of the dwelling however this is inadequate for the proposed use of the site and the potable demands so it is recommended that a second water tank of at least the same size be installed adjacent to the existing tank.
2.17	Vegetation	The vegetation formations throughout the property are dominated by open paddocks that have historically had improved pastures and grasslands for livestock to graze.



2.18		Historically there may have also been silage production with pictorial evidence of regular slashing.
2.19		The dam within the main drainage corridor has a small stand of trees along the western banks whilst the dam near to the northern boundary has scattered trees and shrubs along the incoming and outgoing drainage channels, and around the top of the banks on most aspects.
2.20		Within the western portion of the site where the proposed metal recycling facility will be established the vegetation formations are essentially the same as the paddocks to the east - being dominated by open grasslands, however there is a short row of radiata pine trees just to the south of the main entrance to the holding which provides an element of screening from the prevailing winds and privacy for the existing dwelling from the road corridor.
2.21		On the northern aspect of the main entrance there is a continuation of the trees along the western boundary that extends for approximately 50 metres and then turns at 90° to run east – west which also provides shielding from the prevailing winds and screening of vehicle traffic for the existing dwelling.
2.22	Sewer drainage and water services	The development property is not serviced by Council's sewer and water services and therefore the development is required to be self-sufficient in the provision of these facilities, the details around the retention of rainwater for potable uses has been discussed in one of the earlier items.
2.23		The existing dwelling is serviced by a wastewater management system which comprises a recently installed aerated wastewater treatment system unit (AWTS) that is located to the north of the dwelling footprint.
2.24		The AWTS unit has been installed just to the north of the old septic tank but during the site inspection it was observed that the standard irrigation disposal kit that comes with the 'off the shelf' package was still to be installed correctly suggesting that the unit has very little to no use at present, and it was also noted that the backfilling around the new AWTS unit was not completed properly with the surrounding soils finished below the natural ground level.
2.25		Further details of the site's wastewater management system and the recommendations for its upgrades and commissioning prior to the practical commencement of the recycling facility are addressed in a separate ' <i>Wastewater Management Assessment</i> ' report prepared by <i>SOWDES</i> that accompanies the application.



2.26	Constraints / other matters	The drainage corridors that traverse the site are subject to overland flows and potential flood affects in large to rare rain events, and the site is mapped as being affected by the extents of the probable maximum flood associated with the flooding of the Wollondilly River which lies approximately 800 metres to the north.
2.27		The proposed metal recycling precinct will be located in the southwest corner of the holding which essentially represents the highest elevations of the site and an area that is largely unaffected by large rain events and overland flows apart from some minor surface water ponding within the post-development processing areas that is somewhat deliberate to help prevent the first flush of rainwater leaving the precinct without any form of detention or treatment.
2.28		The location and associated operations of the recycling facility does not involve crossing or access across any of the drainage corridors that traverse through the site.
2.29		The extent of impact from the different flood events and magnitudes is address in a separate ' <i>Local Flood and Overland Flow Assessment</i> ' report prepared by SOWDES that accompanies the application.
2.30		The area in the northwestern corner of the site comprising approximately 1.467 hectares and bounded by the main access carriageway servicing the existing dwelling and the southern aspect of the Right of Carriageway along the northern boundary will essentially be unchanged in the post-development scenario and therefore is not included in the water quality assessment and modelling – further details are contained in the next section of this report.



3. PROPOSED DEVELOPMENT DETAILS		
#	DESCRIPTION	DETAIL
3.1	Proposed development details	The proposed metal recycling facility will be established along the western boundary of the development property and will comprise a total area of 6.50 hectares.
3.2		The facility will be established within a fenced enclosure that will separate it from the remainder of the property and also provide a security and safety barrier to any unauthorised persons or trespassers.
3.3		The overall facility will essentially be separated into two components; the administration building and surrounding curtilage that will facilitate the site's effluent management system and ancillary infrastructure – and this will cover an area of approximately 1.467 hectares; and the recycling precinct covering an area of 4.733 hectares that will be the focal point for all metal receiving, processing, and distribution activities, and includes the staff and visitor car park area.
3.4		The only different between the pre-development and post-development conditions within the administration precinct will be upgrades to the existing wastewater management system and the additional provision of water tanks for rainwater harvesting – essentially all other buildings, surfaces, and vegetation will largely be unchanged.
3.5		The existing dwelling on the site will be retained in its current footprint and will be re-purposed internally to become the administration building with combined staff amenities and training rooms, and to the south of the re-purposed building will be the dedicated staff and visitor parking area with enough spaces for approximately 13 vehicles.
3.6		As the administration precinct will be unchanged apart from some additional rainwater harvesting it is considered that water quality modelling for this area is not required.
3.7	Metal recycling precinct	The metal recycling precinct will include the provision of new entrance and exist facilities within the fenced recycling compound to cater for the inward and outward movement of delivery trucks, and access for service vehicles and technical contractors.
3.8		The entrance and exit points will be linked by an interval concrete roadway that sweeps around the outer perimeter of the processing sectors and includes a link road that effectively separates the sorting bays from the processing bays.



3.9		At the main entrance into the recycling precinct there will be a gate house and weighbridges to record the weight of the incoming and outgoing trucks for reporting and compliance purposes, and there will be an internal weighbridge adjacent to the link road for similar purposes.
3.10		The general concept for the movement of materials through the recycling site will be the receipt of scrap metals in the northern portion of the precinct near to the incoming gate house where the loads will be sorted into the different types of metals and sizes, and as required will be reduced in size by cutting with oxy and acetylene torches to more manageable pieces.
3.11		Once sorted the materials will be transferred to separate stockpile areas in the southern portion of the recycling precinct where they will be processed and reduced through a pre-shredder and hammer mill shredder and conveyed to post-processing stockpile areas.
3.12		A separate processing stream will be located in a covered 'recovery' shed adjacent to the shredding machines that will sort and handle smaller materials from the shredding process and group them into 'like' materials for stockpiling and future removal offsite to other processing and recycling businesses.
3.13		A 'de-pollution shed' will be erected on the western side of the shredding areas which is used for the dismantling of old cars and machinery that may still have fluids or lubricants within them, and the separation of other non-metal components that could contaminate the shredding and sorting process.
3.14		The de-pollution shed will have catchment sumps and apparatus to manage the removal of fluids and lubricants into different collection tanks that will then be removed offsite to by licenced contractors to an appropriate recovery and processing facility.
3.15		Separate to the de-pollution shed will be a combined workshop with staff amenities to be constructed on the eastern aspect of the shredding area, and this will be used to maintain all mobile plant and equipment, and for general machining and workshop repairs.
3.16		The sewage waste from the staff amenities within the workshop building and the entrance gatehouse will be transferred to the wastewater management system located in the administration precinct via separate low-pressure sewer pump stations – the details of the system and the management of sewage are contained in the separate ' <i>Wastewater Management Assessment</i> ' report prepared by <i>SOWDES</i> that accompanies the application.



3.17		The fixed machinery and conveyor transfer system associated with the recycling, sorting, and shredding processes will be placed on concrete pads to absorb the loads and forces, and each will have a roofed cover to help keep the operating areas dry and generally protect the machinery from the elements of rain, sun, wind, and dust.
3.18		Rainwater runoff from the various sheds in the southern portion of the recycling precinct will be plumbed into a 150,000-litre metal water tank to be located on the northern end of the workshop building with the retained water used for non-potable applications such as general cleaning, dust suppression, and as a source of static water supply for firefighting purposes.
3.19		The roofed covers over the shredding machines and ancillary recycling plant and equipment are more likely to have a higher level of dust and sediment loading (with possible traces of heavier metals) than the other sheds therefore the rainwater runoff from these sources will not be plumbed into the same water tank – refer to Section 4 for further details of the stormwater drainage and water quality management system.
3.20		Other items of infrastructure to form part of the recycling operations includes mobile machinery such as loaders, forklifts, and specialised handling equipment; and there will also be a range of monitoring equipment to record various parameters such as noise, dust, radiation, and weather conditions.
3.21		The internal roadways will facilitate the movement of semi-trailers and B-double trucks through the facility with the general flow of traffic being from the north, around the eastern perimeter, through the loading and unloading areas, and then exiting the property via the main gate or a separate entrance / exit gateway in the southwest corner of the property.
3.22		The northern and southern infill areas of the recycling precinct that are located inside the road network will be formed and finished with a compacted gravel that is slightly graded to the northeast to encourage surface water runoff during rain events and thereby prevent saturated zones within the main trafficable areas.
3.23		Prior to the installation of the gravel surfaces - including the sub-base and sub-grade zones below the internal roadways the area will be excavated to a nominal depth of 500mm below the design finished level and then compacted and rolled to remove any sharp rocks or gravels, and to help provide a relatively smooth finish.



3.24		At this stage all proposed stormwater drainage and inground services and infrastructure throughout the recycling precinct will be installed to the design levels and grades.
3.25		Once all inground services are installed a 50mm to 100mm layer of fine sand will be spread over the resulting surface area to smooth over any imperfections or residual rock and gravel, and then a layer of geosynthetic clay liner will be placed over the top as a primary seal to separate surface water in the post-development conditions from any underlying ground water.
3.26		Once the geosynthetic clay liner is installed a 1.5mm to 2.0mm linear low-density polyethylene (LLDPE) geomembrane will be placed over the entire area to provide a watertight seal – with particular attention around the abutment of any concrete slabs and plinths, drainage pits and pipes, and service conduits.
3.27		To protect the layer of LLDPE from possible damage or puncture a layer of A64 geotextile will be applied over the entire surface with a final layer of 50mm to 100mm fine sand that is lightly compacted before placement of the gravel fill material.
3.28		The gravel fill material will be applied in layers not exceeding 100mm and will be compacted to achieve at least 100% dry density ratio to standard compaction, including the areas that will form the sub-grade zones below the internal roadways.
3.29		Compaction of the gravel material and associated testing will be undertaken in consultation with and under the supervision of a suitably qualified geotechnical engineer.
3.30		The installation of the waterproofing materials under the recycling precinct and internal roadways, particularly how they are finished around the outer perimeter of the affected area and around retaining walls, concrete plinths and slabs, and other penetrations is to be undertaken in consultation with specialist suppliers and installers of such systems to ensure that the final product is able to be certified as being suitable and appropriate.
3.31		It is noted that the indicative depths of materials quoted in the preparation of the site may need to be amended once earthworks and the underlying geology and substrates are fully identified and assessed.
3.32		As part of the stormwater drainage and water quality management system within the recycling precinct three separate sedimentation basins will be constructed to collect, settle, and then discharge water to an 'end-of-line' treatment device before any runoff flows further downstream of the site.



3.33		The three sedimentation basins will also be fully lined internally to prevent any potentially contaminated water percolating down into the groundwater system.
3.34		Lining of the basins will include a 50mm to 100mm layer of fine sand under a sheeting of A64 grade geotextile to cushion against any imperfections or irregularities, and this will be covered by a 1.5mm to 2.0mm thick LLDPE geomembrane over the top to provide an impermeable barrier with the top of the liner to be secured into the ground around the outer perimeter of each basin by trenching and backfilling and/or in accordance with the manufacturer's or suppliers specifications.
3.35		When the basins are initially constructed they will not be lined but rather will be used as temporary sedimentation basins for the control of sediment laden stormwater during the earthworks and civil construction phases.
3.36		Once the civil works are nearing completion the dams will be gradually decommissioned by decanting the contents in accordance with the relevant industry guidelines ('Blue Book – Section 6.3, Landcom, 2004), and at that stage the lining of the basins will be undertaken – refer to Section 8 for further details on the use and decanting of the sedimentation basins.
3.37		Once operational the long-term maintenance of the sedimentation basins will require periodic removal of accumulated sediments and any entrapped heavy metals from the base to retain the design operating volumes.
3.38		Due to the use of a geomembrane liner around the internal faces removal of accumulated materials will need to be performed manually rather than by machine to avoid causing damage to the lining material, and this will involve dewatering of the basin to expose the sediment layer, and then removal of as much material as practically possible with a soft shovel or similar tool into bins or the bucket of an excavator to be transferred outside.
3.39		The removed materials can be placed onto a 'drying bed' to allow water to drain and evaporate off, and the resulting material can then be removed offsite by truck to an approved repository – it is not to be used, buried, or retained in any manner or form within the development site.
3.40		Within the northern processing area that receives the incoming materials for sorting there will be a dedicated 'hot works' bay for the cutting of larger materials into smaller and more manageable sections, and to separate dissimilar materials from each other.



3.41		The hot works bay will be enclosed on three sides by a 1.80-metre-high wall made entirely from non-combustible materials to help prevent sparks and embers being migrating out of work area the that could potentially result in a fire within the vegetated areas that surround the recycling precinct.
3.42		Additional management measures will be in place to prohibit any hot works during periods of extreme to catastrophic fire weather conditions, or under a set of predetermined weather parameters occurring outside of adverse fire weather forecasts.
3.43		Surface water runoff from the landscaped areas between the western boundary of the property and the recycling precinct will be directed away from the internal catchment areas by a diversion swale and/or berm to be constructed adjacent to the western aspect of the internal roadway which can be then shaped to drain into the roadside swales along Murrays Flat Road just prior to the main entrance into the recycling precinct.
3.44		A narrow corridor of land between the southern aspect of the recycling precinct and the southern boundary will also be formed with a diversion swale to redirect surface water inflows from the southern aspect away from the internal catchment areas into the main drainage channel to the east that runs through the development property.
3.45		An existing dam that is located to the immediate east of the proposed location for the workshop and recovery structures within the recycling precinct will be decommissioned and the site regraded to form a uniform fall across the surface that matches the surrounding slopes and terrain.
3.46		The dam to be decommissioned is only small and has a relatively small catchment area with the main source of inflows that currently feed into the dam which originate on the southern aspect being redirected to the main drainage channel running through the site by the proposed swale to be formed along the southern boundary of the property.
3.47		Any overland flows that drained into the dam from the western aspect will be managed by the proposed site regrading, landforming, and stormwater management system associated with the establishment of the metal recycling precinct.



Table 1. Distribution of surfaces areas and pollutant source nodes used in the *MUSIC* model (areas are m²).

