Appendix R

Surface and Groundwater Management Plan

Surface & Groundwater Management Plan

For the Greenspot Ravensworth Composting Facility

Located Via New England Highway,

Muswellbrook NSW 2333

Written on behalf of

Bio-Recycle Australia Pty Ltd

By

The LZ Environmental Company Pty Limited

Document Control

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Person Responsible

	Name	Position
Author	Luke Zambelli	Director
Contributing Author(s)		
Reviewing Officers(s)	John Vyse	Business Manager
Authorised by	Neil Schembri	Director

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Glossary of Terms

EPA	Environment Protection Authority
EPL	Environmental Protection Licence
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
IECA	International Erosion Control Association
SGWMP	Surface and Groundwater Management Plan

1 Introduction

This Surface and Groundwater Management Plan (SGWMP) has been prepared for Bio-Recycle Australia Pty Ltd in response to the Pollution Reduction Program required by the EPA via Licence Variation (Notice No. 1533678) to be implemented at its Ravensworth Composting Facility – Environment Protection Licence EPL7654, located at New England Highway, Muswellbrook.

It is to be noted that this SGWMP provides information applicable to the current area where pasteurised greenwaste is being stored for use in AGL Macquarie's rehabilitation program for the Ravensworth mine site (area 1) and also to the future composting site (area 2) that is being proposed to be constructed due to constraints that exist with the currently used area.

The following figure defines the areas that are referenced within this SGWMP.

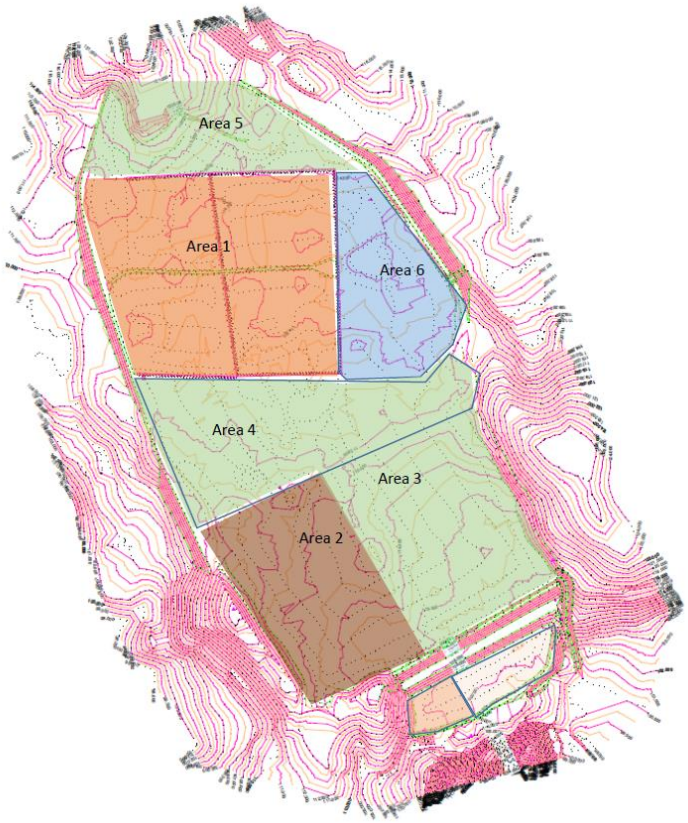


Figure 1: Areas identified within the SGWMP

It is to be noted that areas 3 and 4 are to be revegetated and area 1 will transition into a standard that is comparable to areas 3 and 4 once stored material is removed. Area 5 is to be revegetated. Whilst area 6 is denoted as the sedimentation basin for area 1 currently, it will remain into the future albeit that it will be revegetated.

This SGWMP will provide information that:

- details control measures and procedures that will minimise contamination of stormwater and groundwater;
- demonstrates that clean surface waters are not mixed with leachate (contaminated surface water) by way of appropriately positioned and constructed infrastructure that provides for the diversion of uncontaminated (or clean) stormwater;
- demonstrates that the volume of leachate contained on site will be greater than what is ordinarily considered to be representative of industry practice and how containment will be assured;
- the mass movement of sediment or significant erosion will not occur;
- demonstrates that the quality of leachate contained will be maintained as far as possible such that offensive or noxious odours are not released;
- demonstrates that the quality of leachate contained within the detention basin will be of such a pH that any seepage from the detention basin will not mobilise heavy metals in the underlying fly ash;
- demonstrates that whilst highly unlikely, (due to rarity of occurrence), that the quality of leachate that may be released in an emergency event (defined as an abnormal rainfall event that causes a release offsite) will in no way cause material harm to receiving waters or will result in worsening water quality conditions downstream of the facility, (i.e. Void 4, including groundwater) due to onsite leachate management practices, onsite uses and the volume of secondary containment provided; and that including groundwater due to the amount of leachate containment provided; and that
- demonstrates only clean stormwater will leave the site from remaining areas not included within the operational area.

  It is to be noted that whilst the primary leachate detention basin has a capacity for the containment of leachate that is equivalent in volume to that of a 1 in 100 year 24 hour rainfall event, Bio-Recycle will commit to ensuring that the detention basin will always have the available capacity to contain rainfall events up to and including a 1 in 25 year 24 hour rainfall event so as to comply with EPL condition O4.1.

It is to be also noted that rainfall events greater than a 1 in 25 year 24 hour rainfall event are unlikely to result in an emergency release occurring due to the volume of leachate that will be reused within the composting process on a daily basis (i.e. the volume utilised for moisture addition to windrows and dust suppression) and the volume used for dust suppression and irrigating revegetated areas (described further on).

It is to be noted that the International Erosion Control Association (IECA) guideline (November 2008, reprinted June 2012) has been acknowledged in developing this SGWMP, specifically in terms of Erosion and Sediment Control Planning, and the monitoring of implemented measures so as to continually improve on site conditions.

Similarly, the document authored by the NSW Government and titled "Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition, March 2004" has also been considered in the preparation of this document.

It is to be noted that considerations pertaining to the above mentioned publications are further detailed in *Section 7* below.

Similarly, this SGWMP has been prepared with consideration of the Environmental Guideline, titled, Composting & Related Organics Processing Facilities, prepared by the Department of Environment & Conservation 2004.

It is to be noted that during the drafting of this SGWMP a risk assessment was performed in relation to the various aspects of water management. The risk assessment has been incorporated into the WHS & Environment Site Specific Management Plan for the Ravensworth Facility.

It is to be noted that this document supports and expands on information provided within the onsite document, titled "Compost Management Plan, Including Management for CA-05 Biosecure Treatment of Phylloxera Host Plant material for Recycling, Version 3".

It is essential that the facility employees are aware that this SGWMP details important requirements for conducting surface water management, including the management of leachate which need to be adhered to. Specifically, the control strategies outlined within the various workplace and emergency procedures, provided within **Appendix 1** must be adhered to. Moreover, employees must become familiar with and implement the control measures provided within the respective procedures in their entirety.

Further to the above, **Appendix 2** contains a copy of all forms and checklists which must be utilised in conjunction with the aforementioned procedures.

Appendix 3 - Figures contains seven figures, the first of which outlines the four hardstand pad areas that will be constructed as the activity requires albeit that Pads 3 and 4 will be vegetated in the interim

so as to reduce the requirement to treat stormwater that is influenced by suspended solids, including colloidal clay material. The same figure includes the location of the primary leachate detention basin, the secondary basin and the lower basin in relation the northern end of void 4, the location where overflows from the lower basin will flow into. Figure 2 portrays a cross section cut through the respective containment dam (offering a total storage volume equivalent to a 1 in 100 year 24 hour rainfall event).

The third figure portrays the gradient of the area whilst the fourth figure indicates the stormwater flow paths. The fifth figure of **Appendix 3** portrays the erosion and sediment control plan for the facility and the sixth figure highlights the location the facility in relation to its surroundings, including the New England Highway. The seventh Figure of **Appendix 3** portrays the leased area for reference.

Section 3 below shows the organisational structure in place at the site to manage activities, including the management of stormwater.

1.1 Purpose

The purpose of this document is to provide detail surrounding the management of surface water such that releases of contaminated water to the receiving environment do not occur.

This document details how surface water management, including leachate management will occur at the site such that Bio-Recycle will operate in compliance with conditions of the EPL, namely condition L1.1, U1.1 and U1.2. Moreover, this document describes the actions that will be carried out to ensure that leachate is separated from external clean surface waters and as to how erosion and sediment transport and subsequent stormwater contamination will be minimised. The purpose of this document is to also stipulate the monitoring and management protocols that will be implemented to ensure that the receiving environment is protected in the event of an emergency release of leachate from the site.

Provided the directives contained within this SGWMP are followed, including the control measures contained within the respective workplace and emergency procedures, namely ones related to sediment and erosion control, stormwater and leachate management and emergency stormwater and leachate management (refer to **Appendix 1**) by facility employees, it is ensured that effective leachate management including erosion and sediment control will occur.

2 Environmental Commitments

This section outlines the various commitments made by Bio-Recycle for the effective management of stormwater generated externally and leachate generated within the composting activity area, inclusive of which is sediment and erosion control. Bio-Recycle is aware of the importance of managing all leachate generated within the area of the facility such that environmental harm is avoided. Similarly, Bio-Recycle will ensure that stormwater generated within remaining areas not associated with the composting activity, but are in fact located within Bio-Recycle's licenced area (see **Appendix 3 – Figure 7**) will not cause material harm. These areas will be vegetated so as to prevent the re-entrainment of soil particles. Namely the following areas listed will be revegetated, after commencement of the proposed compost area (area 2) with a mixture of grass seeds suitable to the yearly climate.

- Area 3 = 109,947 m^2;
- Area 4 = 110,112 m^2;
- Area 1 = 170,155 m^2; and
- Area 6 = 70,726 m^2.

Once area 2 activities commence, the preparation of 4 will begin at the release point in the south east corner. This will extend 40 metres back in towards Pad 4 so that a suitable growing medium is prepared in readiness for the spreading of grass seed. This grassed area will progressively move over Pads 4 and will eventually extend into the Pad 3 area. This will be done so as to reduce the ability of rain drops to re-entrain suspended soil particles within stormwater flow.

Bio-Recycle is committed to complying with all conditions contained within EPL 7654. In doing so, and wherever possible, Bio-Recycle will try to minimise the amount of contaminated stormwater generated by avoiding such contamination.

When considering the existing area, currently being utilised for the storage of pasteurised greenwaste, the following commitments are provided:

- Sections of windrows where possible have been removed from areas where ponding of stormwater may occur and also where the stormwater flow path has been covered or blocked with material;
- Any remaining ponding is managed by being mopped up with windrow material and added to windrows;
- Windrows are consolidated where appropriate; and
- The majority of the liquid retained in the leachate sumps is pumped out following rainfall, with liquid being incorporated into windrowed greenwaste material;

Within area 2, Bio-Recycle will re-use contained leachate primarily for the composting process, which is a nett user of water. In addition leachate will be used for dust suppression within the area of the composting facility, including haulage roads that are located within the composting facility. Bio-Recycle will not use leachate for dust suppression upon haulage roads that are external to the composting facility. Bio-Recycle will not use leachate for dust suppression upon haulage roads that are external to the composting facility. Bio-Recycle will treat water whenever required so as to reduce contaminant levels that are not conducive to composting or for use for any other purpose. Finally, Bio-Recycle may elect to irrigate leachate in times where the primary leachate detention basin requires emptying for the purpose of desilting or simply dewatering.

Bio-Recycle will utilise a spray gun irrigator so as to irrigate broadcasted grass seed over areas where compost is to be applied within areas 3 and 4 of Figure 1. At an operating pressure of 550 kPa, 16 L/s or 960 L/m can be delivered. This will provide for a rapid response time should in fact there be the need to reduce the height of contained leachate within the primary leachate detention basin. If for example a reduction was required, the pump and spray irrigator configuration could remove 1.382 Ml / 24 hours. When considering the combined area of area 3 and area 4 (220,059 m^2), at an irrigation rate of 5 L/ m^2 or 5mm of irrigation, approximately 1.1 Ml would be consumed. Irrigation will be performed when winds are low so that aerosols are not liberated far and wide and will only occur when the wind direction is such that air movement is away from onsite personnel. Appropriate buffer distance's exists such that no sensitive receptor will be affected.

With regard to the above hierarchy, it can be noted that Bio-Recycle will ensure that the generation of leachate is (in this order) avoided, reused, recycled or disposed of in accordance with best practice environmental management.

Bio-Recycle is committed to implementing an onsite surface water management plan that contains procedures which effectively manage leachate and stormwater generated within the area of the site, and which also prevents stormwater flows generated external to this area from entering the site.

Bio-Recycle is committed to ensuring that erosion protection and sediment control measures are implemented and maintained to minimise erosion and the release of sediment from the site.

Whilst the leachate detention basin has an overall capacity to contain a 1in 100 year 24 hour rainfall event, Bio-Recycle is committed to ensuring the containment capacity within the onsite detention basin is sufficient to contain the volume of stormwater runoff generated over the operational catchment area of the site during a 1 in 25 year AEP 24 hour rainfall event (~ 5.99 mm/hr) or less. Moreover, Stormwater generated in excess of the 25 year rainfall event may release to a secondary basin and then

to a lower basin so as to allow further deposition of sediment prior to leaving the licenced area and emptying into Void 4 for containment.

Bio-Recycle will ensure that storage capacity on site will be capable of containing a 1 in 25 year rainfall event at all times. In addition Bio-Recycle will further aim to contain stormwater generated in rainfall events up to and including a 1 in 100 year 24 hour rainfall event on site which far exceeds the minimum design requirements contained within the NSW EPA guideline, titled Composting and Related Organics Processing facilities, July 2004.

Bio-Recycle is also committed to ensuring that onsite employees are familiar with this SGWMP in its entirety, including understanding the various workplace and emergency procedures that have been created (refer to **Appendix 1**).

2.1 Site Water Characteristics

It is recognised that fly ash generated at the nearby Bayswater Power Station is pumped as a dense phase slurry back to the Ravensworth mine site and is utilised in the backfilling of open cut voids as part of the site's rehabilitation program. It is to be noted that Void 4 is integral to AGL Macquarie Pty Ltd's water management strategy associated with rehabilitation whereby Void 4 receives decant water from Void 5 (the current location for ash deposition). Water contained within Void 4 is transferred back (at 120 litres /second) to the Bayswater Power Station whereby it utilised again in the ash pumping cycle. It is also understood that any seepage from the deposited fly ash contained within Void 3 also releases to Void 4.

The quality of water contained within Void 4 is a result of seepage through fly ash and overburden, surface water runoff and decant water also from Void 5. Due to the placement of fly ash in direct contact with water, it is likely that pH's encountered will be alkaline. The report titled Ravensworth South Final Void Plan, prepared by Aurecon for AGL and dated 1 May 2012 indicated that the historical average pH within Void 4 was 8.54 pH units (1996 to Nov 2010). Data also indicates that conductivity of water contained within Void 4 is brackish with various anionic and cationic salts present. The Aurecon report stated that Void 4 is effective at holding water due to a depression in the Bayswater Syncline Axis. It is understood that the base of Void 4 is formed by the Archerfield Sandstone Unit and the water level in Void 4 is kept below the maximum RL of 46.5 m to avoid seepage in a south direction. It is understood that there is no evidence to suggest that any extensive seepage occurs from Void 4 and as such releases beyond the boundary of the facility are unlikely.

Due to the thickness of the fly ash that underlays the composting facility in Void 3, it is unlikely that seepage water from the lined detention basin will significantly influence the water quality

characteristics of Void 4. Due to the volume of water contained within Void 4 and the capacity provided within the detention basin associated with the composting activity plus the additional water detention areas in the stormwater flow path it is unlikely that water quality within Void 4 could be significantly changed in times when an emergency release did occur. If a release from the detention basin was to occur however, a release from the detention basin would flow firstly through a secondary basin and then to the lower basin before reaching Void 4. The volume of surface water that would be flowing into Void 4 from other areas of the mine site during such a rainfall event would negate any significant influence a release of contained leachate from the composting facility could have. It is for the above reasons why it is considered that the location of the composting facility is considered appropriate.

3 Organisational Structure

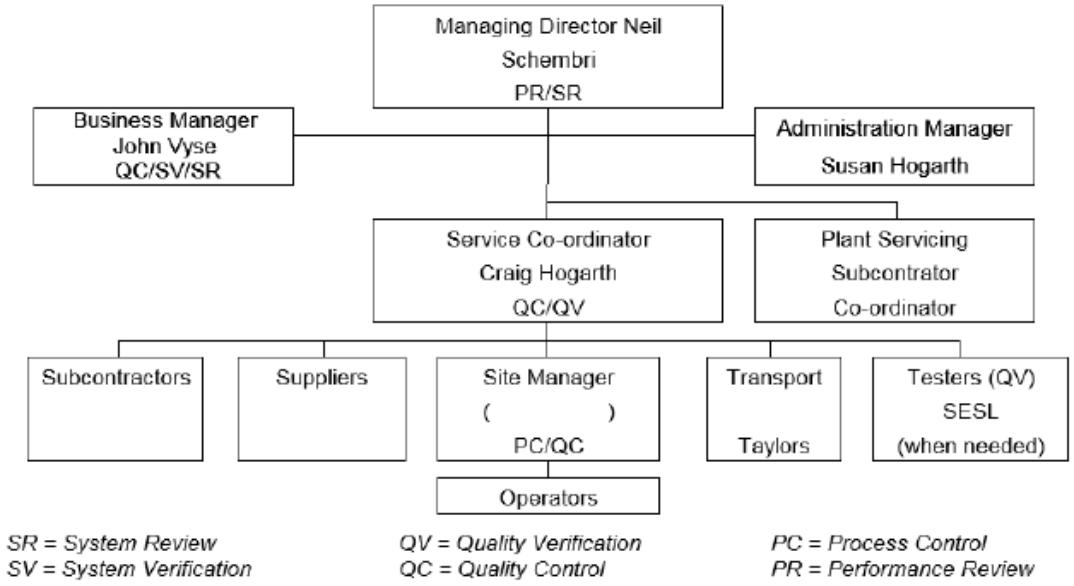


Figure 2: Organisation structure

3.1 General Contact Detail

	Managing Director	Site Manager	Organics Business Manager
Name:	Neil Schembri	Chris Payne	John Vyse
Mobile:	0419 636 088	0477 344 969	0403 996 518
Phone:	(02) 4587 7852		
Fax:	(02) 4577 2603		
Email:	neil@Bio-Recycle.com.au	chris@bettergrow.com.au	john@bettergrow.com.au

Table 1: General Contact Detail

3.2 Roles and Responsibilities

The principal QA/OHS/environmental responsibilities are outlined below. Responsibilities and authorities are defined in more detail in Bio-Recycle's System Procedures.

3.2.1 Managing Director

The Managing Director is responsible for setting Company quality, safety and environmental policies and objectives and for allocation of resources to each service area.

3.2.2 Contracts Manager

The Contracts Manager is the Company's corporate "quality management representative" (ISO9001 5.5.2), "environmental management representative" (ISO14001 4.4.1) and "WHS management representative" (AS4801 4.4.1.2) and has the authority to resolve any QA/WHS/Enviro management system matters.

3.2.3 Administration Manager

The Administration Manager is responsible for managing the Company's administrative / accounting functions, including:

- Debtors and Creditors, all accounts receivable and payable;
- payroll;
- administering legal obligations such as motor vehicle, public liability and workers compensation insurances, registrations and licenses;
- maintaining and updating various registers of staff, plant and equipment;
- workplace injury management;
- secretarial duties.