Source node description	Surface Type & Model Node				
	Roof 100% impervious	Sealed Road concrete 100% impervious	Unsealed Road Compacted Gravel 50% impervious	Rural Residential 5% impervious	Rural Residential 10% impervious
Pre-development				47,330	
Total	47,330				
Post-development					
Roofed area - sheds and covers	3,400				
Internal roadways		8,960			
Infill areas			27,480		
Landscaping					7,490
Total	47,330				

Roof areas

Description	Area	Drains to
Workshop	480m ²	150,000 litre Rainwater tank
Recycling shed	1,060m ²	150,000 litre Rainwater tank
De-pollution shed	450m ²	150,000 litre Rainwater tank
Pre-shredder cover	160m ²	Basin #1
Hammermill shredder cover	580m ²	Basin #1
Cyclone plant cover	270m ²	Basin #1
Storage bay cover	100m ²	Basin #1
Shearing zone cover	300m ²	Basin #1
Total	3,400m²	

Road areas

Description	Area	Drains to
Road 01 chainage 0.00m to 115m	1,650m ²	Basin #2
Road 02 chainage 270m to 408.72m		
Road 01 chainage 415m to 580.34m	5,100m ²	Basin #1
Road 02 chainage 0.00m to 270m		
Road 03 – entire length		
Road 01 chainage 115m to 415m	2,210m ²	Basin #1 Eastern swale
Total	8,960m²	

Infill and gravel areas

Description	Area	Drains to
Northern half of northern infill zone	3,830m ²	Basin #2
Southern half of northern infill zone	22,920m ²	Basin #1
Southern infill zone		
Staff and visitor parking area	730m ²	Basin #3
Total	27,480m²	



4. 'MUSIC' MODELLING & STORMWATER MANAGEMENT

#	DESCRIPTION	DETAIL
4.1	Model version	6.4.0
4.2	Rainfall data	Goulburn Mulwaree Council geographical region – pluviography data at 6-minute time steps from 1 st January 1995 to 31 st December 1999
4.3	Reduction targets	Total Suspended Solids ≥10%
		Total Phosphorus ≥10%
		Total Nitrogen ≥10%
		Cumulative frequency of reductions ≥98%
4.4	Modelling assumptions, settings and details	The water quality model is limited to the area that lies to the immediate south of the existing internal access carriageway servicing the dwelling where it is proposed to establish the metal recycling precinct and vehicle parking facilities – an area of 47,330m ²
4.5		The eastern edge of the recycling precinct will be aligned such that no part of the operations will be within 50 metres of the 'top of bank' of the main drainage channel that runs through the property, noting that the existing small dam that lies to the east of the location of the proposed workshop and recycling structures will be decommissioned and the area regraded.
4.6		The remaining portion of the site which comprises the administration precinct to the north of the access carriageway is not included in the model as no significant surface changes are scheduled to occur.
4.7	Pre-development conditions	The site for the metal recycling precinct will be established within the western portion of the property in an area that is presently set to grasslands that are regularly slashed and has formerly been used for recreational activities which historical imagery shows once included a type of moto-cross training / riding area with formed sand mounds and tracks in the northern and central portions. Source: Nearmaps, March 2018. 



4.8		Based on the historical use of the western portion of the property for recreation purposes in combination with other general land disturbances the pre-development conditions have been modelled as 'rural residential' with a 5% impervious fraction.
4.9	Post-development	The post-development site conditions will include a mix of concrete roadways around the perimeter of the recycling facility with a link road; metal roof decks over the sheds and mechanical equipment; an unsealed gravel surface as the infill areas where the sorting, shredding, and some of the post-processing materials will be stored in dedicated stockpile areas; and a vegetated area around the perimeter of the recycling precinct that is contained within the fenced compound – refer to Table 1 for the distribution of surface types in the post-development conditions.
4.10		A 20 metre wide landscape buffer zone between the western boundary and the western aspect of the recycling precinct has been excluded from the modelling calculations as it will essentially be unchanged apart from improved re-vegetation and the clean water runoff generated within this area will be diverted away from the recycling precinct by swales and berms.
4.11	Stormwater management and conveyance	The finished surface levels for the compacted gravels areas within the metal recycling precinct will be formed with a slight crossfall from the south to the northeast to help drain water away from the main operating areas, and to avoid creating zones or areas of undue saturation that could create potential long-term problems within the site.
4.12		Within the southern infill zone which is an area of 1.897 hectares around the shredding machines and support sheds there will be a series of stormwater drainage pits along the southern edge of the internal link roadway that will collect any surface water runoff from within the zone whilst drainage pipes connected to the roofed covers over the processing machines which are likely to have the higher sediment loading (with possible traces of heavier metals) will be also be connected to the pits and all water will drain to a sedimentation basin that is to be constructed on the southern aspect of the main entrance into the recycling precinct, Basin #1
4.13		Basin # 1 will have a surface area of 1,560m ² , an extended detention zone of 800mm, a permanent pool volume of 1,700m ³ , a 300mm diameter outlet pipe with a 150mm orifice plate; and retained water has been modelled for reuse at a rate of 500 litres per day for activities such as dust suppression.



4.14		The northern infill zone where the initial materials sorting areas, hot work bay, and mobile plant parking areas are to be established will similarly have a graded fall from the south to the northeast to help manage surface water runoff and prevent potential site saturation issues.
4.15		The surface water runoff from the northern infill area will be divided into two sections; a southern section of 3,950m ² that can drain into Basin #1 via a series of pits and pipes; and a northern section of 3,830m ² that drains beyond the effective catchment that drains into Basin #1 and is captured in a separate set of pits and pipes that discharges to a smaller sedimentation basin on the northern side of the main entrance to the recycling precinct, Basin #2.
4.16		Basin # 2 will have a surface area of 440m ² , an extended detention zone of 500mm, a permanent pool volume of 120m ³ , a 225mm diameter outlet pipe with a 150mm orifice plate; and retained water has been modelled for reuse at a rate of 500 litres per day for activities such as dust suppression.
4.17		Basins #1 and #2 will each have a high-level outlet pipe that drains into a third basin (Basin #3) which is to be constructed on the eastern aspect of the proposed staff and visitor parking area.
4.18		The finished surface of the staff and visitor parking area (730m ²) which will also be a compacted gravel finish will be graded to fall from the west to the east such that surface water runoff will flow into Basin #3.
4.19		Basin # 3 will have a surface area of 1,200m ² , an extended detention zone of 800mm, a permanent pool volume of 1,100m ³ , a 225mm diameter outlet pipe with a 150mm orifice plate; and retained water has been modelled for reuse at a rate of 500 litres per day for activities such as dust suppression.
4.20		The internal roadways around the perimeter of the recycling precinct will be a reinforced 150mm to 200mm concrete for durability under the truck loads, and the finished levels will have a slight fall from the outer edge to the inner edge at grades of approximately 0.5% to help promote surface water runoff into the infill areas.
4.21		The finished level of the inner road edges will be approximately 100mm to 150mm higher than the finished level of the adjoining gravel infill areas which is a design measure intended to help retain the first flush of rainwater which is likely to have heaviest concentrations of dust, sediments, and any entrapped heavy metals within the recycling precinct for collection and conveyance through the various pit and pipe systems to the sedimentation basins.



4.22		The northern section of 'Road 01' between the front entrance at chainages 0.00 metres and 115 metres and 'Road 02' between chainages 270 metres and the exit gateway at 408.72 metres - a total area of 1,650m ² will drain to the northern end of the north infill area and drain into Basin #2.
4.23		The southern section of 'Road 01' between chainages 415 metres the exit gateway at chainage 580.34 metres, 'Road 02' between chainages 0.00 metres and chainage 270 metres, and all of 'Road 03' – a total area of 5,100m ² will drain to the southern infill area and the southern end of the north infill area and drain into Basin #1.
4.24		The eastern section of the internal roadway between chainage 115 metres to 415 metres – an area of 2,210m ² will be bordered by a grass swale for the entire length that will intercept and collect any surface water runoff from the roadway or overflows from the infill areas.
4.25		The rainwater runoff from the shed structures will be directed to a 150,000 litre tank to be located at the northern end of the workshop building with a nominal reuse of 3,000 litres per day for general cleaning and dust suppression, and the overflow from the tank will drain to the grass swale along the eastern side of the recycling precinct referenced in Item 4.24 with a stabilised outlet or concrete headwall at the discharge point.
4.26		The swale along the eastern perimeter of the recycling precinct will be 1 metre wide across the base with an average depth of 300mm and 1:3 side batters, and flows captured in the swale will drain into Basin #3.
4.27		The design length of the swale is approximately 270 metres however the modelling has assumed slightly less than half the distance which is 130 metres.
4.28		Rainwater runoff from the covered machinery, plant, and equipment which is likely to have the higher concentrations of dust and sediments will be plumbed directly into the stormwater pits that are to be installed along the southern edge of the internal link road where it will then be directed to Basin #1 for initial settling.
4.29		The final stage in the stormwater conveyance measures is an end-of-line biofiltration raingarden system to be constructed just downslope of Basin #3 and just on the edge of the 1% AEP overland flow extents.
4.30		The biofiltration raingarden treatment device will have a surface area of 1,000m ² (nominally 50 metres long by 20 metres wide) with the following characteristics: Extended detention depth of 300mm



		• Filter media depth of 800mm (refer to Section 7 for the typical characteristics of the filter media used in the biofiltration device) • A drainage layer depth of 200mm • Saturated hydraulic conductivity of 200mm/hour • Total nitrogen content of 400mg/kg • Orthophosphate content of 30mg/kg • Vegetated with effective nutrient removal plants • 100Ø socked and slotted draincoil underdrains at the rate 1 per 1 metre width of biofiltration media • 50mm layer of 20mm to 40mm diameter rock mulch over the surface area • A 225mm diameter outlet pipe at the base of the drainage layer that will extend to the existing dam located on the southern aspect of the Right of Carriageway that runs along the northern boundary with a stabilised outlet
4.31		The biofiltration treatment devices will have 65Ø socked and slotted draincoil pipes installed just under the layer of rock mulch to act as distribution laterals with the number of distribution laterals will be equal to the number of underdrains in the same system and each distribution lateral will extend for the length of the system.
4.32		The use of distribution laterals will alleviate scouring and preferential wetting around the location of the incoming flows whilst also ensuring an even distribution of the rainwater across the entire surface area of the system.
4.33		The outlet control pit within the biofiltration treatment device will be fitted with a grated lid and set slightly below the nominated finished height for the top of the extended detention depth to allow ponded water in excess of the extended detention volume to rapidly drain away during large rain events.
4.34		The outer perimeter of the biofiltration treatment device which includes the height of the required extended detention depth provisions should be formed with a concrete edging or other form of strong and durable impervious material that will not warp, shrink, rot, or twist that extends downward to be at least equal to half of the depth of the filter media material to help retain the integrity and prevent damage to the system, and to also to help delineate the location of the device for future reference, management, and maintenance purposes
4.35		The biofiltration treatment device will need to be protected from possible damage caused by vehicles or other sources by the placement of bollards, fencing, signage and/or other suitable preventive measures.

4.36	Detained water re-use calculations from the 'MUSIC' model "Node Water Balance" summaries.	Basin #1 will satisfy 99.92% of the annual re-use requirements. Basin #2 will satisfy 97.23% of the annual re-use requirements. Basin #3 will satisfy 99.50% of the annual re-use requirements. The 150,000 litre rainwater tank at the end of the workshop will satisfy 92.33% of the annual re-use requirements.
4.37		Refer to the accompanying <i>Stormwater Drainage and Water Quality Management Site Plan</i> Ref: 006022-S101-A details of the location and connectivity between the stormwater drainage system and the water quality treatment measures.

Table 2. Base flow pollutant concentrations used in the pre-development and post-development models.

Concentration (mg/L-log ₁₀)						
	Suspended solids		Phosphorus		Nitrogen	
Surface type	mean	std. dev	mean	std. dev	mean	std. dev
Roof	1.20	0.17	-0.85	0.19	0.11	0.12
Sealed Roads	1.20	0.17	-0.85	0.19	0.11	0.12
Unsealed Roads	1.20	0.17	-0.85	0.19	0.11	0.12
Rural Residential	1.15	0.17	-1.22	0.19	-0.05	0.12

Table 3. Storm flow pollutant concentrations used in the pre-development and post-development models

Concentration (mg/L-log ₁₀)						
	Suspended solids		Phosphorus		Nitrogen	
Surface type	mean	std. dev	mean	std. dev	mean	std. dev
Roof	1.30	0.32	-0.89	0.25	0.30	0.19
Sealed roads	2.43	0.32	-0.30	0.25	0.34	0.19
Unsealed roads	3.00	0.32	-0.30	0.25	0.34	0.19
Rural Residential	1.95	0.32	-0.66	0.25	0.30	0.19

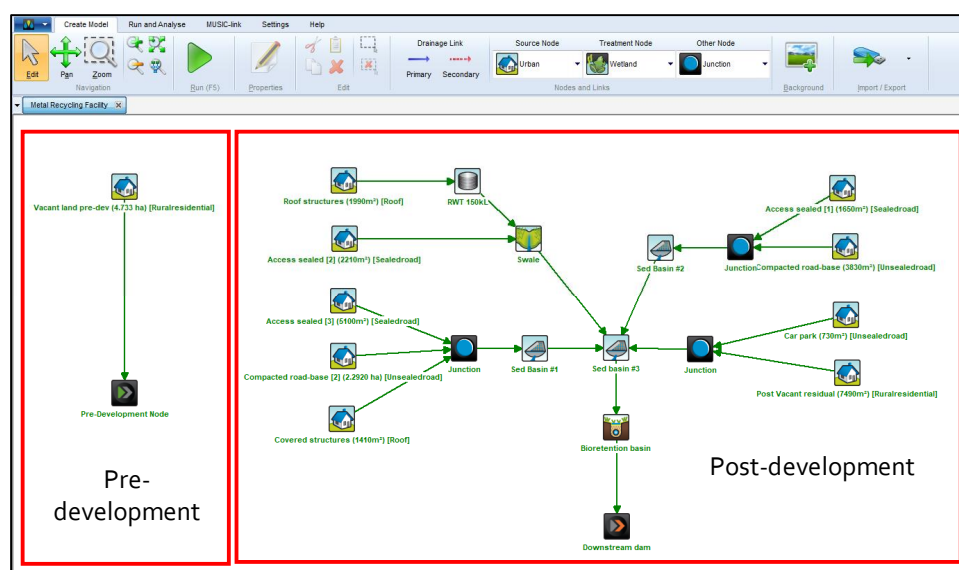


Figure 2. Layout of the pre-development and post-development source, treatment and receiving nodes in the MUSIC model.

5. The Results.

The water quality modelling results are measured on two scales; the reduction of pollutant loads between the pre-development and post-development events – ideally by no less than 10% for suspended solids, phosphorus and nitrogen, and a reduction in the pollutant concentrations in the post-development case compared to the pre-development concentrations between the 50th and 98th frequency percentiles when runoff occurs.

The 10% reduction of pollutant load target is to account for variations within the model associated with the stochastic generation at the start of the model run, and to allow for general uncertainties and parametrisation within the various source and treatment nodes. A 'neutral effect' on water quality is achieved if the pollutant loads between the pre-development and post-development results are the same, whilst a 'beneficial effect' on water quality is achieved by any reduction of pollutant loads in the post-development outcomes.