3.2.4 Service Co-ordinator

The Service Co-ordinator is responsible for managing the delivery of the various organics service and compliance with contract requirements including time, quality, safety, environmental and industrial matters.

The Service Co-ordinator is required to notify the Contracts Manager of any deficiencies or potential problems with Company procedures.

Table 2 is provided below to summarise the key management functions and responsibilities.

3.2.5 Site Manager

The Site Manger is responsible for the day to day management of the facility and to implement the requirements of the Organics Business Manager. The Site Manager is responsible for ensuring all onsite employees/operators are well versed in the respective workplace and emergency procedures that are associated with the facility. The Site Manager is responsible for advising the Organics Business Manager of incidents that are likely to cause material harm to the environment. The Site manager is responsible for ensuring that workplace health and safety is being provided to onsite employees and any visitors that attend the facility.

Function	Managing Director	Organics Business Manager	Service Coordinator	Site Manager
Authorise QA/WHS/environmental policies & objectives	*			
Management system document control		*		
Ascertain customer requirements for planning service delivery		*		
Evaluate suppliers and subcontractors	*			
Manage WHS Consultation		*		
WHS Hazard/Risk Identification & Establish Safety Controls		*	*	*
Prepare Environmental Impact Register & Establish Environmental Controls		*		*
Prepare Service Management Plans		*		
Personnel management and management of training	*	*		
Implement Training		*	*	*
Implement Service Management Plan			*	
Implement WHS Risk Controls				*
Implement Environmental Controls				*
Maintain vehicles and equipment in proper operating condition			Plant Servicing Co-ordinator	
Calibration of inspection & measuring equipment			Plant Servicing Co-ordinator	
Review effectiveness of service delivery		*	*	

Liaise with clients on service delivery issues		*	*	
Resolve service delivery nonconformities		*	*	
Investigate WHS incidents			*	*
Investigate environmental incidents			*	*
QA/WHS/environmental records		*	*	
Initiate corrective/preventive action including authority to temporarily restrict work		*	*	*
Follow through corrective preventive actions and monitor their effectiveness		*		
Internal Auditing		*	*	
Review effectiveness of QA/WHS/ environmental management system	*	*		
Management of industrial relations	*			

Table 2: Key management Functions and Responsibilities

All employees are required to immediately inform the Site Manager of any environmental risks, issues or incidents that have the potential to cause environmental harm. Any major incidents that may cause environmental harm must also be reported to the EPA by the Site Manager or the Organics Business Manager. If either is not available the employee is responsible for notifying the EPA when necessary (i.e. in the event of environmental harm or a release that is not in compliance of the relevant conditions of the EPL occurs).

4 Description of Activity

The following section provides detail on how stormwater generated within the area of the facility (designated as the catchment area, refer to *Section 11*) and stormwater generated externally to the facility will be managed.

Employees must understand that integral to the management of stormwater is the control of the volume of leachate generated within the designated catchment area and clean stormwater generated external to the designated catchment area and which is prevented from entering the composting area.

Further to the above, the quality characteristics of the leachate generated must not be such that it becomes significantly contaminated with compost or compost feedstocks as this will increase the potential to cause environmental nuisance (considered unlikely in an emergency release) from the release of anaerobic odour if the detention basin sours or creates worsening receiving water conditions due to elevated levels of contaminants being released.

Whilst *Section 8.1.1* provides further detail on how uncontaminated and leachate waters will be separated, it can be noted here however that stormwater generated externally to the operational hardstand areas will be actively directed away from entering the designated catchment area through the use of diversion drains and perimeter bunding as determined where being required (refer to **Appendix 3, Figure 5** for locations of perimeter bunding). Bund walls will be constructed from overburden located in close proximity and will be covered in compost amended overburden and grassed so as to stabilise. So as to comply with requirements of CA05 - biosecure transport and treatment of host plant material destined for recycling, a 10 m vegetation free buffer zone will exist between bunds and composting windrows. The perimeter bund will also ensure any internally generated stormwater is effectively directed as desired.

Employees must notify the Site Manager if it has been discovered that uncontaminated stormwater is entering the hardstand areas such that prompt repair can occur. Repairs can be performed promptly as there is a plentiful supply of overburden material that is suitable for construction of bunds or raising ground surface levels for example so as to exclude or retain water.

All leachate that is generated within the areas of the initial two hardstand pads (designated as the catchment area) must be directed via concrete spillway to the designated 1 in 100 year 24 hour ARI detention basin (refer to **Figure 5** of **Appendix 3**). A concrete sedimentation fore-bay will be located prior to the release point so as to minimise sediment loss into the detention basin. The sediment detention bay is considered to be key piece of infrastructure to restrict gross solids entering the detention basin and must regularly be desilted. Once full, the detention basin will spill into the secondary basin which at the current spillway height (RL104.85), will contain approximately another 1 ML. The secondary basin will release to the existing lower basin which will be in place primarily to settle any solids released prior to any waters entering Void 4.

Appendix 3 – Figure 1 highlights the two hardstand areas that makes up the entire catchment area for leachate. It is to be noted that Pads 1 and 2 located on the most western side of the catchment area is to be constructed first and Pads 3 and 4 will be constructed as and when required.

Surface gradients of hardstand pads and the strategic positioning of diversion bunds are such that respective pads (1, 2) drain to the primary detention basin without delay (refer to **Appendix 3**, **Figure 3**). Employees must be aware that the surface gradients of the hardstand pad needs to be maintained so

that leachate flows easily to the primary detention basin but not excessively, such that compost and sediments are not mobilised. There must be no ponding or pooling on the hardstand surface and if, encountered must be promptly attended to so as to establish desirable conditions.

The location of the detention basin will assist in the removal of contained water via pump for reapplication to composting windrows so as to ensure optimal moisture conditions exist throughout the composting cycle. The pump located at the detention basin will also be utilised from time to time to transfer and circulate contained leachate so as to aerate the dam in conjunction with the duty aerator that will be operational to maintain desirable dissolved oxygen levels within the detention basin.

It is to be understood that due to the average annual volume of rainfall (~658.4 mm) that is experienced at the site, and the need for a constant supply of water for the composting activity, Bio-Recycle will at all times be able to contain leachate runoff generated up to and including a 1 in 25 year 24 hour event with additional capacity for an overall maximum containment volume equivalent to a volume generated within a 1 in 100 year 24 hour event (i.e. 14.7 Ml). Stormwater generated in excess of this amount will flow to the second basin which will have a 1 ML capacity which will then release via spillway to the existing lower basin and then into void 4, thus preventing any releases to surrounding receiving surface waters located off site for a rainfall event in excess of a 1 in 100 year 24 hour event.

Appendix 3 – Figure 1 portrays how the secondary detention basin will release to the lower basin via a rock pitched spillway. The image further portrays topography that will see releases from the lower basin enter Void 4 for containment.

It is to be noted that windrows will be positioned parallel to the surface water flow on top of the hardstand pads to ensure that generated leachate does not accentuate the removal of compost at the base of the respective windrow and thus overload the detention basins with organic matter entering via flows. It is important to understand that excess organic matter entering detention basins will create reducing conditions as organic matter breaks down and due to this, reduced gases such as hydrogen sulphide (rotten egg gas) can be liberated. Due to the size and volume the primary leachate detention basin contains, allowing any anaerobic conditions to predominate will result in extra operational costs in its management, a scenario that is not supported by Bio-Recycle. To be absolutely clear in relation to this aspect of management, all windrows must be aligned with the gradient of the surface so as to minimise the re-entrainment of compost with flowing leachate. This action will minimise the amount of solids that enter the detention basin.

It is important to understand that other factors such as pH play a role in the amount of odour that is released such that if the pH is < 6.5 pH units, sulphide release can be accentuated. Therefore, an understanding that the pH of detention leachate should remain above a pH of 6.5 is essential.

Similarly, composting feedstock can introduce excess nutrients or oxygen demanding substances that can cause a deterioration in the quality of water contained and commensurate with that, an increase in the management that is required to maintain aerobic (oxygenated) conditions. As such it is essential that raw feedstocks do not enter detention basin. To minimise the level of contaminants entering the water column, wash out and wash-downs will occur initially on a bed of greenwaste to filter out solids and to absorb nutrients prior to its release to the detention basin. This initial wash-down area will be located at the southern end of Pad 2 so that wash waters can be easily directed to the pipe transferring leachate to the detention basin. The saturated greenwaste material will be added to compost recipes and will be replaced regularly. The greenwaste will be laid on top of crushed rock/concrete so that muddy conditions are not created. Within 12 months from the commencement of the activity within area 2, Bio-Recycle will construct a designated wash-out and wash–down area. A purpose built concrete hardstand will be constructed with a slight grade that will facilitate the movement of wash waters to a designated drive in sump, allowing for the easy removal of contained solids with a front end loader. Wash-down waters contained in the sump will be removed via pump.

Due to the size of containment provided by the primary detention basin and the leachate management practices mentioned previously, it is unlikely that dissolved oxygen levels within the water column of the detention basin will become significantly low. By not allowing excess compost/sediment to enter the detention basin the oxygen demand of the leachate will be significantly lower than it would if solids and organics were present.

If required, an aerator will be installed within the primary detention basin to ensure that contained leachate is aerated, particularly after rainfall events. If rapid oxygenation is required, hydrogen peroxide will be used.

Employees must be aware that as aerobic microbes degrade organic matter, oxygen present in the water column is consumed. As Oxygen levels diminish or disappear, anaerobic degradation occurs with the liberation of offensive odours such as sulphide or ammonia albeit that the scale of such a release is largely dependent upon pH however.