The first of these measures are summarised in Table 4 which demonstrates that the residual pollutant concentrations between the pre-development and post-development stages have achieved the objectives of the NorBE (Neutral or Beneficial Effect) criteria by achieving a minimum of 10% reduction for all three pollutant types.

Table 4. Comparison of the residual pre-development and post-development pollutant concentrations

	Annual pollutant loading (kg/year)		
	TSS	TP	TN
Pre-development loading	567	0.892	8.380
Post-development loading	442	0.555	7.385
Reduction %	22.05	37.78	11.87

The second of these measures is the reduction in pollutant concentration in the post-development case compared to the pre-development concentration between the 50th and 98th frequency percentiles when runoff occurs.

The following images of the pre-development and post development cumulative frequency charts for the flow-based sub-sample values for the parameters of suspended solids, phosphorus and nitrogen demonstrate that the proposed chain of treatment measures achieve the required objectives. The red line in the images represents the pre-development frequency values whilst the blue line represents the post-development frequency values. It is noted that the post-development frequency line in the total suspended solids graph is very close to the pre-development line, but it actually does not cross at any point.

Cumulative Frequency Pollutant Concentrations.

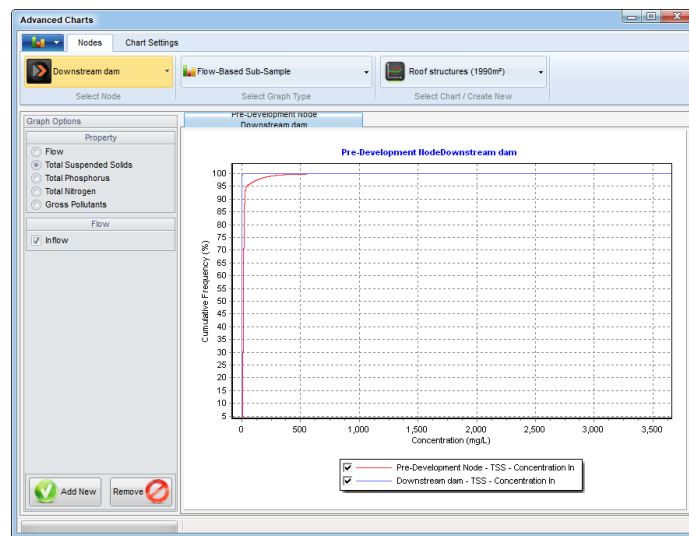


Figure 3. Comparison of the pre-development and post-development outcomes for Total Suspended Solids (TSS).

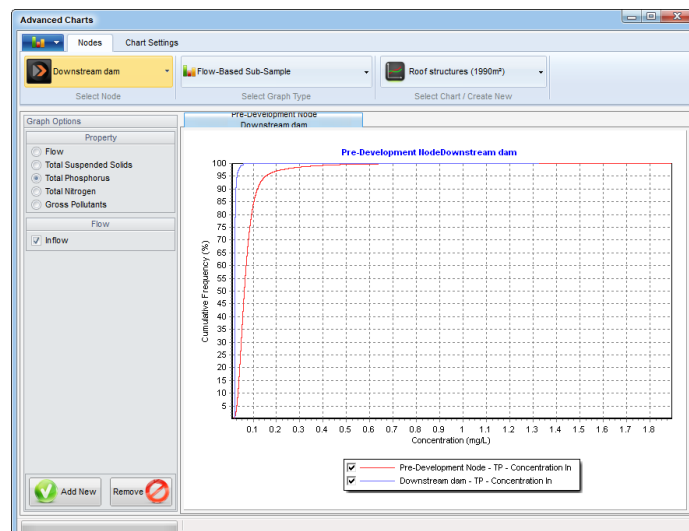


Figure 4. Comparison of the pre-development and post-development outcomes for Total Phosphorus (TP).

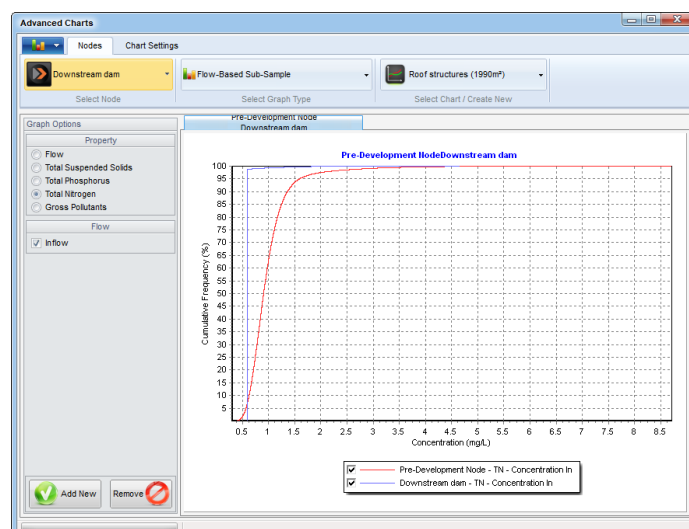


Figure 5. Comparison of the pre-development and post-development outcomes for Total Nitrogen (TN).



6. Conclusion.

Measures to ensure the protection of the proposed stormwater treatment devices, in particular the biofiltration 'raingarden' device from mechanical and physical damage - particularly during their construction phase as well as into the future is an important part of the overall effectiveness and investment in stormwater quality improvements. As a means of ensuring the long-term viability and efficacy of the proposed stormwater treatment measures an 'Operational Environmental Management Plan' (OEMP) aimed at producing effective understanding and maintenance of the individual stormwater quality improvement devices (SQID's) should be prepared prior to practical completion and sign-off of the works. The OEMP should be prepared in association with a progressive 'works as executed' site plan showing the type, location, and dimensions of all stormwater treatment devices and should be used as reference resource for the future management of the facility.

The location of the proposed biofiltration treatment device conceptually shown in the accompanying *Stormwater Drainage and Water Quality Management Site Plan* (Ref 0060222-S101-A) should not be installed until all earthworks and the majority of all construction work and hardstand areas are completed to limit the potential for physical damage, and to prevent sediment laden stormwater runoff entering the system. Sowing of the plant species for the biofiltration raingarden device should be undertaken as soon as practical after the new buildings has been constructed and the roof drainage system is connected to the rainwater tank, and the hardstand areas completed. The long-term efficiency and viability of the biofiltration raingarden devices is largely dependent upon the quality of the stormwater entering the system and sediment laden stormwater will only introduce soil particles and contaminants to the filter media and effectively negate all the benefits of the design. All sedimentation basins will need to be dewatered and de-silted on a regular basis to ensure that they maintain adequate water detention and ongoing sediment storage capacity to prevent migration of sediment laden stormwater to the end-of-line biofiltration treatment system.

The design of the stormwater conveyance, storage, and treatment measures recommended within this report are based on a thorough assessment of the site including all known and associated features and constraints. The proponents of the development have been consulted throughout the design process and have constantly provided feedback with respect to the proposed stormwater treatment measures and the viability of those measures within the scope of their development aspirations. The outcomes delivered by adopting these design recommendations satisfy the 'Neutral or Beneficial Effect' criteria as defined by Water NSW and the Goulburn Mulwaree Council.

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Registered Design Practitioner (Drainage) NSW Fair Trading – DEP0002293



1st October 2025

7. Maintenance of Stormwater Quality Improvement Devices (SQID's)

One of the principal measures of stormwater treatment proposed within the context of this stormwater quality assessment is the use of the biofiltration system (raingarden). The importance of installing these systems correctly is pivotal to the overall success of the stormwater quality outcomes. To aid in the correct installation of the bioretention systems a series of checklists for the various stages of their respective construction is included for use on the site and should be completed during construction and commissioning and retained onsite for certification at the completion of each stage of development. The construction checklist is a generic checklist designed to cover many different types of possible development and site situations and should be completed as appropriate for the site. The checklist is also a useful tool for reading prior to the construction of the bioretention raingardens as the sequence of lists follows a structured approach to the general construction requirements and will assist the installer to know what has to be installed, the requirements of that material, and a process for checking along the way.

At the rear of the construction checklist is a detailed description relating the requirements of the filter media material which is not simply a loamy garden variety of material that is readily available from most landscape supply centres. There are very specific requirements for the filter media material and the information provided will assist the supplier in achieving the correct grade of constituents to ensure compliance with the requirements. It may be a condition of the development consent and concurrence requirements that the construction of the bioretention systems be certified by a recognised consultant in which case the correct filter media material must be supplied and certified as such by the supplier. The information in this section will be very useful for the filter media material supplier as there are only a few known local sources that to date have supplied to the required standards.

Following the construction checklists and the filter media material descriptions is a sample maintenance table and maintenance checklist to be used as the standard approach to the longer-term maintenance of the biofiltration raingardens. The maintenance table and checklist for the each of the stormwater quality improvement devices (SQID's) are to be used on a regular basis as indicated to ensure the long-term efficiency and efficacy of the individual devices. Poor maintenance or checking will lead to imminent failure of the individual devices in turn leading to potentially detrimental environmental impacts. The individual items in the following tables and checklist are to be used as applicable as all items may not necessarily be a component of the individual stormwater quality treatment devices. In particular, the following tables and checklists will be appropriate to use during the establishment and construction phases of the development until such time as an Operational Environmental Management Plan (OEMP) is developed and approved in conjunction with Water NSW.



BIORETENTION SYSTEM CONSTRUCTION & ESTABLISHMENT SIGN-OFF FORMS				
Project No:			DA No:	
Project Site Address:				
Catchment Area:		(m ²)	Number of Bioretention Systems:	
Bioretention System Identifier:				
Bioretention System Identifier:				
Reference Drawing No:			Landscape Drawing No:	
ROLE / STAKEHOLDER	COMPANY	CONTACT NAME		CONTACT DETAILS
Developer				
Site Superintendent (civil)				
Site Superintendent (landscape)				
Bioretention Designer				
Civil Engineer				
Landscape Architect				
Civil Contractor				
Landscape Contractor				
Council Compliance Officer				
SCA Compliance Officer				
CHECKLIST OF SIGN OFF FORMS				
Sign-off Form	Date Completed	Name of Signatory & Role		Signature
Pre-Start Meeting				
Form A: Earthworks & Functional Services				
Form B: Under Drainage				
Form C: Bioretention Media				
Form D: Finished Levels				
Form E: Coarse Sediment Forebay				
Form F: Protective Measures				
Form G: Landscape Installation				
Form H: Landscape Establishment				



<u>PRE-START MEETING</u>			
List Pre-Start meeting attendees who are to sign indicating they have attended the meeting and understand the design intent, construction and establishment process			
Location of Meeting:			
Date:			
ROLE / STAKEHOLDER	COMPANY	CONTACT NAME	CONTACT DETAILS
Developer			
Site Superintendent (civil)			
Site Superintendent (landscape)			
Bioretention Designer			
Civil Engineer			
Landscape Architect			
Civil Contractor			
Landscape Contractor			
Other			
Other			
Other			
Comments (attach and refer to additional pages as necessary):			
Actions (attach and refer to additional pages as necessary):			



Bioretention System Identifier:				
FORM A - EARTHWORKS AND FUNCTIONAL HYDRAULIC STRUCTURES				
Purpose: To ensure earthworks bulking out, trimming and profiling and the key levels of functional (hydraulic) structures are in accordance with design drawings and specifications. The earthworks and structures dictate the movement of stormwater through the bioretention system and are a critical element in the function of the system.				
Items	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
As constructed survey complete and attached to this form				
Photos taken and attached to this form				
Set-out of system is correct				
Base levels are at correct elevation ($\pm 50\text{mm}$)				
Base at correct grading (0.5%)				
Punch out holes in overflow pit are correct size, correct level and above invert level of outlet pipe ($\pm 25\text{mm}$)				
Overflow pit is correct size and crest and invert is at correct level ($\pm 25\text{mm}$)				
Outlet pipe invert levels are correct (upstream & downstream)($\pm 25\text{mm}$)				
Outlet pipe is free draining				
Overflow weir (if required) is correct length and at correct level ($\pm 25\text{mm}$)				
Overflow weir (if required) is keyed into bund				
Bunds / embankments surrounding the system are correct levels or above				
HOLD POINT: Superintendent and Bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages as necessary):				
Signed by Superintendent		Signed by Bioretention Designer:		
Print Name:		Print Name:		
Date:		Date:		



Bioretention System Identifier:				
FORM B - UNDER DRAINAGE				
Purpose: To ensure under drainage is installed correctly before the bioretention media is installed.				
Items	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Base of system free from debris				
Liner (typically filter cloth) correctly installed (if required)				
There is no 'fabric sock' around the draincoil				
Correct draincoil has been supplied and slotted at 2mm or smaller				
Draincoil pipes are laid at the correct spacing (small bioretention systems 1.5 metres, large system 2.0 metres) Required grade verified using level or string line				
Draincoil pipes laid at required grade (verified using level or string line to achieve design level $\pm 25\text{mm}$ and 0.5% grade)				
Overflow pit is correct size and crest and invert is at correct level ($\pm 25\text{mm}$)				
All junctions and connections have been appropriately sealed				
Outlet pipe is free draining				
Top of clean-out points at design level (i.e. approximately 50 - 150mm above filter media level)				
HOLD POINT: Superintendent and Bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages as necessary):				
Signed by Superintendent		Signed by Bioretention Designer:		
Print Name:		Print Name:		
Date:		Date:		



Bioretention System Identifier:				
FORM C - BIORETENTION MEDIA				
Purpose: To ensure that the media placed in the system meets the required specifications and that there is a record of the media being delivered to site.				
To ensure media layers are installed correctly and meet the design and specification requirements				
Sourcing, Testing and Supplying Bioretention Media				
Drainage Layer	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Meet the specifications				
Meets the required hydraulic conductivity (180mm/hour)				
Delivery supply docket certifies that the material delivered is the material tested (delivery docket attached)				
Transition Layer Supply	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Meets the specifications				
Supplier certification provided (certification attached)				
Delivery supply docket certifies that the material delivered is the material tested (delivery docket attached)				
Filter Media Supply	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Meets the FAWB's guideline: <i>Biofiltration Filter Media Guidelines, Appendix C</i> (June 2009) (copy attached)				
Meets the required hydraulic conductivity (180mm/hour)				
Supplier certification provided (certification attached)				
Delivery supply docket certifies that the material delivered is the material tested (delivery docket attached)				
HOLD POINT: Superintendent and Bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages as necessary):				



Bioretention System Identifier:				
FORM C - BIORETENTION MEDIA - (continued)				
Installation of Bioretention Media				
	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Base of the system is free from debris				
Drainage layer (fine gravel) installed to correct depth (±25mm)				
Transition layer (coarse sand) installed to correct depth (±25mm)				
Placement of filter media completed to avoid compaction of media and using at least two lifts whilst being installed				
Filter media installed to correct depth				
Light and even compaction applied to remove air gaps (e.g., light roller or single pass with pozitrack bobcat)				
Spreader bar used to flatten surface of filter media				
Sediment fences in place				
INSPECTION: Superintendent and Bioretention designer inspection and sign-off to occur while installation of media is occurring. Photos must be taken by the superintendent, bioretention designer or the installer.				
Comments (attach and refer to additional pages as necessary):				
Signed by Superintendent		Signed by Bioretention Designer:		
Print Name:		Print Name:		
Date:		Date:		



Bioretention System Identifier:				
FORM D - FINISHED LEVELS				
Purpose: To ensure finished levels of the system surface and bunds are correct and meet the design.				
Items	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Landscaping topsoil applied to surrounding bunds to achieve design levels				
As-constructed survey of the system surface and surrounding bunds completed				
Final constructed levels are consistent with the design levels				
Under drainage clean-outs extended 50 - 150mm above finished filter media level				
Under drainage pipes are flushed to remove any sediment accumulation ingress during construction				
HOLD POINT: Superintendent and Bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages as necessary):				
Signed by Superintendent		Signed by Bioretention Designer:		
Print Name:		Print Name:		
Date:		Date:		



Bioretention System Identifier:				
<u>FORM E - COARSE SEDIMENT FOREBAY</u>				
Purpose: To ensure the coarse sediment forebay is constructed correctly.				
Items	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Extent of coarse sediment forebay correctly set out				
Rocks to be used to line the base of the forebay are correct size and shape				
Base of the constructed forebay is flat and set at the correct level below the surface of the filter media				
Rocks placed for energy dissipation are of appropriate size and in correct location				
Interface between the forebay and filter media is structurally sound and not prone to collapse				
HOLD POINT: Superintendent and Bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages as necessary):				
Signed by Superintendent		Signed by Bioretention Designer:		
Print Name:		Print Name:		
Date:		Date:		



Bioretention System Identifier:				
FORM F - PROTECTIVE MEASURES				
Purpose: To ensure protective measures are correctly installed to protect the bioretention system while building is occurring in / and around the catchment area of the bioretention system.				
Protection Option Adopted (choose 1, 2 or 3)				
Option 1: Surface Protection During Building Phase	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Continuous sediment fences are installed around the perimeter of the filter media and top of batter				
Where landscape works are not to commence immediately then cover batters with filter cloth				
Protective covering (filter cloth + 25mm topsoil + turf) installed across the entire filter media area of the system				
Option 2: Bypass and Early Establishment	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Continuous sediment fences are installed around the perimeter of the filter media and top of batter				
Where landscape works are not to commence immediately then cover batters with filter cloth				
Temporary bund installed (where required) to prevent stormwater run-off from entering bulk of system. Bund keyed into batters of bioretention system and crest level higher than pits and weirs				
Temporary protective covering (filter cloth + 25mm topsoil + turf) installed within the bunded area				
Comments (attach and refer to additional pages as necessary):				



Bioretention System Identifier:				
FORM F - PROTECTIVE MEASURES - (continued)				
Purpose: To ensure protective measures are correctly installed to protect the bioretention system while building is occurring in / and around the catchment area of the bioretention system.				
Option 3: Sediment Basin and Bioretention Function	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Continuous sediment fences are installed around the perimeter of the filter media and top of batter				
Sediment basin installed upstream of bioretention system in accordance with Chapter 2 of NSW Landcom's <i>Soil and Construction: Managing Urban Stormwater</i> (2004) manual - the "Blue Book", and shall be to the satisfaction of Council				
Suitable access provided to sediment basin for clean out				
Bioretention system installed downstream of sediment basin				
Protective covering (filter cloth + 25mm topsoil + turf) installed across the entire filter media area of the basin				
HOLD POINT: Superintendent and Bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages as necessary):				
Signed by Superintendent		Signed by Bioretention Designer:		
Print Name:		Print Name:		
Date:		Date:		



Bioretention System Identifier:				
FORM G - LANDSCAPE INSTALLATION				
Purpose: To ensure the correct plants are supplied, installed and established				
Items	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Correct mulch has been supplied				
Mulch applied at correct depth and secured				
Supplied plants are correct species				
Supplied plants are in correct pot sizes at maturity (e.g., minimum 300mm pots)				
Plants have been installed at the correct planting density (refer to the list entitled 'Plant Species for Bioretention Systems' for planting density specifications)				
As constructed drawings marked with final plant species and densities				
Mulch is clear of the plant stems by approximately 50mm				
HOLD POINT: Superintendent and Bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages as necessary):				
Signed by Superintendent		Signed by Bioretention Designer:		
Print Name:		Print Name:		
Date:		Date:		



Bioretention System Identifier:				
FORM H - LANDSCAPE ESTABLISHMENT				
Purpose: To ensure the correct plants are supplied, installed and established				
Items	Checked (Date)	Satisfactory	Action (If Unsatisfactory)	Initials
Weeds being removed as required				
Watering occurring as required				
Re-planting occurring as required to replace desiccated plants				
Plants successfully established, plant propagation is occurring. Measures of successful establishment include: ☼ survivorship greater than 90% ☼ 80% coverage of bioretention system by plants ☼ preferably more than one species per macrophyte zone ☼ at least 5 plants/m ² (preferably 6 - 10 plants/m ²) ☼ plant height at least 50% ☼ propagation is occurring (evident by new stems seeding) Growth and maturity should be recorded every three months, using photos as logs of development				
HOLD POINT: Superintendent and Bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages as necessary):				
Signed by Superintendent		Signed by Bioretention Designer:		
Print Name:		Print Name:		
Date:		Date:		

GUIDELINES FOR FILTER MEDIA IN BIOFILTRATION SYSTEMS (Version 3.01)

June 2009

The following guidelines for filter media in biofiltration systems have been prepared on behalf of the Facility for Advancing Water Biofiltration (FAWB) to assist in the development of biofiltration systems, including the planning, design, construction and operation of those systems.

NOTE: This is a revision of the previous FAWB guideline specifications (published in 2006 (Version 1.01), 2008 (Version 2.01)). It attempts to provide a simpler and more robust guideline for both soil-based and engineered filter media. FAWB acknowledges the contribution of EDAW Inc., Melbourne Water Corporation, Dr Nicholas Somes (Ecodynamics), Alan Hoban (South East Queensland Healthy Waterways Partnership), Shaun Leinster (DesignFlow) and STORM Consulting to the preparation of the revised guidelines.

Disclaimer

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1 GENERAL DESCRIPTION

The biofiltration filter media guidelines require three layers of media: the filter media itself (400-600 mm deep or as specified in the engineering design), a transition layer (100 mm deep), and a drainage layer (50 mm minimum cover over underdrainage pipe). The biofiltration system will operate so that water will infiltrate into the filter media and move vertically down through the profile.

The filter media is required to support a range of vegetation types (from groundcovers to trees) that are adapted to freely draining soils with occasional wetting. The material should be based on **natural or amended natural soils** or it can be **entirely engineered**; in either case, it can be of siliceous or calcareous origin. In general, the media should have an appropriately high permeability under compaction and should be free of rubbish, deleterious material, toxicants, declared plants and local weeds (as listed in local guidelines/Acts), and should not be hydrophobic.

The filter media should contain some organic matter for increased water holding capacity but be low in nutrient content. In the case of natural or amended natural soils, the media should be a **loamy sand**.

Maintaining an adequate infiltration capacity is crucial in ensuring the long-term treatment efficiency of the system. The ability of a biofiltration system to detain and infiltrate incoming stormwater is a function of the filter surface area, extended detention (ponding) depth, and the hydraulic conductivity of the filter media (Figure 1). Most importantly, design of a biofiltration system should optimize the combination of these three design elements.

For a biofiltration system in a temperate climate with an extended detention depth of 100 – 300 mm and whose surface area is approximately 2% of the connected impervious area of the contributing catchment, the prescribed hydraulic conductivity will generally be between 100 – 300 mm/hr in order to meet best practice targets (Figure 2). This configuration supports plant growth without requiring too much land space. In warm, humid (sub- and dry- tropical) regions the hydraulic conductivity may need to be higher in order to achieve the required treatment performance using the same land space (i.e., ensuring that the proportion of water treated through the media meets requirements).

Where one of these design elements falls outside the recommended range, the infiltration capacity can still be maintained by offsetting another of the design elements. For example, a filter media with a lower hydraulic conductivity may be used, but the surface area or the extended detention depth would need to be increased in order to maintain the treatment capacity. Similarly, if the available land were the limiting design element, the system could still treat the same size storm if a filter media with a higher hydraulic conductivity were installed. Where a hydraulic conductivity greater than 300 mm/hr is prescribed, potential issues such as higher watering requirements during the establishment should be considered. Biofiltration systems with a hydraulic conductivity greater than 600 mm/hr are unlikely to support plant growth due to poor water retention, and may also result in leaching of pollutants. However plant survival might be possible if the outlet pipe were raised to create a permanently submerged zone.

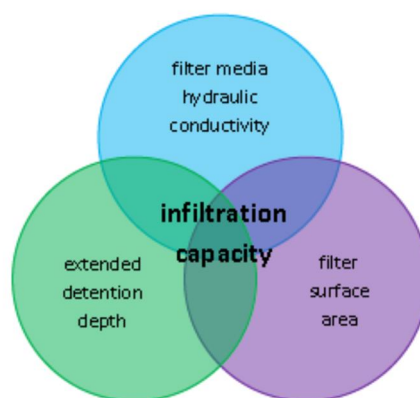


Figure 1. Design elements that influence infiltration capacity.

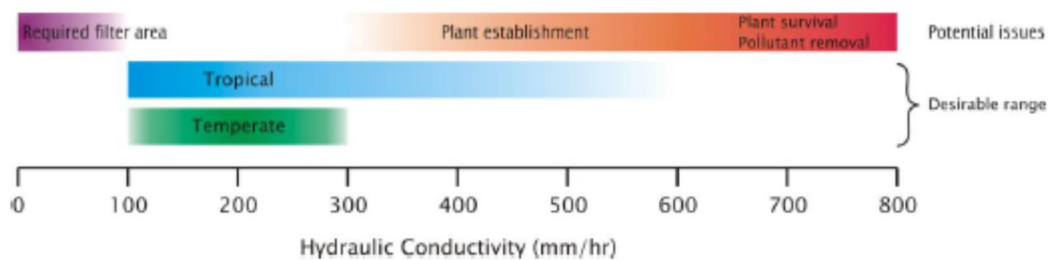


Figure 2. Recommended filter media hydraulic conductivity range and potential issues

The infiltration capacity of the biofiltration system will initially decline during the establishment phase as the filter media settles and compacts, but this will level out and then start to increase as the plant community establishes itself and the rooting depth increases. In order to ensure that the system functions adequately at its eventual (minimum) hydraulic conductivity, a safety co-efficient of 2 should be used: i.e., **designs should be modelled using half the prescribed hydraulic conductivity**. If a system does not perform adequately with this hydraulic conductivity, then the area and/or ponding depth should be increased. It may also be desirable to report sensitivity to infiltration rate, rather than simply having expected rate. This is important when assessing compliance of constructed systems as systems should ideally meet best practice across a range of infiltration rates.

2 TESTING REQUIREMENTS

2.1 Determination of Hydraulic Conductivity

The hydraulic conductivity of potential filter media should be measured using the ASTM F1815-06 method. This test method uses a compaction method that best represents field conditions and so provides a more realistic assessment of hydraulic conductivity than other test methods.

Note: if a hydraulic conductivity lower than 100 mm/hr is prescribed, the level of compaction associated with this test method may be too severe and so underestimate the actual hydraulic conductivity of the filter media under field conditions. However, FAWB considers this to be an appropriately conservative test, and recommends its use even for low conductivity media.

2.2 Particle Size Distribution

Particle size distribution (PSD) is of secondary importance compared with hydraulic conductivity. A material whose PSD falls within the following recommended range does not preclude the need for hydraulic conductivity testing i.e., it does not guarantee that the material will have a suitable hydraulic conductivity. However, the following composition range (percentage w/w) provides a useful guide for selecting an appropriate material:



Clay & Silt	<3%	(<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 mm)

Clay and silt are important for water retention and sorption of dissolved pollutants, however they substantially reduce the hydraulic conductivity of the filter media. This size fraction also influences the structural stability of the material (through migration of particles to block small pores and/or slump). It is essential that the total clay and silt mix is **less than 3% (w/w)** to reduce the likelihood of structural collapse of such soils.

The filter media should be well-graded i.e., it should have all particle size ranges present from the 0.075 mm to the 4.75 mm sieve (as defined by AS1289.3.6.1 - 1995). There should be no gap in the particle size grading, and the composition should not be dominated by a small particle size range. This is important for preventing structural collapse due to particle migration.

2.3 Soil-Based Filter Media: Properties

The following specifications are based on results of extensive treatment performance testing conducted by FAWB as well as recommendations made by AS4419 – 2003 (Soils for Landscaping and Garden Use). Filter media must be tested for the following; media that do not meet these specifications should be rejected or amended:

i. Total Nitrogen (TN) Content – <1000 mg/kg.

The specified TN content for this project is ~400mg/kg

ii. Orthophosphate (PO_4^{3-}) Content – <80 mg/kg

The specified orthophosphate content for this project is ~30mg/kg

Soils with total phosphorus concentrations >100 mg/kg should be tested for potential leaching. Where plants with moderate phosphorus sensitivity are to be used, total phosphorus concentrations should be <20mg/kg.

iii. Organic Matter Content – at least 3% (w/w). An organic content lower than 3% is likely to have too low a water holding capacity to support healthy plant growth. In order to comply with both this and the TN and PO_4^{3-} content requirements, a low nutrient organic matter will be required.

iv. pH – as specified for 'natural soils and soil blends' 5.5 – 7.5 (pH 1:5 in water).

v. Electrical Conductivity (EC) – as specified for 'natural soils and soil blends' <1.2 dS/m.

Optional testing:

vi. Dispersibility – this should be carried out where it is suspected that the soil may be susceptible to structural collapse. If in doubt, then this testing should be undertaken. Potential filter media should generally be assessed by a horticulturalist to ensure that they are capable of supporting a healthy vegetation community. This assessment should take into consideration delivery of nutrients to the system by stormwater. Any component or soil found to contain high levels of salt (as determined by EC measurements), high levels of clay or silt particles (exceeding the particle size limits set above), or any other extremes which may be considered retardant to plant growth should be rejected.