It is important to note that if the pH range limit is met (i.e. 6.5-8.5 pH units), then the likelihood of environmental nuisance occurring is remote to non-existent.

In ensuring that the onsite erosion and sediment transport (i.e. contamination of stormwater) is minimised, various erosion and sediment controls (ESCs) will be implemented. Sections *7-8* provides details of the various ESCs that will be implemented, including the various management controls and techniques that will be adopted onsite to minimise erosion and the subsequent contamination of stormwater.

It can be noted that the ESCs that have been adopted are focused towards minimising erosion and sediment transport at their source in accordance with the *IECA Guideline 2008, Book 1, section 2 - Principles of ESC, Principle 8.10, - 'Wherever reasonable and practicable, sediment should be trapped as close to its source as possible'*. Where this cannot happen, sediment ladened waters will be directed to designated sedimentation dam(s) for the retention of sediment.

Further to the above, guidance was provided from the document titled "Managing Urban Stormwater – Soils and Construction Volume 1, 4th edition, March 2004 (the blue book) for establishing the erosion hazard rating of the hardstand pad area and for also predicting the amount of soil loss that is expected to occur annually from the hardstand pad so as to assist in predicting when the detention basin may require desilting. *Section 7.1* below provides information surrounding soil loss from the operational hardstand area.

In ensuring the containment capacity provided by the detention basin is maintained so as to be able to at least contain a 1 in 25 year 24 hour event, the basin must be managed as outlined within *Section 9.5* Detention Basin Management. Briefly however, it can be noted that the regular de-silting of the basin will occur as and when directed by the Site Manager to maintain required volumes. As such regular observation for the accumulation of silt/sediment must occur.

In the event that a release of contained leachate occurs from the primary detention basin via the designated spillway into the secondary basin, additional monitoring of the water contained within this basin may be required to ensure that an understanding of the quality of water released has been established. Observations must note if released waters have been contained within the secondary basin, the lower basin or in fact released to Void 4.

Bio-recycle has established the following aspirational emergency release limit to ensure that offsite impacts are minimised should they in the unlikely event occur:

- a pH value that is within the range of 6.5-8.5.

Section 13 - Emergency Stormwater Release Management and Monitoring, provides specific detail on any additional monitoring that should be conducted prior to an anticipated emergency release and the necessary adjustments that can be made prior to a release occurring if the aspirational pH range limit is not achieved.

It is to be noted that the pH of contained water, is proposed to be monitored regularly for the understanding of the ability of water contained within the detention basin to release odour pertaining to ammonia and sulphides. As such, if pH of contained water requires adjustment it can be done so at the time of measurement as opposed to performing mass dosage events should the need arise prior to an anticipated emergency release.

For further reference, employees are directed to **Workplace Procedure 1 – Leachate Management** (refer to **Appendix 1**) for further direction.

The hardstand pad is considered to have a low permeability (refer to **Appendix 4** for detail regarding density and permeability results associated with onsite overburden) and as such meets the minimum design requirements for working surfaces as detailed within the NSW EPA Composting & Related Organics Processing Facilities, Environmental Guideline.

Where depressions or undulations are experienced, they are to be repaired with screened overburden; with emplaced overburden being slightly wetted and compacted so as to emulate the primary gradient of the surrounding surface.

The hardstand pad material is considered to be appropriate for the protection of receiving groundwater when considering the permeability and also the underlying strata, which is comprised of approximately 50 m (depth) of fly ash. **Appendix 4** indicates that the onsite overburden will achieve an appropriate impermeability (i.e. 1.45 x 10^{-9} m/s = 3.6 x 10^{-6} m/hr or 0.0036 mm/hr) such that the minimum design requirements detailed within the NSW EPA Composting & Related Organics Processing Facilities, Environmental Guideline for a leachate barrier system will be achieved. It is essential that when overburden is to be utilised for detention basin lining, it must be installed in accordance with the engineering design specification supplied by Aurecon.

It is worth mentioning here that the underlying fly-ash demonstrates a low permeability. The following table is reproduced from the report prepared by Aurecon for AGL Macquarie regarding the insitu permeability of fly-ash located within Void 3.

	BH1	BH2
Slug 1	1.3E-05 m/s	-
Slug 2	7.7E-06 m/s	8.4E-06 m/s
Slug 3	6.7E-06 m/s	6.6E-06 m/s
Average	8.9E-06 m/s	7.5E-06 m/s

Table 1 Permeability results from slug tests

Table 3: Permeability of underlying fly-Ash (source Aurecon

What is evident from the above table is that the permeability of the flysh-ash becomes lower with each successive slug test.

The detention basins will also be lined with overburden and drill muds that accord to the drill mud exemption and order, issued by the NSW EPA. Unsuitable material must not be utilised.

The addition of drill muds will assist in sealing the liner further. Whilst it is unlikely that significant volumes of contained stormwater will percolate through the 50 m of fly ash, it is to be noted that all percolate through the fly ash is contained within the onsite AGL Macquarie groundwater management system which is monitored. Due to the depth of fly ash (~ 50 m), confidence can be given that no contamination of groundwater is likely if hardstand pads and detention basins are maintained.

5 Items to Be Addressed

The information in the below sections directly addresses how Bio-Recycle will manage stormwater at the facility, including erosion and sediment control in compliance with conditions of the EPL.

6 International Erosion Control Association (IECA) Guidelines

In preparing this document, Bio-Recycle acknowledges the key principles of erosion and sediment control as listed within the IECA Best Practices Erosion and Sediment Control Guideline, November 2008, reprinted June 2012, of which certain aspects have been and will be considered where deemed necessary and desirable.

Further to the commitments made in section 2, Bio-recycle is committed to the following objective:

- ***To taking all reasonable and practicable measures to minimise short and long-term soil erosion and the adverse effects of sediment transport.***

The key principles portrayed within Section 2 of the IECA Guideline that have been considered as essential to the overall success of Bio-Recycle's erosion and sediment strategy at the site are to:

- appropriately integrate the facility into the existing site;
- integrate erosion and sediment control into the construction of the hardstand pads;
- develop an effective and flexible erosion and sediment control plan;
- control water movement on the site;
- maximise sediment retention on the site;
- maintain all erosion and sediment control ESC measures in proper working order at all times; and
- monitor the site and adjust ESC practices to maintain the required performance standard.

The Erosion and Sediment Control Pan (ESCP) has been created so that Bio-Recycle can integrate erosion and sediment control issues into on site stormwater planning and management on an ongoing basis so as to provide short and long term solutions to erosion and sediment control. The following

paragraphs provide detail in relation to how the above key principles have been and will be met by Bio-Recycle in carrying out composting and soil conditioner manufacturing with regards to effective erosion and sediment control.

Whilst the current plan delivers effective erosion and sediment control measures based on anticipated clay properties, weather and operational conditions, flexibility has also been provided such that Bio-Recycle can re-evaluate implemented measures to determine if improvements needs to be made (as and when required), a principle supported by IECA.

7 Erosion and Sediment Strategy

In accordance with IECA principles Bio-Recycle has adopted the following key strategies in order to meet site compliance obligations.

1) Clean water diversions will be maintained to minimise the risk of 'clean water' mixing with contaminated water and contributing to the overall site contaminated water inventory. Stormwater flows will be controlled to reduce velocities and minimise erosion.

2) Stormwater flows within the designated catchment will be controlled to reduce velocities and minimise erosion.

3) Maximise sediment retention on site by ensuring sediment laden waters are directed to respective sediment detention basins within the designated areas.

4) Maximise sediment retention outside the designated area by ensuring sediment laden waters are directed to sediment basins and in the long term establishing grass within swales or diversion drains.

5) Stabilise & Rehabilitate disturbed areas as soon as practical to control long term erosion and meet long term performance targets.

6) ESC controls will be maintained to ensure effective management of erosion and sediment and water quality objectives.

7) Monitor the site and adjust ESC practices and where necessary revise the ESCP to maintain performance standards and compliance outcomes.

Further to the above, consideration has been given to various aspects mentioned within the document, Managing Urban Stormwater – Soils and Construction, Volume 1 (the blue book).

7.1 Erosion Hazard & Soil Loss Estimation

The following section provides information pertaining to the erosion hazard status of the hardstand material. The overburden is considered to be a Group D type soil with a very high runoff potential as per Appendix F of the blue book.

The very high runoff potential is because observations and permeability results portray that water moves into and through these soils very slowly (i.e. less than 1 mm/ hr) when thoroughly wetted. The overburden is considered to be poorly structured which is comprised of fine textured clay in part. Observations highlight that the layer near the surface is nearly impervious and due to this shed runoff from most rainfall events. The overburden is considered to be dispersive.

To predict soil loss, the revised universal soil loss equation (shown below) was utilised (Appendix A of the blue book).

A= R .K. LS. P. C (tonnes / ha/yr).

The rainfall erosivity factor (the R factor) for the Singleton area is 1500 and the soil erodibility factor, K was determined to be 0.05 which is considered conservative because the initial value was increased by 20% because of potential dispersion.

The texture of the existing hardstand surface was considered to be a silt to clay, containing an organic carbon content of 2 % which is converted to an organic matter of 3.44 % with a soil structure on the surface being very fine and equivalent to rating 1 with a profile permeability rating of 6 which is very slow.

For the purpose of calculating the K value, the percentage of silt = 65% and the percentage of sand = 10 %.

The Slope length/gradient factor – LS of 0.19 (i.e. 1% slope over slope length of 80 m) was chosen as this will be approximately the length of the windrows. An erosion control practice factor (the P factor) of 1.3 was selected. A cover factor (the C factor) of 1 for bare soil and no grass cover was selected to be representative of future conditions.

When calculating A; A = 1500 x 0.05 x 0.19 x 1.3 x 1.0 = 18.53 tonnes of soil/ha /yr which equates to a volume of 23.2 cubic metres/ ha / year when you multiply tonnes by 1.25 tonnes/cubic metre. It is to be noted however that this estimation considers a cleared hardstand pad. Soil loss is predicted to be less due to the attenuation that windrows will provide. The above estimation does indicate that minimal height reduction of the hardstand pad will occur annually.