3 ENGINEERED FILTER MEDIA

Where there is not a locally available soil-based material that complies with the properties outlined in Sections 2.1 - 2.3, it is possible to construct an appropriate filter medium. A washed, well-graded sand with an appropriate hydraulic conductivity should be used as the filter medium. Suitable materials include those used for the construction of turf profiles (e.g. golf greens); these materials are processed by washing to remove clay and silt fractions. In large quantities (>20 m³), they can be obtained directly from sand suppliers, while smaller quantities can be purchased from local garden yards. The **top 100 mm of the filter medium** should then be ameliorated with appropriate organic matter, fertiliser and trace elements (Table 1). This amelioration is required to aid plant establishment and is designed to last four weeks; the rationale being that, beyond this point, the plants receive adequate nutrients via incoming stormwater.

Table 1. Recipe for ameliorating the top 100 mm of sand filter media

Constituent	Quantity (kg/100 m ² filter area)
Granulated poultry manure fines	50
Superphosphate 2	2
Magnesium sulphate 3	3
Potassium sulphate 2	2
Trace Element Mix 1	1
Fertilizer NPK (16.4.14) 4	4
Lime 20	20

Laboratory testing has shown that biofilters that contain an engineered filter medium will achieve essentially the same hydraulic and treatment performance as those containing a soil-based filter medium (Bratieres *et al.*, 2009). However, it is recommended that a submerged zone be included in biofiltration systems that utilise such a free draining filter medium to provide a water source for vegetation between rainfall events.

4 TRANSITION LAYER

The transition layer prevents filter media from washing into the drainage layer. Transition layer material shall be a clean, well-graded sand material containing <2% fines. To avoid migration of the filter media into the transition layer, the particle size distribution of the sand should be assessed to ensure it meets 'bridging criteria', that is, the smallest 15% of the sand particles bridge with the largest 15% of the filter media particles (Water by Design, 2009; VicRoads, 2004):

$$D_{15} (\text{transition layer}) \leq 5 \times D_{85} (\text{filter media})$$

where: D_{15} (transition layer) is the 15th percentile particle size in the transition layer material (i.e., 15% of the sand is smaller than D_{15} mm), and

D_{85} (filter media) is the 85th percentile particle size in the filter media.

A dual-transition layer, where a fine sand overlays a medium-coarse sand, is also possible. While it is acknowledged that this can increase the complexity of the construction process, testing indicates that a dual-transition layer produces consistently lower levels of turbidity and concentrations of suspended solids in treated outflows than a single transition layer. Therefore, it is recommended that this design be specified for stormwater harvesting applications (to enable effective post-treatment disinfection) and where minimising the risk of washout during the establishment period is of particular importance.

The transition layer can be omitted from a biofiltration system provided the filter media and drainage layer meet the following criteria as defined by the Victorian Roads *Drainage of Subsurface*

Water from Roads - Technical Bulletin No 32 (VicRoads, 2004):

$$D_{15} (\text{drainage layer}) \leq 5 \times D_{85} (\text{filter media})$$

$$D_{15} (\text{drainage layer}) = 5 \text{ to } 20 \times D_{15} (\text{filter media})$$

$$D_{50} (\text{drainage layer}) < 25 \times D_{50} (\text{filter media})$$

$$D_{60} (\text{drainage layer}) < 20 \times D_{10} (\text{drainage layer})$$

These comparisons are best made by plotting the particle size distributions for the filter media and gravel on the same soil grading graphs and extracting the relevant diameters (Water by Design, 2009).

5 DRAINAGE LAYER

The drainage layer collects treated water at the bottom of the system and conveys it to the underdrain pipes. Drainage layer material is to be clean, fine gravel, such as a 2 – 5 mm washed screenings. Bridging criteria should be applied to avoid migration of the transition layer into the drainage layer (Water by Design, 2009; VicRoads, 2004):

$D_{15} \text{ (drainage layer)} \leq 5 \times D_{85} \text{ (transition layer)}$

where: D_{15} (drainage layer) is the 15th percentile particle size in the drainage layer material (i.e., 15% of the gravel is smaller than D_{15} mm), and
 D_{85} (transition layer) is the 85th percentile particle size in the transition layer material.

Note: The perforations in the underdrain pipes should be small enough that the drainage layer cannot fall into the pipes. A useful guide is to check to that the D_{85} (drainage layer) is greater than the pipe perforation diameter.

Geotextile fabrics are **not recommended** for use in biofiltration systems due to the risk of clogging. An open-weave shade cloth can be placed between the transition layer and the drainage layer to help reduce the downward migration of smaller particles if required, however this should only be adopted where there is insufficient depth for transition and drainage layers.

6 INSTALLATION

It is recommended that filter media be lightly compacted during installation to prevent migration of fine particles. In small systems, a single pass with a vibrating plate should be used to compact the filter media, while in large systems, a single pass with roller machinery (e.g. a drum lawn roller) should be performed. Under no circumstance should heavy compaction or multiple-passes be made. Filter media should be installed in two lifts unless the depth is less than 500 mm

7 FIELD TESTING

It is recommended that field testing of hydraulic conductivity be carried out at least twice: 1. One month following commencement of operation, and 2. in the second year of operation to assess the impact of vegetation on hydraulic conductivity.

The hydraulic conductivity of the filter media should be checked at a minimum of three points within the system. The single ring, constant head infiltration test method (shallow test), as described by Le Coustumer *et al.* (2007), should be used. Given the inherent variability in hydraulic conductivity testing and the heterogeneity of the filter media, the laboratory and field results are considered comparable if they are within 50% of each other. However, even if they differ by more than 50%, the system will still function if both the field and laboratory results are within the relevant recommended range of hydraulic conductivities.



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SOWDES

Routine maintenance requirement for Biofiltration Systems and Raingardens.

To be performed every three months or as site conditions dictate after significant weather events.

Item to be monitored	Purpose of monitoring	Performance target	Schedule maintenance or investigation	Immediate action required	Maintenance action required
The inlet and outlet structures of a bioretention system or raingarden should be free of debris, litter and sediment to ensure flow is not impeded. Large storms, flood events and vehicles can also damage or block these structures and prevent the system working as designed. The main structural and monitoring elements of a bioretention system or raingarden are:					
Structures	- Inlet structures, pits, grates and channels - Overflow pipes, junction pits, underdrains and outlet pipes	Clear and undamaged	Partially blocked, observed damage	Mostly blocked, severe damage	Organise removal of debris, inspect for associated erosion and scour damage within the raingarden and organise repair work as required
Erosion	Erosion will affect the distribution of flow across the raingarden. If left untreated small sites of erosion can quickly spread over large areas becoming costly to repair	Erosion absent	Erosion damage visible but structure functional	Severe erosion. Damage impairing function of the raingarden	Schedule investigation into cause of the erosion. Once the source of the damage is rectified scour holes should be replaced with appropriate filter material. Replace any damaged plants to meet the design plant schedule
Sediment build up	The accumulation of sediment is part of the prescribed function of a raingarden. However, sediment must be regularly removed when accumulated to ensure that the sediment trapping performance of this system is sustained.	Sediment absent	Sediment accumulation appears excessive	Sediment accumulation to more than 10% of surface area	Undertake investigation to identify sediment source. Remove accumulated debris. Replace any damaged plants to meet the design plant schedule
Weeds	Weeds should be removed from the sedimentation basin: - Weeds compete with the desirable plants for the available soil moisture - Weeds compromise the visual amenity of the raingardens	No weeds present	Weeds present	Noxious or environmental weeds present, or weeds cover more than 25%	Hand removal or targeted herbicide treatment with registered chemicals. General spraying should not be undertaken as overspray will kill the desirable plant species.



Item to be monitored	Purpose of monitoring	Performance target	Schedule maintenance or investigation	Immediate action required	Maintenance action required
Plant condition	Plants are crucial to the performance, function and visual amenity of the raingardens. The raingardens become as much a feature of the development as the buildings themselves.	Healthy vegetation	Poorly growing or visually stressed	Die back / dead plants	Investigate possible causes of observed changes in plant health; eg, due to inappropriate soil moisture content, disease, competition by weeds, poison containment. Once the problem has been rectified infill re-planting may be required if more than 10% of plants are affected which must be as per the original design planting schedule.
Litter - organic	Organic litter can provide an additional source of nutrients and introduce weed species which can compete for soil moisture and reduce raingarden efficacy. Accumulated organic matter and litter can affect the visual amenity of the raingardens	No litter visible	Litter visible	Litter blocking structures or detracting from visual amenity	Identify the sources of organic litter and address with appropriate response action. All litter must be removed from the raingarden.
Litter - anthropogenic	Litter can potentially block the inlet and outlet structures resulting in flooding, as well as detract from the visual amenity	No litter visible	Litter visible	Litter blocking structures or detracting from visual amenity	Identify and address the sources of rubbish generating within the development eg, overflow from rubbish bins, dumping or wind blown from nearby sources.
Oil slicks	Oil spills / inflows are better trapped and isolated within a raingarden than allowed to flow to enter the stormwater system	No visible oil	Persistent but limited visible oil	Extensive or localised thick layer of oil visible	It is better that the oil is contained within the system rather than allowed to flow to the downstream waterway. Once contained and 'mopped up' remove affected section of raingarden and replace with same as original filter media and plant species.



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SOWDES

Maintenance checklist – Biofiltration Systems / Raingardens.

Recommended to be undertaken every 3 months, as necessary after significant rain events or as site conditions dictate.

Item		Performance Target	Schedule Maintenance or Investigation	Immediate Action Required	Comment	Action Processed
		Tick relevant category or write 'NA' in Comments column				
1	Inlet structures, grates & pits	Clear and undamaged	Partially blocked or observed damage	Mostly blocked, severe damage		
		☐	☐	☐		
2	Overflow pits & grates	Clear and undamaged	Partially blocked or observed damage	Mostly blocked, severe damage		
		☐	☐	☐		
3	Underdrains	Clear and undamaged	Partially blocked or observed damage	Mostly blocked, severe damage		
		☐	☐	☐		
4	Erosion	Erosion absent	Erosion damage visible but function not impaired	Severe erosion damage impairing function of device		
		☐	☐	☐		
5	Sediment accumulation (raingardens)	Sediment absent	Fine sediment accumulation apparent on the raingarden media surface	Coarse sediment or large volumes of sediment accumulation apparent on the raingarden media surface		
		☐	☐	☐		



Item		Performance Target	Schedule Maintenance or Investigation	Immediate Action Required	Comment	Action Processed
		Tick relevant category or write 'NA' in Comments column				
6	Compaction of filter media surface	No compaction evident	Localised compaction or subsidence evident. Localised ponding longer than 24 hours after storm event	Water remains ponding longer than 24 hours after storm event		
		☐	☐	☐		
7	Weeds	No weeds present	Weeds present	Noxious or environmental weeds present or weed cover > 25%		
		☐	☐	☐		
8	Plant condition	Healthy vegetation	Poorly growing or visibly stressed	Die back or dead plants		
		☐	☐	☐		
9	Litter (organic)	No litter visible	Litter visible	Litter thickly covers filter media surface or detracting from visual amenity		
		☐	☐	☐		
10	Litter (anthropogenic)	No litter visible	Litter visible	Litter blocking structures or detracting from visual amenity		
		☐	☐	☐		
11	Oil spills/inflows	No visible oil	Persistent but limited visible oil	Extensive or localised thick layer of oil visible		
		☐	☐	☐		

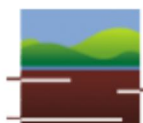
Biofiltration System Plant Species **(check with local nurseries for other options)**







TYPICAL ANALYSIS OF MEDIA USED IN BIOFILTRATION DEVICES



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Quality
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Batch N°: 21713A Sample N°: 1 Date Received: 15/3/12 Report Status: ☐ Draft ☒ Final

Client Name: Benedict Industries Project Name: FAWB Analysis
 Client Contact: David Connor Location: M165 Standard Testing
 Client Job N°: SESL Quote N°:
 Client Order N°: Sample Name: M165
 Address: PO Box 431 Description: Soil
 FRENCHS FOREST NSW 1640 Test Type: PSA US, HC-USGA, Olsen P

Particle Range (mm)	Fraction	% Retained by mass	Target Range
>3.35	Gravel	0.3	-
2.0 - 3.35	Fine Gravel	0.2	< 3.0 %
1.0 - 2.0	Very Coarse Sand	0.6	7 - 10 %
0.25 - 1.0	Medium to Coarse Sand	78.2	40 - 60 %
0.15 - 0.25	Fine Sand	14.1	10 - 30 %
0.05 - 0.15	Fine to Very Fine Sand	3.3	5 - 30 %
<0.05	Silt and Clay	3.1	< 3.0 %
Physical Performance			
Hydraulic Conductivity			
Predicted based in PSA		839	
Actual ASTM F 1815-06		457	> 100 mm/hr
Soil Properties			
Organic Matter	% dry weight	1.2	≥ 3.0 %
pH in H ₂ O (1:5)	pH unit	7.4	5.5 - 7.5
Electrical Conductivity (1:5)	dS/m	0.16	< 1.2 dS/m
Phosphorus (Olsen)	mg/kg	9.3	< 80 mg/kg
Total Nitrogen	mg/kg	600	< 1000 mg/kg

Commentary from SESL not requested.

Consultant: Scott Fraser

Authorised Signatory:

Methods

< 4.75mm by hydrometer sedimentation (Reference BS 410 (1975) Method 4-5)

< 4.75 > 4.75mm by wet sieve analysis

> 4.75mm by dry sieve analysis (Reference ASTM F 1815-06 modified)

Hydraulic conductivity to ASTM F 1815-06

Soil Properties were assessed in accordance with AS 4454-2008 (Soils for Landscaping and Garden Use). The Bio Retention Filter Media Guidelines (Version 3.1), prepared by the Facility and endorsed under Bio Retention (FAWB), June 2011 was used for the interpretation of the test.

Date of Report: 05/03/2012

END OF REPORT

Total No Pages: 1/1

8. Conceptual Soil and Water Management Strategy.

The following erosion and sediment control measures are recommended for the site during the site establishment and operational phases of the development and are to read in conjunction with the 'Blue Book' (Landcom 2004), the *Stormwater Drainage and Water Quality Management Site Plan* – Ref: 0060222-S101-A, and the *Conceptual Soil and Water Management Site Plan* – Ref: 0060222-E101-A.

Site pre-works and establishment

- For the duration of the civil works phase establish a stabilised site access in accordance with Standard Drawing SD6-14 at each of the proposed entrances to the site that will eventually become the formal entrance and exit points for the metal recycling precinct component of the development.
- Prior to the commencement of any civil works install sediment control barriers in accordance with Standard Drawing SD6-8 along the eastern aspect of the recycling precinct and the location of Basin #3 and the biofiltration raingarden system and ensure that the clean water diversion on the western and southern aspects are formed.
- Establish a site office and compound area that will be the designated space for carparking on the site for the duration of the civil works.
- Define the work areas for the construction and installation of the various stormwater quality improvement devices (SQID's) and create a clear separation from the main traffic streams that will be used during the earthworks and civil works.
- Determine the location for separate stockpile areas for rubble, concrete, and excavated spoil within the higher elevations of the site and away from any overland flow paths, form the stockpiles in accordance with Standard Drawing SD4-1 and line the lower side of each stockpile with barrier fencing in accordance with Standard Drawing SD6-8.
- Determine a site for the placement of general rubbish and the delivery of associated materials to the site – in particular the supply of the soils and earth-based filter media materials and line the lower side of each site with barrier fencing in accordance with Standard Drawing SD6-8.
- As much as possible and practical limit the amount of delivered soil-based materials to quantities that can be installed at one time to avoid the need for stockpiling
- Terminate all redundant utilities and services that are in the nominated work zone, make safe, and remove unwanted infrastructure.
- Until all works associated with the development are completed check and maintain the condition of all sediment control fences and other measures on a weekly basis or after rain events that generate 25mm or more within a 24 hour period, and be prepared to stop all works on short notice if there is a possibility that rain events could generate overland flows that could burden the site.
- Prior to commencing any bulk earthworks have provisions and arrangements in place for the transfer of virgin excavated soil, gravel, and/or rock materials to a suitable receival facility that will be in excess of the quantities that can practically be re-used on the site - spreading of excess spoil or other excavated materials on the site it not permitted due to potential changes in surface water flow patterns and possible downstream impacts.

Construction phase – metal recycling precinct, access, car park areas, and water treatment areas

- Maintain and continue to use the established stabilised site accesses created off Murrays Flat Road for the duration of the civil works
- Erect sediment control barriers in accordance with Standard Drawing SD6-8 along the lower eastern aspects of the development site and maintain until all earthworks are completed and re-vegetation / landscaping has achieved an effective 80% cover.
- Create the clean water diversion swales and berms along the western and southern aspects of the recycling precinct to redirect surface water away from the work zones.
- Remove all bitumen, concrete, sub-grade materials, topsoil, and excess soil from the metal recycling precinct, the internal roadways, car parking provisions, sedimentation basins, and biofiltration raingarden system including any inground services and temporarily store in the nominated stockpile areas for later use and/or removal off site
- Decommission the existing dam located to the east of the proposed location for the workshop and recycling shed structures by draining the water, allowing the area to dry to a workable state, and then fill with clean material in layers not exceeding 150mm with compaction of each layer to achieve 98% dry density ratio to standard compaction.
- Undertake all site levelling and/or regrading to the design specifications to establish the base levels and profiles for the new works and stabilise any batters with a grass cover once the final levels are achieved - place all excess materials in the nominated stockpile areas and bays for later reuse or removal offsite.
- Install all inground pipes, pits, and junctions associated with the installation of stormwater and sewer drainage services, the water supply systems, and all utilities within the metal recycling precinct and between the administration precinct and the metal recycling precinct and cap-off or terminate so as to not cause nuisance and protect from possible damage.
- Construct the sedimentation basins to the design levels including the incoming and outgoing pipes, and allow each basin to be used as a temporary sedimentation basin for the duration of the earthworks and site regrading. Water captured in the sedimentation basins can be reused throughout the civil works phase for dust suppression, irrigating landscaped areas, and material compaction purposes.
- For the duration of the civil works the collection, treatment, and use of water within the sedimentation basins is to be managed in accordance with Section 6.3 of the 'Blue Book' (Landcom, 2004).
- Undertake the subsurface waterproofing works to the manufacturer's technical instructions and specifications and ensure that all treatment layers are installed properly and sealed around possible weak points such as the pit and pipe upturns, concrete plinths and slabs, retaining walls, and any other service or infrastructure element that will penetrate the continuity of the lining materials.
- Once the waterproofing process is completed and certified the base layer of the gravel materials can be imported and compacted in layers not exceeding 100mm to the design levels and grades under the supervision of a certified geotechnical engineer.



- It is recommended that the concrete roadways not be constructed at this stage to alleviate the possibility of unnecessary damage, and to allow continued traffic movement over the compacted gravel which will help stabilise and test the base layers for any weaknesses before the roadway is finally formed and finished.
- For pits and pipe upturns associated with the drainage systems that will not be finished until later in the works protect the inlets from sediment ingress in accordance with Standard Drawing SD6-12 and retain until all earthworks and the drainage systems are finalised.
- After the gravel layers are finished construction can commence for the new buildings to the design specifications and the placement of processing machinery with covers can be undertaken in the designated locations.
- Once the new sheds are constructed the proposed 150,000 litre rainwater tank is to be installed to allow the rainwater runoff from the sheds to drain into the tank and lessen any nuisance around the work zones.
- Similarly, once the processing machinery is installed and roofed covers completed the rainwater runoff from these structures is to be connected to the stormwater pits along the southern edge of the internal link roadway to also lessen any nuisance around the work zone.
- When construction of the sheds and the placement of the processing machinery is completed any final trimming, filling, levelling, and compaction of the gravel base layer is to be undertaken in readiness for forming and pouring of the internal concrete roadways to the design details.
- With the internal carriageways completed the grass lined swale along the eastern aspect of the recycling precinct can be formed to the design levels and grades, and at the same time the clean water diversions on the western and southern aspects of the recycling precinct can be checked for any damages, rectified and necessary to ensure that they will continue to divert clean water away, and any re-vegetation can be implemented.
- At this stage the sedimentation basins can be decommissioned from their temporary function during the civil works phase to their intended permanent use by appropriately settling the water and decanting the contents, allowing the surface to dry to a workable state, and then placing the waterproofing membranes and geotextile layers as per the manufacturer's specifications.
- The final phase of the civil works involves the construction of the biofiltration raingarden system on the outlet side of Basin #3 to the design details and specifications, and the placement of the drainage layer, filter media, rock mulch cover, and vegetation to achieve the required plant density over the entire surface area. This stage should be undertaken close to the end of the civil works to help prevent sediment laden stormwater drainage adversely affecting the different filter and drainage layer materials, and to protect the integrity of the plans until such time as cleaner water is effectively entering the system.
- After all earthworks and the construction of the new buildings and covers are completed remove any excess excavated materials that cannot be reused otherwise on the site along with other rubbish and general waste to an approved offsite repository.

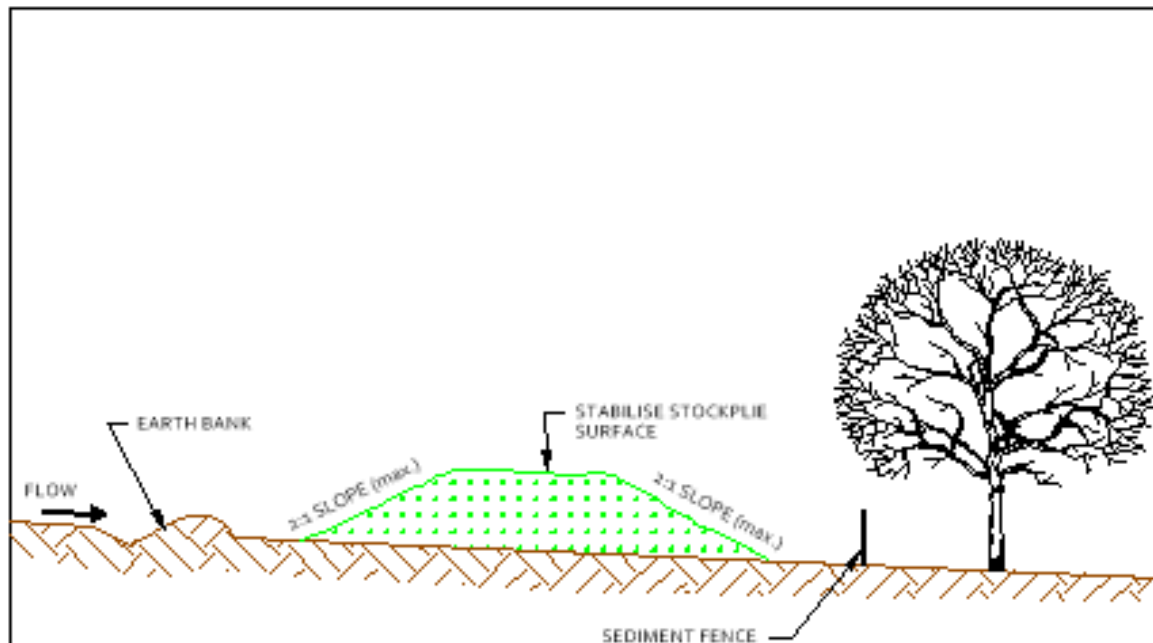


Post construction undertakings;

- Remove all temporary barrier fencing and sediment control measures once any re-vegetation and/or landscaping has achieved the desired effective cover or finish
- Monitor the survivability of the plants within the biofiltration system and replace as necessary until at least 80% effective cover has been established

General comments;

- Check the condition of all sediment control fencing at least weekly and after rain events and rectify as necessary to ensure that they are effective and ready for next rain event
- All topsoil stockpiles to be in accordance with Landcom Standard Drawing SD4-1
- All sediment control barriers to be in accordance with Landcom Standard Drawings SD6-8
- All pipe upturns and drainage pits to be protected from sediment laden stormwater ingress in accordance with Standard Drawing SD6-12
- The stabilised site accesses are to be installed in accordance with Landcom Standard Drawing SD6-14