When considering that the primary leachate detention basin has a volume 14,700 m^3 and that the Pad 1 & 2 hardstand areas equals 8.78 ha, approximately 203 m^3 could potentially enter the detention basin which is representative of 1.4 % of the volume of the detention basin. It is therefore estimated that de-silting would occur every 5 years where the amount of silt/sediment removed would equate to 6.9 % of the detention basin's volume. If the sediment fore-bay is regularly maintained after rainfall events, the estimated loss of soil to the leachate detention basin will reduce and it is likely that the amount of silt/sediment removed from the basin every 5 years will be significantly less than the above estimated percentage.

8 Control Plan (ESCP)

This and proceeding sections are focused on detailing the proposed sediment control measures that have been and will be (if determined as necessary) implemented as part of effective stormwater and leachate management at the facility as part of short and long-term measures. For reference, **Appendix 3 – Figure 4** portrays the direction of leachate flow within and stormwater external to the designated operational area. **Appendix 3 – Figure 5** portrays the erosion and sediment control plan that must be followed at the facility and portrays key pieces of stormwater infrastructure. It is to be noted that erosion and sediment control devices that have been and will be implemented as part of an effective ESCP must be maintained and promptly repaired as and when required.

Bio-Recycle will work with AGL Macquarie to stabilise the ground surface of areas external to the composting platform. Measures could include grassing, installation of sediment socks or fibre logs on the ground surface so as to slow stormwater flow by reducing the fetch length of a surface.

Employees must be aware that from time to time extra ESC infrastructure construction maybe required to prepare for extended inclement weather conditions such that worsening conditions do not occur whilst managing the activity. This may mean that temporary bunds or sediment logs are installed for example to reduce the fetch lengths of flow paths.

The sediment fore-bay located prior to the headwall will release to the leachate dam which once full, will spill into the secondary dam with an additional ~ 1 Ml of containment and thence to the lower basin via rock pitched spillways. Any sediment that carries over into the lower basin will be allowed to settle.

The respective dams, flow paths and various ESCs are to be regularly monitored and maintained, and if required further ESCs will be implemented.

The above measures are expected to minimise soil erosion and maximise sediment retention onsite. **Workplace Procedure 4 – Erosion and Sediment Control Procedure** provides further examples of

management and outlines onsite duties to maintain all erosion and sediment control measures in proper working order at all times. All Site employees are to become familiar with this procedure and any daily observations of any maintenance issues are to be reported to the Site Manager for prompt action.

Daily monitoring of the Site infrastructure and feedback to management will be used to adjust any ESC practices to maintain the required performance standard. This is a particularly important aspect as there is always an exception to the rule, in that what works on a site successfully may not necessarily work on another. Nevertheless, under the ESC strategy Bio-Recycle is committed to ensuring that any failures will be recorded and rectified promptly so as to demonstrate continual improvement (refer to **Appendix 2 – Forms and Checklists**).

8.1 Erosion and Sediment Controls

The focus of ESCs as detailed in *Section 8.1.1 – 8.1.6* below are to minimise the occurrence and therefore risks associated with erosion and sediment transport at their source.

Bio-Recycle recognises that effective ESCs can provide many benefits to the site including:

- Increased on-site safety;
- Reduced down time after rain;
- Reduced clean-up costs after rain;
- Reduced damage to infrastructure; and
- Fewer contractor, transport or public complaints.

The ESCP that has been initiated by Bio-Recycle incorporates the implementation of the various ESCs previously mentioned above and described below at the site in order to achieve the bulleted benefits listed above.

For example, reducing hardstand fetch lengths will occur so that the velocity of flowing leachate is decreased. This can be achieved by slightly raising the hardstand pad at the end of each windrow where vehicles traverse so that flowing leachate can be slightly diverted. The change in grade has to only be slight. This action will negate the need to install a sedimentation basin prior to the headwall of the transfer pipe albeit as a precautionary measure a sediment fore-bay will be installed.

It is to be noted however, that whilst the primary detention basin has enough capacity for it to be also considered as sedimentation basin, there may come a time in the future based on observation of performance, that smaller sediment basins will be required to be installed above the detention dam so that sediment ladened leachate is prevented from entering the primary detention basin. This will likely

be the case when Pad 3 is brought on line with regards to compost production. But in the meantime, as stated previously Pads 3 and 4 will have compost applied and grass seed broadcasted with regular irrigation occurring so as to accentuate grass coverage that will ultimately minimise sediment movement from the current exposed surface.

When only considering Pads 1 and 2, the sediment fore-bay servicing the hardstand pads will be sufficient to slow the velocity and momentum of leachate exiting the hardstand pads so as to allow for the trapping of large solids.

Batter slopes that lead into the primary detention basin will be progressively covered with compost and topsoil so as to facilitate successful vegetation cover. In some areas, the use of sediment logs may be required to reduce the fetch length of slopes so as to minimise rill erosion. Mulch, too can be utilised to minimise the erosive force of rain drops. This can be easily determined when observations occurs for sediment and erosion control performance after rainfall events and erosion or sediment movement is observed. When this occurs, the Site Manager must be informed so that prompt attention can occur.

Where appropriate, rock check dams will be located within drainage channels to reduce the velocity of water and to also trap sediment. Drainage channels or broad water conveyance areas that are not located within the operational area will be initially targeted for grassing.

To ensure that externally generated stormwater does not enter the operational area, small perimeter bunds will be strategically positioned so as to prevent such entry.

In addressing the risk of erosion and sediment transport at their source however, whether it is external to the operational hardstand area or within its perimeter, protection of the detention basin can be achieved such that the requirement to desilt it can be reduced.

The above approaches to ESC (i.e. prevention at the source, installation of check dams and sediment logs, covering exposed surfaces with top soil and compost so as to achieve vigorous grass growth, covering exposed areas with pasteurised mulch to minimise rain drop penetration, including the provision to grass swale drains and drainage paths and ensuring grass is established on batter slopes and stormwater retention dam walls and bunds) creates a chain of ESC's that affords the receiving environment the greatest level of protection from erosion and the re-entrainment of sediment.

Integral to the successful performance of sedimentation and detention basins, is for the efficient management of suspended solids or colloidal suspensions. The importance of implementing a flocculating program so as to clarify contained leachate or sediment ladened stormwater is discussed further on within *Sections 8.1.5* and *9.5* respectively.

8.1.1 Bunding and drains for the Diversion of Stormwater from Undisturbed Areas

Perimeter bunding will be constructed as and when required so as to ensure that clean stormwater does not enter the hardstand pad. The current requirement is for the western side of the hardstand pad to have a bund installed. Similarly, diversion drains will be constructed to facilitate the movement of any accumulating stormwater. **Appendix 3 – Figure 5** highlights where bunding and diversion drains are to be located.

8.1.2 Cover of Exposed Areas with Vegetation

It is recognised that temporary cover of exposed areas assists in reducing the re-entrainment of sediment during times of rainfall. It is to be noted that the duration of soil exposure and the area of exposure at any given point should be minimised. As described previously, initially areas 3 and 4 will have compost spread with grass seed broadcasted so that grass can be established with irrigation. Area 1 will then be prepared in the same way so as to establish good grass coverage.

8.1.3 Management of Concentrated Flows

Bio-Recycle understands that concentrated flows can accentuate erosion and subsequent sediment re-entrainment. The following sections provide detail on how concentrated flows will be managed. In essence, concentrated flows wherever possible will be converted into sheet flow via the use of level spreaders or will be subject to energy dissipation.

8.1.3.1 Level Spreaders

When utilising level spreaders, sheet flow will be collected and concentrated and converted back into sheet flow. The determination to convert concentrated into sheet and vice versa will be determined by the Site Manager as and when required and will be primarily related to the fetch length where erosion starts to appear along batter slopes or graded surfaces. Emphasis will be given to installing channel grades at less than 1 % on the inside of bunding/drainage channels such that the level spreader can be created at 0% grade.

8.1.3.2 Energy Dissipaters

Bio-Recycle understands that concentrated flows can be further managed firstly by slowing the velocity or minimising the momentum of the subsequent flow. This will be achieved by installing energy

dissipaters such as check dams along the flow paths plus rip rap in combination with rock structures at the base of containment dam discharge locations/spillways.

Additional check dams may be installed if monitoring of onsite stormwater management determines that installation of such energy dissipaters is required to improve the level of protection provided to sedimentation and detention basins and the receiving environment. *Section 8.1.4* below details the monitoring that will be conducted with regard to the assessment of onsite stormwater management and the need for installation of additional ESC controls such as check dams.

8.1.4 Additional Erosion and Sediment Controls

The above detailed ESC measures have been provided with the view that compliance with EPL conditions will be achieved. However, if unknown sources of erosion or sediment load become apparent additional sediment and erosion control measures will be implemented as and when required. Prompt measures such as the installation of sediment fencing or rock armouring will occur as and when required. Sediment fencing at this time is not considered to be a main tool to erosion protection.

As part of the management of stormwater, **Form 2 – Stormwater Performance** and **Form 5 – ESC Checklist** (refer to **Appendix 2**) must be completed regularly, particularly after rainfall events, to assess the site performance with regard to erosion and sediment transport. The results obtained, as part of the completion of **Form 2**, will be used to determine where additional ESCs must be implemented.

Workplace Procedure 1 – Leachate Management (refer to **Appendix 1**) and *Section 9* below provide further detail on completing **Form 2 – Stormwater Performance** .

It can be noted that apart from the ESCs detailed above (i.e. diversion of external stormwater flows, rehabilitation of designated areas, installation of check dams, perimeter bunding etc), the maintenance of these controls, when and where appropriate (refer to *Section 9*), and the management and maintenance of the sedimentation dams (refer to *Section 9.6*), must be determined by the Site Manager.