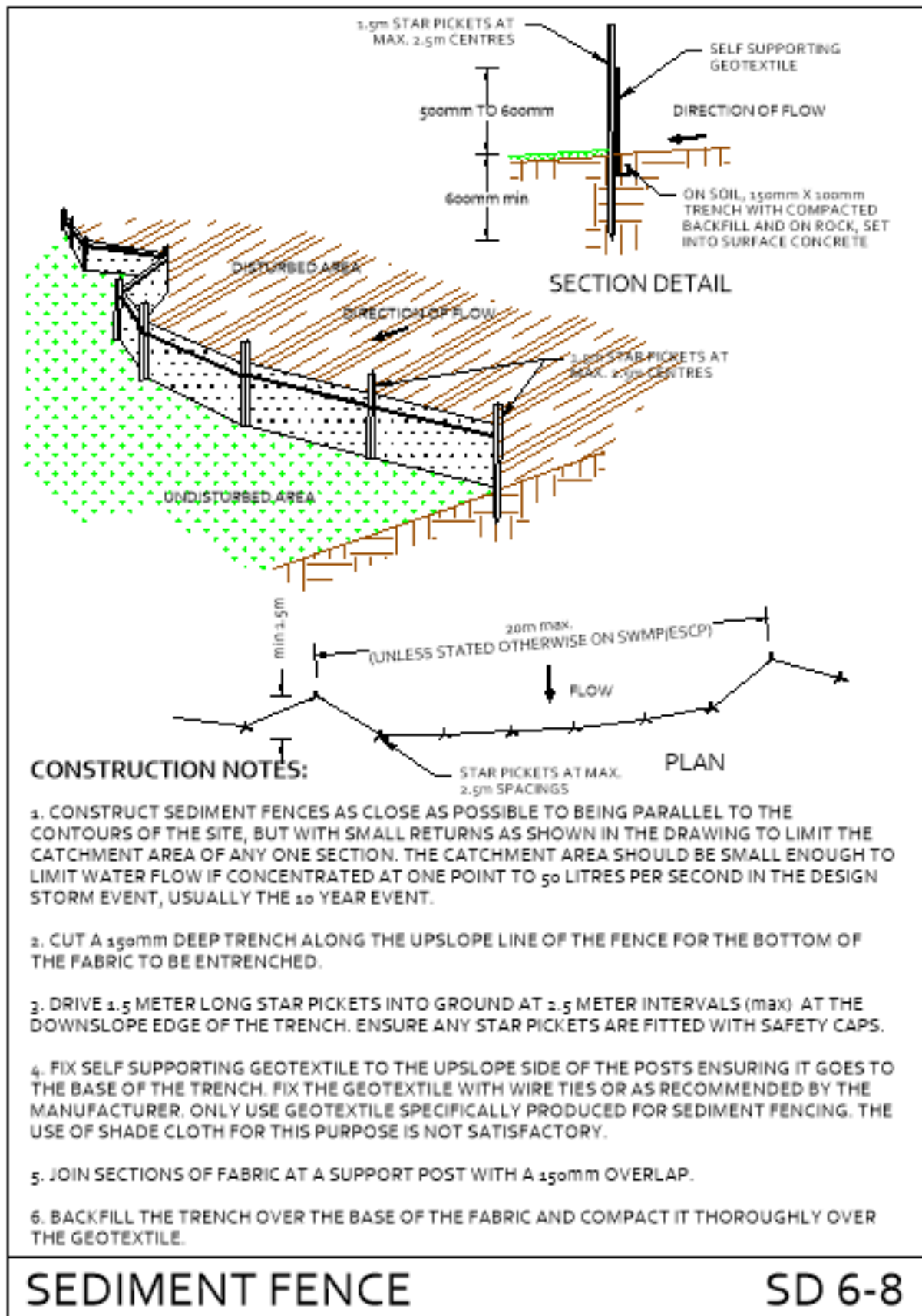


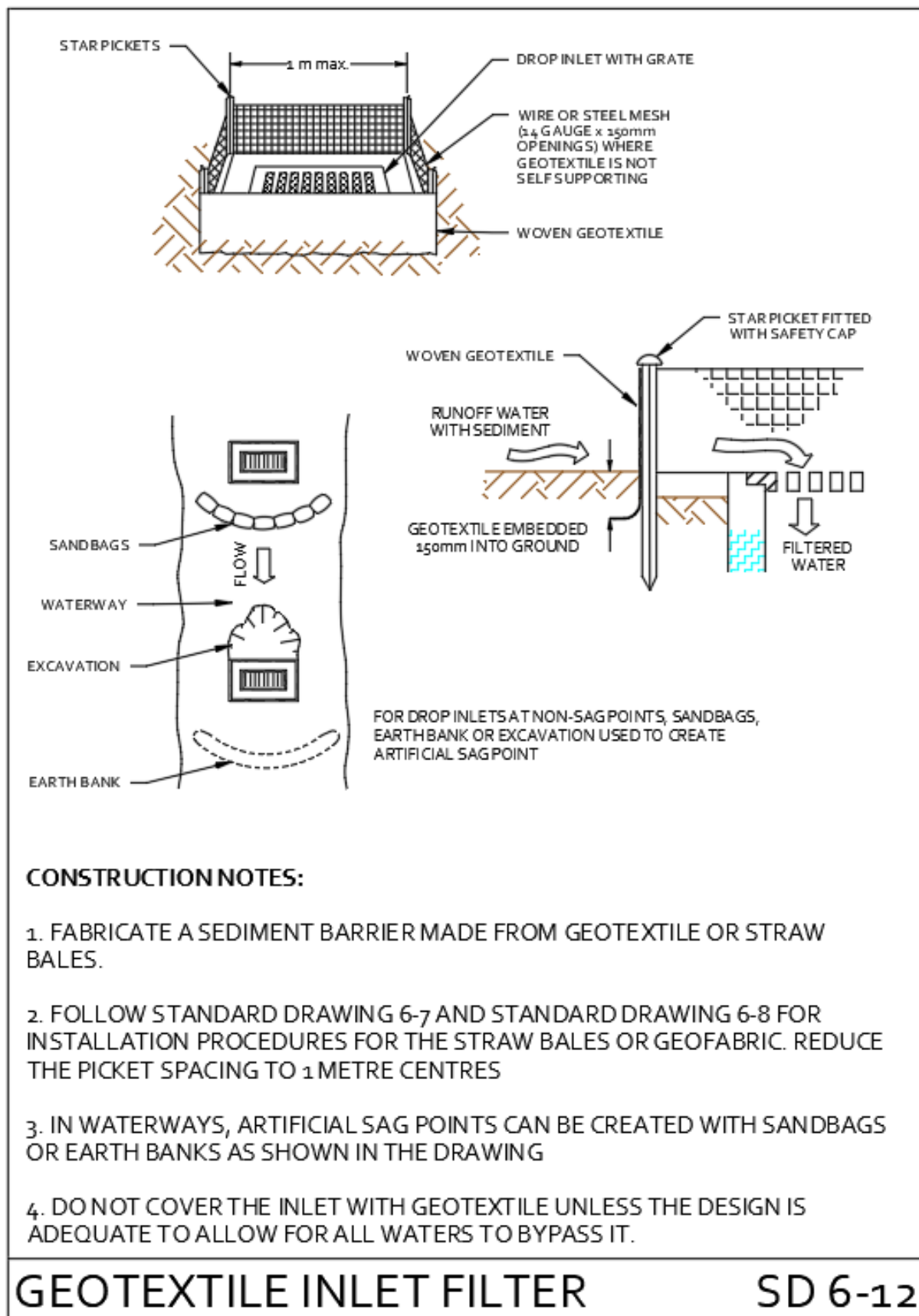
CONSTRUCTION NOTES:

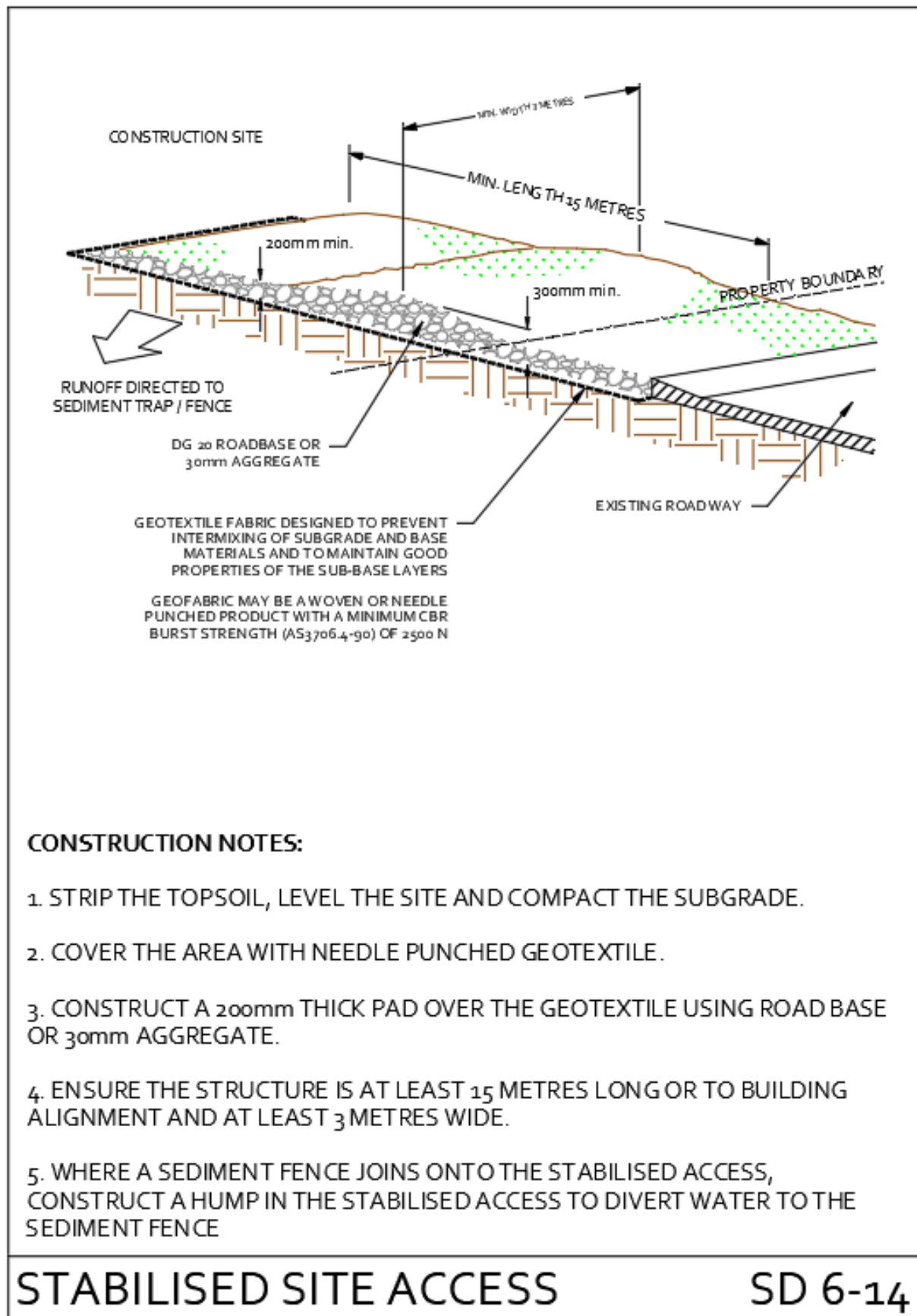
1. PLACE STOCKPILES MORE THAN 2 (PREFERABLY 5) METRES FROM EXISTING VEGETATION, CONCENTRATED WATER FLOW, ROADS AND HAZARD AREAS.
2. CONSTRUCT ON THE CONTOUR AS LOW, FLAT, ELONGATED MOUNDS.
3. WHERE THERE IS SUFFICIENT AREA, TOPSOIL STOCKPILES SHALL BE LESS THAN 2 METRES IN HEIGHT
4. WHERE THEY ARE TO BE IN PLACE FOR MORE THAN 10 DAYS, STABILISE FOLLOWING THE APPROVED ESCP OR SWMP TO REDUCE THE C-FACTOR TO LESS THAN 0.10
5. CONSTRUCT EARTH BANKS (STANDARD DRAWING 5-5) ON THE UPSLOPE SIDE TO DIVERT WATER AROUND STOCKPILES AND SEDIMENT FENCES (STANDARD DRAWING 6-8) TO 1 TO 2 METRES DOWNSLOPE

STOCKPILES

SD 4-1







Site pre-works and establishment

- For the duration of the civil works phase establish a stabilised site access in accordance with Standard Drawing SD6-14, at each of the proposed entrances to the site that will eventually become the formal entrance and exit points for the metal recycling precinct component of the development.
- Prior to the commencement of any civil works install sediment control barriers in accordance with Standard Drawing SD6-8 along the eastern aspect of the recycling precinct and the location of Basin #3 and the biofiltration raingarden system.
- Establish a site office and compound area that will be the designated space for carparking on the site for the duration of the civil works.
- Define the work area for the construction and installation of the various stormwater quality improvement devices (SQUID's) and create a clear separation from the main traffic streams that will be used during the earthworks and civil works.
- Determine the location for separate stockpile areas for rubble, concrete, and excavated spoil within the higher elevations of the site and away from any overland flow paths, form the stockpiles in accordance with Standard Drawing SD4-1 and line the lower side of each stockpile with barrier fencing in accordance with Standard Drawing SD6-8.
- Determine a site for the placement of general rubbish and the delivery of associated materials to the site – in particular the supply of the soils and earth-based filter media materials and line the lower side of each site with barrier fencing in accordance with Standard Drawing SD6-8.
- As much as possible and practical limit the amount of delivered soil-based materials to quantities that can be installed at one time to avoid the need for stockpiling
- Terminate all redundant utilities and services that are in the nominated work zone, make safe, and remove unwanted infrastructure.
- Until all works associated with the development are completed check and maintain the condition of all sediment control fences and other measures on a weekly basis or after rain events that generate 25mm or more within a 24 hour period, and be prepared to stop all works on short notice if there is a possibility that rain events could generate overland flows that could burden the site.
- Prior to commencing any bulk earthworks have provisions and arrangements in place for the transfer of virgin excavated soil, gravel, and/or rock materials to a suitable receive facility that will be in excess of the quantities that can practically be re-used on the site - spreading of excess spoil or other excavated materials on the site it not permitted due to potential changes in surface water flow patterns and possible downstream impacts.

Construction phase – metal recycling precinct, access, car park areas, and water treatment areas

- Maintain and continue to use the established stabilised site accesses created off Murrays Flat Road for the duration of the civil works
- Erect sediment control barriers in accordance with Standard Drawing SD6-8 along the lower eastern aspects of the development site and maintain until all earthworks are completed and re-vegetation / landscaping has achieved an effective 80% cover.
- Create the clean water diversion swales and berms along the western and southern aspects of the recycling precinct to redirect surface water away from the work zones.
- Remove all bitumen, concrete, sub-grade materials, topsoil, and excess soil from the metal recycling precinct, the internal roadways, car parking provisions, sedimentation basins, and biofiltration raingarden system including any inground services and temporarily store in the nominated stockpile areas for later use and/or removal off site
- Decommission the existing dam located to the east of the proposed location for the workshop and recycling shed structures by draining the water, allowing the area to dry to a workable state, and then fill with clean material in layers not exceeding 150mm with compaction of each layer to achieve 98% dry density ratio to standard compaction.
- Undertake all site levelling and/or regrading to the design specifications to establish the base levels and profiles for the new works and stabilise any batters with a grass cover once the final levels are achieved - place all excess materials in the nominated stockpile areas and bays for later reuse or removal offsite.
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- Once the waterproofing process is completed and certified the base layer of the gravel materials can be imported and compacted in layers not exceeding 100mm to the design levels and grades under the supervision of a certified geotechnical engineer.
- It is recommended that the concrete roadways not be constructed at this stage to alleviate the possibility of unnecessary damage, and to allow continued traffic movement over the compacted gravel which will help stabilise and test the base layers for any weaknesses before the roadway is finally formed and finished.
- For pits and pipe upturns associated with the drainage systems that will not be finished until later in the works protect the inlets from sediment ingress in accordance with Standard Drawing SD6-12 and retain until all earthworks and the drainage systems are finalised.
- After the gravel layers are finished construction can commence for the new buildings to the design specifications and the placement of processing machinery with covers can be undertaken in the designated locations.
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- At this stage the sedimentation basins can be decommissioned from their temporary function during the civil works phase to their intended permanent use by appropriately settling the water and dewatering the contents, allowing the surface to dry to a workable state, and then placing the waterproofing membranes and geotextile layers as per the manufacturer's specifications.
- The final phase of the civil works involves the construction of the biofiltration raingarden system on the outlet side of Basin #3 to the design details and specifications, and the placement of the drainage layer, filter media, rock mulch cover, and vegetation to achieve the required plant density over the entire surface area. This stage should be undertaken close to the end of the civil works to help prevent sediment laden stormwater drainage adversely affecting the different filter and drainage layer materials, and to protect the integrity of the plans until such time as cleaner water is effectively entering the system.
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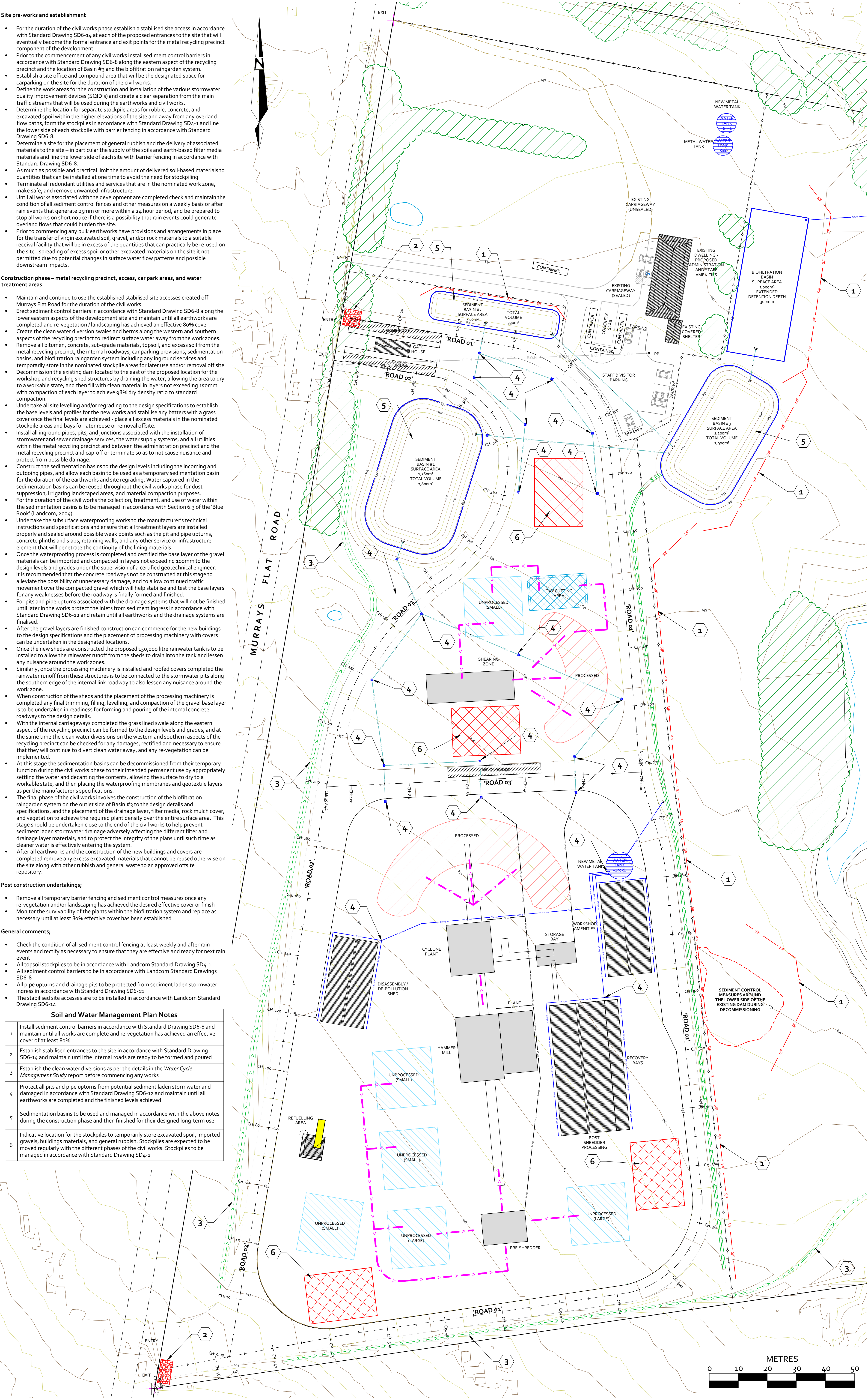
Post construction undertakings;

- Remove all temporary barrier fencing and sediment control measures once any re-vegetation and/or landscaping has achieved the desired effective cover or finish
- Monitor the survivability of the plants within the biofiltration system and replace as necessary until at least 80% effective cover has been established

General comments;

- Check the condition of all sediment control fencing at least weekly and after rain events and rectify as necessary to ensure that they are effective and ready for next rain event
- All topsoil stockpiles to be in accordance with Landcom Standard Drawing SD4-1
- All sediment control barriers to be in accordance with Landcom Standard Drawings SD6-8
- All pipe upturns and drainage pits to be protected from sediment laden stormwater ingress in accordance with Standard Drawing SD6-12
- The stabilised site accesses are to be installed in accordance with Landcom Standard Drawing SD6-14

Soil and Water Management Plan Notes	
1	Install sediment control barriers in accordance with Standard Drawing SD6-8 and maintain until all works are complete and re-vegetation has achieved an effective cover of at least 80%
2	Establish stabilised entrances to the site in accordance with Standard Drawing SD6-14 and maintain until the internal roads are ready to be formed and poured
3	Establish the clean water diversions as per the details in the <i>Water Cycle Management Study</i> report before commencing any works
4	Protect all pits and pipe upturns from potential sediment laden stormwater and damaged in accordance with Standard Drawing SD6-12 and maintain until all earthworks are completed and the finished levels achieved
5	Sedimentation basins to be used and managed in accordance with the above notes during the construction phase and then finished for their designed long-term use
6	Indicative location for the stockpiles to temporarily store excavated spoil, imported gravels, buildings materials, and general rubbish. Stockpiles are expected to be moved regularly with the different phases of the civil works. Stockpiles to be managed in accordance with Standard Drawing SD4-1



PROJECT TITLE:
METAL RECYCLING FACILITY DEVELOPMENT

DRAWING TITLE:
CONCEPTUAL SOIL AND WATER MANAGEMENT SITE PLAN

TITLE PARTICULARS:
LOT 3 DP251779

STREET ADDRESS:
**88 MURRAY'S FLAT ROAD
TOWRANG, NSW. 2580**

DRAWING DATE:
01/10/2025

PROJECT NUMBER:
0060222

DRAWING SCALE:
1:600

DRAWING REFERENCE:
E101

CONTOUR INTERVALS
MAJOR: 1.0m
MINOR: 0.5m

REVISION / DATE / DESCRIPTION:

A	01/10/2025	DEVELOPMENT APPLICATION
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SHEET NUMBER:
01

DRAWN BY:
PJ

SHEET SIZE:
A1

REVISION:
A

31 Huddle Avenue
Caulburn, NSW 2580
E: sowedes@power.com
M: 0428 863 401

SOWDES

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THIS SITE PLAN IS TO BE READ IN CONJUNCTION WITH SECTION 4 AND SECTION 8 OF THE ACCOMPANYING 'WATER CYCLE MANAGEMENT STUDY' REPORT.

STOCKPILES

SD 4-1

CONSTRUCTION NOTES:

- PLACE STOCKPILES NO MORE THAN 1 (PREFERABLY 0.5) METRES FROM EXISTING VEGETATION, CONCENTRATED WATER FLOW, ROADS AND HAZARDOUS AREAS.
- CONSTRUCT ON THE CONTOUR AS LOW, FLAT, ELONGATED MOUNDS.
- WHERE THERE IS SURFACE AREA, TOPSOIL STOCKPILES SHALL BE LESS THAN 1 METRE IN HEIGHT.
- WHERE THEY ARE TO BE IN PLACE FOR MORE THAN 30 DAYS, STABILISE FOLLOWING THE APPROVED SLOPE OR GRAD TO REDUCE THE CHANCE OF EROSION TO LESS THAN 0.10.

STANDARD DRAWING: 4-1 TO 1 METRES DOWNLOADER

SEDIMENT FENCE

SD 6-8

CONSTRUCTION NOTES:

- CONSTRUCT SEDIMENT FENCE AS CLOSE AS POSSIBLE TO BANK CHANNELS TO THE CATCHMENT AREA OF ANY ONE SECTION. THE CATCHMENT AREA SHALL BE SMALL ENOUGH TO ALLOW MATERIALS CONCENTRATED IN ONE POINT TO BE REMOVED BY THE DESIGN OF THE FENCE.
- LOCATE SEDIMENT FENCE ALONG THE UP-SLOPE LINE OF THE FENCE FOR THE BOTTOM OF THE FENCE.
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GEOTEXTILE INLET FILTER

SD 6-12

CONSTRUCTION NOTES:

- FABRICATE A SEDIMENT BARRIER MADE FROM GEOTEXTILE OR STRAW BALES.
- FOLLOW STANDARD DRAWINGS 6-1 AND STANDARD DRAWING 6-8 FOR NOT ALLATION PROCEDURES FOR THE STRAW BALES OR GEOTEXTILE. REDUCE THE PORE SPACING TO 10 METRE CENTRES.
- IN WATERWAYS, ARTIFICIAL SLOPE POINTS CAN BE CREATED WITH SANDBAGS OR EARTH BANS AS SHOWN IN THE DRAWING.
- DO NOT COVER THE INLET WITH GEOTEXTILE UNLESS THE DESIGN IS ADEQUATE TO ALLOW FOR ALL WATERS TO BE PASSED.

STABILISED SITE ACCESS

SD 6-14

CONSTRUCTION NOTES:

- STRIP THE TOPSOIL LEVEL, THE SITE AND COMPACT THE SUBGRADE.
- COVER THE AREA WITH NEEDLE PUNCHED GEOTEXTILE.
- CONSTRUCT A 100mm THICK PAD OVER THE GEOTEXTILE USING ROAD BASE OR 100mm AGGREGATE.
- ENSURE THE STRUCTURE IS AT LEAST 15 METRES LONG OR TO BUILDING ALIGNMENT AND AT LEAST 15 METRES WIDE.
- WHERE A SEDIMENT FENCE ZONE OVER THE STABILISED ACCESS, CONSTRUCT A HUMP IN THE STABILISED ACCESS TO DIVERT WATER TO THE SEDIMENT FENCE.

PROJECT TITLE:
METAL RECYCLING FACILITY
DEVELOPMENT

DRAWING TITLE:
INDICATIVE CUT AND FILL SITE
PLAN

TITLE PARTICULARS:
LOT 3 DP251779

STREET ADDRESS:
88 MURRAYS FLAT ROAD
TOWRANG. NSW. 2580

DRAWING DATE:
01/08/2025

SHEET NUMBER:
01

PROJECT NUMBER:
0060222

DRAWN BY:
P.J

DRAWING SCALE:
1:600

SHEET SIZE:
A1

DRAWING REFERENCE:
M101

REVISION:
A

CONTOUR INTERVALS
MAJOR:
MINOR:

REVISION / DATE:

DESCRIPTION:

A08/08/2025

DEVELOPMENT APPLICATION

SOWDES

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Height Table for volume Pre-Dev - Post-Dev	
Elevation	Colour
-4.00 to -3.06	
-3.06 to -3.00	
-3.00 to -2.50	
-2.50 to -2.00	
-2.00 to -2.00	
-2.00 to -1.50	
-1.50 to -1.00	
-1.00 to -1.00	
-1.00 to -0.50	
-0.50 to -0.10	
-0.10 to 0.00	
0.00 to 0.10	
0.10 to 0.50	
0.50 to 1.00	
1.00 to 1.00	
1.00 to 1.50	
1.50 to 2.00	
2.00 to 2.00	
2.00 to 2.50	
2.50 to 3.00	
3.00 to 3.00	
3.00 to 3.50	
3.50 to 4.00	

DTM Volume Calculation

Add DTM Comparison

Two Surfaces PST-Roads + basins + swales STR-NS

Compute Volumes

Volume Surface

Volumes Summary

Volume Units: Cubic Metres

Raw Figures

Raw	Cut	36,411.782
Raw	Fill	2,585.294

Adjusted Figures

Total Cut	36,411.782 (Cut factor 1.000)
Total Fill	2,585.294 (Fill factor 1.000)
Net volume CUT	33,826.488

Area Summary

Total Cut Area	126,411.532
Total Fill Area	191,847.203
Total Area	318,258.735

Close

Subject to local availability a blend of the following plants are to be used in the biofiltration subvegetation:

- *Chamaecrista ligularifolia*,
- *Eleusine indica*,
- *Eleusine coracana*,
- *Commersonia bartramia*,
- *Commersonia impatiens*,
- *Eleusine indica*,
- *Eleusine coracana*.

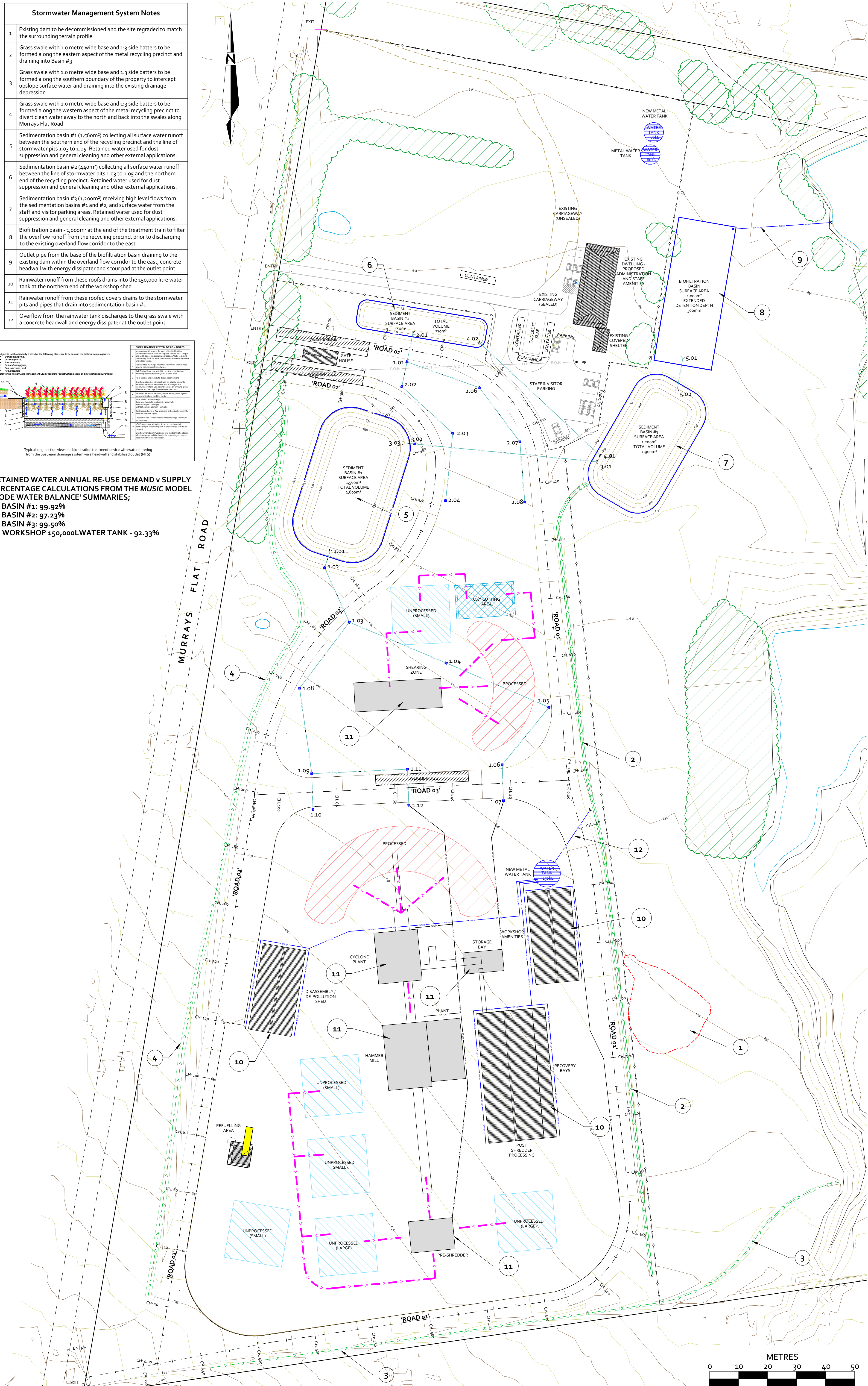
Refer to the Water Cycle Management Study report for construction details and installation requirements.

BIOFILTRATION SYSTEM DESIGN NOTES

1. Plants must be selected on the basis of the following criteria:
 - a. Plants must be able to tolerate the range of water quality conditions that may be encountered.
 - b. Plants must be able to tolerate the range of soil conditions that may be encountered.
 - c. Plants must be able to tolerate the range of light conditions that may be encountered.
 - d. Plants must be able to tolerate the range of temperature conditions that may be encountered.
 - e. Plants must be able to tolerate the range of salinity conditions that may be encountered.
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 - d. Plants must be able to tolerate the range of temperature conditions that may be encountered.
 - e. Plants must be able to tolerate the range of salinity conditions that may be encountered.

Typical long-section view of a biofiltration treatment device with water entering from the upstream drainage system via a headwall and stabilised outlet (NTS)

- BASIN #1: 99.92%
- BASIN #2: 97.23%
- BASIN #3: 99.50%
- WORKSHOP 150,000L WATER TANK - 92.33%

[illegible]

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THIS SITE PLAN IS TO BE READ
IN CONJUNCTION WITH THE
ACCOMPANYING 'WATER CYCLE
MANAGEMENT STUDY' REPORT.