8.1.5 Sediment Fore-Bay and Sedimentation Basin Management

Integral to successful leachate management and minimising the level of sediment movement or loss from the hardstand pad into the primary detention basin is the management of the sediment fore-bay initially, from Pads 1 and 2, and when Pad 3 is brought on line, the management of the sedimentation basin located within Pad 3.

Section 11.1 below details that the containment capacity provided within the primary detention basin exceeds the volume of leachate that will be produced over the disturbed area of the site during a 1 in 25 year 24 hour rainfall event and as such there is some capacity available for sediment storage. Whilst that is the case, s*ection 7.1* above provided an estimate of yearly soil loss from Pads 1 and 2 that shows desilting of the primary dam should occur every 5 years thus ensuring that less than 10 % of the volume for containment will be compromised. Whilst the chance of the primary detention basin being significantly filled with sediment so that the above required containment volume cannot be catered for is unlikely, observation must occur so as to determine if excessive amounts of sediment have in fact entered the detention basin. If observed to be the case, further small sediment basins must be installed, preferably close to the source if the source cannot be eliminated or manage via another technique. For it to continue to be able to retain desired volumes, sediment release from the hardstand must not be significant and as such the sediment fore-bay and eventually, when operational, the sedimentation basin within Pad 3 must be regularly desilted.

The Site Manager is responsible for ensuring that extended weather forecasts are considered such that the required capacity for the effective operation of the sediment fore-bay and sedimentation basin are achieved, prior to the possible rainfall event occurring. In observing the extended weather forecast, the Site Manager may determine that enough capacity exists within the fore-bay and or sedimentation basin for the containment of sediment that may possibly be delivered during the incoming rainfall event and as such an emptying or desilting of the basin prior to the rainfall event occurring will not be required.

It is expected that the frequency at which sediment and organic solids must be removed from the fore-bay and sedimentation basin will increase during the wet season. This will ensure their efficiency to remove solids and sediment from flowing leachate.

Bio-Recycle will manage stormwater in accordance with the conditions of the hierarchy highlighted in *Section 2* above. In ensuring this, including the ability to contain a 1 in 25 year 24 hour rainfall event when necessary, the water contained within any of the onsite basins will be reused as dust suppression water, compost make up or adjustment water and irrigation water within the licenced area of the site.

Stormwater monitoring of the primary detention basin must occur regularly for insitu parameters (pH, electrical conductivity, dissolved oxygen and redox potential) with a full analysis of target compounds and elements being conducted at half yearly intervals.

It can be noted here that prior to the reuse of contained leachate, treatment may be required and in particular pH adjustment.

In ensuring that the design capacity of all sedimentation basins is maintained, all sedimentation basins must be regularly de-silted to remove built up sediment. The Site Manager is responsible for determining when the removal of silt/sediment from the sedimentation basins and even the respective

stormwater detention basins must occur. However it can be noted that this will be largely dependent upon the volume of stormwater runoff generated as a result of rainfall over the area of the site. Regular measurement of sediment build up is required to ensure that the required volume of containment can be achieved.

Gypsum will be utilised to reduce suspended solids/colloidal material that is present within the water column of the primary leachate detention basin from time to time. Dosing will occur at 100 kg/ 100 m^2.

For further detail on the management of sedimentation basins as outlined above, readers are directed to **Workplace Procedure 2 – Leachate Detention Basin Management** (refer t**o Appendix 1**). Similarly, further information regarding maintenance is provided within *Section 9.6* below.

8.1.6 Grass Lined and or rock armoured drainage channels

Stormwater flow paths will be inspected and planted out where required to increase the roughness co-efficient to stem flow velocity, and filter sediment to control erosion as per the recommendations made within the IECA guideline. Performance of the flow paths and drainage channels will be monitored in accordance with **Workplace Procedure 4 – Erosion and Sediment Control Procedure** and if warranted Bio-Recycle will consider rock armouring drainage channels.

9 Maintenance of Erosion and Sediment Controls

Effective stormwater management cannot occur if ESCs, including the sedimentation dams and flow paths (i.e. surface gradients) are not properly maintained. Stormwater management must not be compromised due to ESC infrastructure not performing effectively.

The ESC controls detailed above, including flow paths must be maintained such that they are performing effectively. The sections below provide information on how these controls will be maintained such that offsite impact does not occur. It is to be noted that regular site observation must occur whereby **Form 2 – Stormwater Performance** and **Form 5 – ESC Checklist** will be utilised to gauge performance and to assist in determining if further ESC's are required (refer to **Appendix 2**). In general, the purpose of the site observation is to determine if:

- The adopted Erosion and Sediment Control Plan (ESCP) is still appropriate for the site;
- The ESCP is being appropriately implemented;
- The ESC measures are being appropriately maintained;

- The works are un-necessarily contributing to environmental harm or environmental nuisance; and
- An amended ESCP needs to be prepared and/or approved.

A Daily Running Sheet is provided in **Appendix 2** for the recording of any observations made during the above mentioned site observations to check leachate and externally generated stormwater management and ESC performance. The running sheet can also be used to document extraordinary events such as non-compliances or emergencies that occur on site.

All onsite employees are required to report to the Site Manager any observations made that may result in environmental harm for attention and necessary action. Some detailed examples of observations that could be made and recorded are provided below:

9.1 Stormwater flow paths (surface gradients)

Flow paths are important for movement and management of stormwater generated within the site. All flows paths must be visually inspected regularly (particularly after rainfall events) for evidence of blocking due to foreign objects being present or from the build-up of soil material resulting in inefficient drainage, misdirection and/or ponding and pooling of stormwater runoff. It is to be noted that some ponding or pooling of stormwater within temporary low points of flow paths created as a result of operations is likely to occur.

It is important for onsite personnel to understand that internal flow paths must be maintained, such that the desired movement of stormwater is not obstructed or prevented. It is also important for vegetation not to be allowed to proliferate along flow paths such that obstruction occurs.

It is considered that drainage channels are representative of appropriate gradients and widths to convey onsite water. However, observation will be performed to determine their efficiency in this regard.

Regular observation will determine flow path integrity and efficacy with the level of performance being recorded (refer to **Appendix 2, Form 2 – Stormwater Performance** and **Form 5 – ESC Checklist** for associated performance checklists).

Any undesirable surface gradients must be repaired or rectified promptly (when and where required). The observations made as part of completing **Form 2 – Stormwater Performance** and **Form 5 – ESC Checklist** must also be used to determine when and where installation of additional ESC controls for the management of concentrated flows and removal of sediment from stormwater runoff is required (refer to **Appendix 2**). For example if observations made as part of completion of **Form 2 –**

Stormwater Performance and **Form 5 – ESC Checklist** highlight that high velocity concentrated stormwater flows are occurring along the flow path then additional check dams will be installed (as determined by the Site Manager) to effectively reduce the velocity of and transport of sediment within stormwater flows along this path.

9.2 Spillways and Chutes

Spillways and chutes shall be created from various sized rock which will be classified as hard, durable albeit evenly graded with 50% by weight larger than (d50) rock size, determined to be 200 mm. Large rock should dominate, with sufficient small rock to fill voids between the larger rocks. The diameter of the largest rock size should be larger than 1.5 times the nominal rock size. Hand placing of rock may be necessary to achieve the proper distribution of rock sizes to produce a relatively smooth, uniform and stable surface.

9.3 Protection Structures and Energy Dissipaters

As referred to in *Section 8.1.3,* for concentrated stormwater flows which require it, protection structures and energy dissipaters will be considered. Significant energy loss can occur within a hydraulic jump and thus their existence is often encouraged at the base of chutes and spillways to dissipate energy (IECA; A.33; 2012).

9.4 Perimeter bunding

All perimeter bunding installed must be maintained as necessary to prevent the ingress of stormwater that is generated external to the area of the operational area. Attention will be given to ensuring that perimeter bunds do not become an entry point for stormwater. It is essential that all perimeter bunds do not develop cracks or gaps that compromise their integrity. Preventing external stormwater flows from entering the facility will reduce sediment transport and erosion onsite, ensuring maintenance of ESC devices is reduced as much as possible.

Care must be taken to ensure that all perimeter drainage has a consistent grade that suits the needs and topography of the site. Care must also be taken to ensure that this grade is maintained. In constructing perimeter bunds consideration must be given to allowing for compaction and settlement. Consideration must also be given to the application of topsoil and seeding perimeter bunding to aid in maintaining its integrity particularly through high rainfall events. However, care must be taken when installing

perimeter bunding such that a worsening condition upon neighbouring properties does not occur. Bio-Recycle, if required will consult with neighbours to ensure that impacts to operations or infrastructure do not occur.

Furthermore, the perimeter bunds must be monitored regularly (particularly after high rainfall events) for evidence of any of the above issues (refer to **Appendix 2, Form 2 – Stormwater Performance**).

When necessary, repair of perimeter bunding must occur as soon as possible following observation made regarding possible entry points within the bund(s) to ensure their integrity is reinstated promptly.

9.5 Detention Basin Maintenance

It is to be noted that due to the nature of the composting activity being performed, the types of wastes received and the method of stormwater management, it is expected that the water contained within the primary, secondary and lower (to a lesser extent) detention basins may be contaminated with nutrients, suspended solids, colloidal material, biological demanding substances, total organic carbon and various anions and cations, including trace elements. Therefore, the environment within the basin(s) is expected to be reduced and thus creating conditions suitable for odour generation.

In the event that the primary detention basin receives significant loading (unlikely if flows first pass through sediment fore-bay or later sedimentation basin on Pad 3) or is releasing unpleasant odour, the basin must be either aerated or treated with a bacterial inoculum or microbial stimulant, to ensure it is maintained in an oxidised, odourless state and that BOD and COD is reduced. The inoculum or stimulant must be mixed to the required dilution and sprayed across the surface of the pond to ensure an aerobic state predominates so that offensive odour is not generated, thus preventing environmental nuisance. If rapid oxygenation is required, then the use of hydrogen peroxide must occur. Before this occurs, the Site Manager must engage a suitably qualified person to provide direction on how the peroxide is to be applied.

Similarly, pH may need to be raised so as to ensure that sulphides remain in solution. The pH of all contained waters must remain above 6.5 pH units and not be allowed to increase above 8.5 pH units.

If the water column within the primary detention basin requires a reduction in suspended solids/colloidal clay suspensions, gypsum will be utilised to flocculate such suspensions. Gypsum will be partially dissolved in water and sprayed over the leachate water's surface. The dossing will be 50-100 kg/ 100 m^2.

9.6 Sedimentation Dams and check dams

After each rainfall event, respective sediment basins and check dams must be inspected, with the removal of accumulated sediment and solids occurring promptly if required.

All cracks or damage observed in the base and side walls of any sedimentation basin or check dams must be repaired promptly. All observations of cracks or damage must be reported to the Site Manager promptly and recorded on **Form 1 - Daily Running Sheet** (refer to **Appendix 2).**

Maintaining the functional integrity of the sedimentation basins and any check dams installed is imperative. Accumulated sediments must be removed from these basins regularly but at least when 30 % of the volume is occupied by sediment. This will be determined when dewatering occurs. This will ensure that the required containment capacity is maintained, the re-entrainment of sediment is reduced as much as possible and that dams are operating to their maximum potential.

10 Daily Weather Conditions

Appendix 2, Form 3 – Daily Weather Conditions must be used to record weather conditions experienced at the site. This is an extremely useful data set that can be used to schedule repair and maintenance of ESC areas after certain rainfall volumes are experienced.

Commensurate with this is the review of extended weather forecasts to assist in predicting unfavourable operational conditions that may arise. Review of such predictions can assist in demonstrating ones environmental duty and ensuring that sufficient containment capacity exists within onsite dams and basins when a 1 in 25 year 24 hour AEP rainfall is considered likely.

11 Leachate Quantity Management

11.1 Capacity for Leachate Containment and Catchment Area

The area of the hardstand pad is equivalent to ~ 8.78 ha. (refer to **Appendix 3, Figure 3**). Containment has been provided for the volume of stormwater that will be produced as a result of a 1 in 100 year 24 hour rainfall event (i.e. 168 mm) over the area of this catchment, which is equal to ~ 14.7 ML of stormwater being produced. Bio-Recycle is committed however to ensuring that available capacity is equivalent to the volume created during a 1 in 25 year 24 hour rainfall event.

It is to be noted that the volume of containment provided by the secondary detention basin of 1 Ml when combined with the primary detention basin exceeds the volume generated within a 1 in 100 year 24 hour event.

12 Leachate Quality Monitoring

As mentioned, monitoring and sampling of the primary detention basin must occur half yearly to determine the quality of water contained. Table 3 below provides the respective analytes that require analysis by a NATA accredited laboratory every 6 months.

Analyte
BOD
COD
Ammonia
Nitrate
Total Phosphorous
Total Nitrogen
Zinc
Copper
Mercury
Selenium
Lead
Nickel
Suspended Solids

Table 4: Analytes to be Determined at Half-Yearly Intervals

If no water is present within the detention basin in order to conduct half yearly stormwater monitoring, photographs of the basin must be taken as evidence to provide to the EPA if requested. In such instances, monitoring of the primary detention basin must occur at the next available opportunity so as to determine water quality.

13 Emergency Leachate Release Management and Monitoring

Monitoring prior to an anticipated emergency release should include the recording of pH, electrical conductivity (EC), dissolved oxygen (DO) and redox potential. Samples should also be obtained so as to allow further testing if considered necessary of analytes presented in Table 3 above.

In accordance with normal operating procedures correction of contained stormwater should occur, for pH, if it is not within the specified range of 6.5-8.5 pH units.

The corrective action associated with the adjustment of pH so as to achieve the aspirational release limit, is bulleted below:

pH adjustment

To increase or reduce the pH such that it is within the desired range (i.e. 6.5-8.5 pH units), caustic soda or lime (preferably), or sulphuric acid or sodium bisulphite must be added to the contained water.

- For further detail on the management and monitoring associated with an emergency release to the, readers are directed to **Emergency Procedure 1 – Emergency Stormwater Release** (refer to **Appendix 1**).

14 Conclusion

The information provided within this SGWMP demonstrates how Bio-Recycle will manage leachate at the site such that the receiving water environment is protected.

It is believed that if all control measures and workplace procedures are adhered to, achievement of the stated measures and design requirements expressed within the Composting & Related Organics Processing Facilities, Environmental Guideline prepared by the Department of Environment & Conservation, 2004 will be achieved.

Moreover, the information provided addresses all items the Pollution Reduction Program issued by the EPA via Licence Variation (Notice No. 1533678) to be implemented at its Ravensworth Composting Facility will be achieved.

Supporting the above, the Erosion and Sediment Control Strategy and subsequent plan proposed within this SGWMP demonstrates Bio-Recycle's commitment to ensuring the site meets its compliance obligations in accordance with IECA principles. Furthermore, the ESCP demonstrates robust processes to ensure erosion and sediment control issues are integrated into workplace operations to achieve the best possible outcomes (refer to Workplace Procedures).

Bio-Recycle is committed to conducting stormwater management in compliance with the requirements of the EPA and the respective conditions of the EPL. As a result of the above information presented, Bio-Recycle is confident that even if stormwater was to be released from the site during an emergency, environmental harm would not likely occur.

Appendix 1

Leachate and Stormwater Management Workplace and Emergency Procedures

1 Introduction

Section 2 below contains the leachate workplace procedures for the management of leachate, including erosion at the site. Stated measures contained within these procedures detail information for site employees to use as a guide when managing leachate. A leachate emergency leachate release procedure is provided within *Section 3* below. This procedure will assist employees when responding to an uncontrolled leachate release from the site.

For the purpose of accessibility, the leachate workplace and emergency procedures will be laminated and positioned in various locations throughout the site. The leachate workplace and emergency procedures are listed as follows:

Workplace Procedure

Emergency Procedures

2 Workplace Procedures

<table>
<tr><th colspan="2">Workplace Procedure 1 – Leachate Management</th></tr>
<tr><td colspan="2">Environmental Commitment:

• To ensure that uncontrolled leachate releases to the receiving environment do not occur during rainfall events up to and including a 1 in 25 year 24 hour rainfall event, therefore preventing environmental harm.
• To effectively manage leachate generated at the site so as to limit onsite erosion and sediment transport and protect the integrity of associated sediment management infrastructure.
• To prevent uncontaminated stormwater runoff generated external to the site from entering the site.</td></tr>
<tr><td>Identification of Issues:

• The development of cracks or gaps in perimeter bunding.
• Uncontaminated stormwater generated external the site is allowed to enter into the site.</td><td>Potential Impacts:

• Increased volume of leachate required to be managed.
• Increased erosion or sediment transport on site.
• Increased contamination of the water column within onsite dams.
• Increased treatment of onsite dams or installation of additional ESC controls, with associated increased costs.
• Increased chance of uncontrolled release occurring.
• Contravention of a permit condition & possible enforcement action by EPA.</td></tr>
<tr><td>• Misdirection of leachate runoff.</td><td>• Increased chance of an uncontrolled release resulting in harm.
• Increased chance of an overtopping of an onsite dam resulting in an uncontrolled release.
• Increased chance of erosion.</td></tr>
<tr><td>• Damage to pad(s) caused by vehicles continually travelling over wet pad(s).</td><td>• Damage to the pad(s) is likely to cause leachate to settle in crevices in the pad(s), potentially causing offensive odour liberation and further damage to the hardstand pad(s).

• Breeding of mosquitos.</td></tr>
<tr><td>• Surface gradients are not maintained such that leachate runoff is directed as necessary.
• The blocking or obstruction of internal drains.</td><td>• Misdirection of leachate from the various areas of the facility that could result in undesirable contamination of basin(s) or releases.
• Ponding or pooling of leachate, which may result in increase in the infiltration of leachate and the redirection of leachate.
• Ponding and pooling of leachate possibly creating anaerobic activity.</td></tr>
</table>

	• Overloading of onsite basin(s) creating anaerobic conditions that if released to the receiving environment could cause environmental harm. • Enforcement action taken by EPA.
• Undesirable/unnecessary ponding or pooling of leachate.	• Operationally inconvenient. • Anaerobic conditions may develop subsequently resulting in generation of offensive odours.
• Allowing erosion to occur as a result of high velocity or concentrated leachate runoff.	• Increased erosion or sediment transport on site. • Increased contamination of the water column within onsite dams. • Increased treatment of onsite basins, with associated increased costs. • Contravention of a permit condition & possible enforcement action by EPA.
• The allowance of significant/unnecessary volumes of sediment to be transported via leachate to onsite basin(s).	• Increased contamination of the water column within onsite dams. • Increased treatment of onsite dams or, with associated increased costs. • Increased chance of an uncontrolled release occurring. • Contravention of a permit condition & possible enforcement action by EPA.
• The allowance of gross solids to be transported via leachate to the onsite basin(s). • Leachate has not been captured, contained and re-incorporated within the windrows.	• Release of offensive odour creating odour nuisance off Site. • Overloading creating anaerobic conditions that if released to the receiving environment could cause environmental harm. • Increased chance in the overloading of one or more of the onsite pond(s) resulting in the release of odour.
• The blocking or obstruction of internal flow paths.	• Ponding or pooling of stormwater, which may result in the redirection of contaminated stormwater. • Increased chance of an uncontrolled release. • Unnecessary contamination of stormwater runoff.
Control Measures:	

- The Site Manager must ensure that perimeter bunding is installed as required to prevent ingress of external stormwater volumes.
- Ensure that all perimeter bunding is integral to prevent the ingress of external stormwater volumes.
- If the integrity of the perimeter bund is found to be compromised the repairs must be conducted immediately.
- Ensure onsite flow paths effectively allow for the direction of stormwater to the onsite sedimentation dams as desired.
- Ensure unnecessary ponding or pooling of leachate onsite does not occur.
- If unnecessary ponding or pooling of leachate is observed, flows paths must be reinstated promptly.
- Ensure unnecessary obstruction/blockage of leachate flow paths does not occur.
- All unnecessary obstructions must be removed from stormwater flow paths promptly.
- **Form 2 – Stormwater Performance** and **Form 5 – ESC Checklist** must be completed regularly (particularly after rainfall events) to assess the management of contaminated stormwater and determine where any additional ESCs may need to be installed to ensure erosion and sediment transport is maintained at a minimum.
- Ensure that additional Erosion and Sediment Control (ESC's) determined as being required following observations made as part of completing **Form 2 – Stormwater Performance** and **Form 5 – ESC Checklist** are implemented.

- Ensure all windrows are constructed such that they run parallel to the leachate flow paths.
- Maintain the hardstand pads, surface gradients (flows paths) and drainage channels such that leachate flows from the various areas of the facility are directed as desired.
- Ensure the hardstand pad(s), drainage channels and pond(s) have structural integrity (particularly after rainfall events) so that movement and storage of leachate does not result in releases to the receiving environment.
- If the integrity of a hardstand pad, drainage channels or pond(s) are found to be compromised, the Site Manager must be informed immediately and repairs must be conducted immediately, by placing clay, gravel in the affected areas and compacting to the required impermeability.
- Inspect all drainage channels regularly to ensure they are maintained free of all obstacles (including waste).
- In the event that ponding or pooling of leachate does occur, clean-up action must be initiated immediately and surface gradients re-established.
- Contain, clean up and reincorporate any bulk leachate emanating from windrows.
- Ensure that all liquid is sufficiently mixed with absorbent material (i.e. greenwaste bund or sawdust etc.) and then is incorporated into the composting process.
- If the velocity of stormwater in diversion drains is such that erosion is occurring, then consideration must be given to the installation rock check dams every 20 m to slow the velocity of water.

Pond Management

- Do not allow high BOD/COD wastes to directly discharge to the onsite basin(s).
- Do not allow solid waste to be discharged to the basin(s).
- Do not allow toxic or hazardous substance to enter the pond(s). If a release or discharge occurs to the pond(s) that results in the souring of the pond(s) and hence the liberation of noxious or offensive odour, the Site Manager must inform the Facility Manager to obtain direction.
- Ensure that once the capacity of the basin(s) is reduced by >30%, excess sediment/sludge must be removed and stockpiled/re-incorporated.
- Ensure a minimum 500mm freeboard is maintained in all ponds at all times, and that it is reinstated promptly after rainfall periods.
- Empty the onsite pond(s) for use as onsite dust suppression or compost moisture control, if required.
- Ensure that the top half of the onsite basin(s) is aerobic (i.e. > 4 ppm dissolved oxygen).

- If the onsite basin(s) have received significant loading, are anaerobic or releasing offensive odour microbial inoculums or bio-stimulants, such as BioAktiv, must be added to the basin(s) to suppress odour.
- If rapid oxidation is required above what the aerator can induce, then consideration should be given to introducing ozone or hydrogen peroxide. If initially ozone or hydrogen peroxide cannot be introduced, calcium nitrate should be utilised to increase the redox potential. **Given the hazardous nature of hydrogen peroxide, specialist help will be required when introducing it to the pond(s).**
- Do not allow pH of the onsite basin(s) to fall below 6.5 or increase above 8.5 pH units.
- If pH adjustment is required, introduce dilute solutions to neutralise. This can be determined by performing a jar or bucket test, whereby solutions of sodium bisulphite, lime or dilute solutions of either sulphuric acid or sodium hydroxide can be added to a sample of contaminated water to determine the volume required. **However, since both sulphuric acid and sodium hydroxide represent a strong acid and alkali respectively, consideration should be given to the use of weaker acids and bases if a significant adjustment is not required. Contact should be made with a person who is appropriately qualified to make this determination.**

Record Keeping:

- Record any repairs conducted to perimeter bunding or flow paths (surface gradients) (refer to **Appendix 2, Form 1 - Daily Running Sheet**).
- Record all observations with regard to stormwater management after rainfall events that induce stormwater runoff and the need for the installation of additional ESCs to maintain erosion and sediment transport at a minimum (refer to **Appendix 2**, **Form 2 – Stormwater Performance**).
- Record installation of any additional ESCs (refer to **Appendix 2**, **Form 1 - Daily Running Sheet**).
- If stormwater does release directly to the receiving environment, the release must be recorded. Refer to **Emergency Procedure 1 – Emergency Stormwater Release** in the event this does occur.
- The parameters required to be monitored when a release occurs must be recorded.

Responsibility and Communication:

- It is the responsibility of onsite employees to ensure that the above controls are carried out.
- Onsite employees must report any release to the receiving environment immediately to the Site Manager for attention and any necessary action.
- The Site Manger is responsible for advising the Facility Manager about a release to the receiving environment.
- The Site Manager is responsible for ensuring any repairs to bunding or flow paths are conducted promptly.
- The Site Manager is responsible for the collection and recording of any observations made as to the performance of the stormwater containment system. (i.e. ensuring **Form 2** is completed as required).
- The Site Manager is responsible for determining when and where additional ESCs must be implemented based on the observations made as part of completion of **Form 2**.

Relevant Legislation:

- *Protection of the Environment Operation Act 1997.*

Workplace Procedure 2 – Leachate Detention Basin Management

Environmental Commitment:

- That the sedimentation and leachate detention basins are maintained such that sufficient capacity exists for the containment of the volume of leachate generated over the disturbed area of the site up to and including an event of a 1 in 25 year 24 hour rainfall event.
- That uncontrolled release of leachate from the onsite basin to the receiving environment does not occur.
- That the re-entrainment of sediment within the water column of sedimentation basins is maintained at a minimum.
- To ensure that the functioning of the onsite basin(s) does not result in the release of offensive and noxious odour that creates environmental harm (including environmental nuisance) at an odour sensitive place.

Identification of Issues:	**Potential Impacts:**
• The allowance of significant/unnecessary volumes of sediment to be transported via leachate to onsite basin(s).	• Increased contamination of the water column within onsite basins. • Increased treatment of onsite basins, with associated increased costs. • Increased chance of uncontrolled release occurring. • Contravention of a permit conditions & possible enforcement action by EPA.
• Unacceptable build-up of sediment at the bottom of the basins.	• Increased contamination of the water column within onsite basins. • Increased treatment of onsite basins or, with associated increased costs. • Increased chance of uncontrolled release occurring. • Possible contravention of a permit condition as a result of inability to contain stormwater runoff generated over the disturbed area of the site in a 1 in 10 year 24 hour rainfall event & possible enforcement action by EPA.
• Extended weather forecast is not regularly consulted to determine when a certain rainfall event may occur (i.e. a 1 in 10 year 24 hour rainfall event or worse a 1 in 25 year 24 hour rainfall event) and the detention basin has enough capacity.	• Unexpected increases in the volume of leachate required to be managed. • Increased chance of release occurring during events that generate less of a volume than a 1 in 25 year 24 hour containment. • Possible contravention of a permit condition as a result of inability to contain leachate runoff generated over the disturbed area of the mine site in a 1 in 25 year 24 hour rainfall event or less & possible enforcement action by EPA.

• The reuse of leachate contained within the basin does not occur as required to ensure capacity to contain the volume of leachate generated as a result of rainfall falling over the disturbed area of the site in a 1 in 25 year 24 hour rainfall event or less.	• Contravention of a licence condition as a result of inability to contain leachate runoff generated over the area of the site in a 1 in 25 year 24 hour rainfall event or less & possible enforcement action by EPA. • Increased chance of release occurring without obtaining sample and therefore inability to accurately report on impact
• The structural integrity of a sedimentation basin is compromised.	• Reduction in the ability to minimise sediment releases to the detention basin. • Reduction in capacity of detention basin with increased risk of releasing contaminated waters in events < a 1 in 25 year 24 hour rainfall event.
• A significant erosion event occurs that results in excessive sediment being released to one or all of the basins.	• Inability to flocculate waters due to excessive suspended solids being present. • Requirement to dispose of waters offsite at such a facility as a composter. • Huge financial loss.
• Overloading the onsite basin(s) with high strength Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) substances, both in liquid or solid forms. • Overloading of the onsite basins(s) with excessive amounts of organic matter, such as green waste/sawdust.	• A reduction in dissolved oxygen (DO) and resulting in anaerobic conditions, which results in the liberation of offensive or noxious odour from the pond(s). • A reduction in redox potential which results in the liberation of offensive or noxious odour. • Enforcement action by the EPA.
• Dissolved Oxygen levels in contained water is < 4 mg/l; • < 2 mg/l; • < 1mg/l.	• Water quality not suitable for release. The lower the dissolved oxygen, the increased chance of causing environmental harm such a fish kills. • The lower the dissolved oxygen the increased chance of creating offensive odour.
• The Redox Potential in contained water is < -240 mv.	• The greater the chance of creating offensive odour due to reduced conditions.
• The pH of contained water is < 6.5 pH units; or • The pH of contained water is > 9.5 pH units.	• The increase in releasing offensive odour pertaining to sulphides. • The increase in chance of releasing ammonia.
• Discharging toxic and hazardous liquid wastes to the onsite basin(s).	• The killing of beneficial aerobic bacteria and the introduction of toxicants to the composting process. • Need for treatment and disposal of contaminated waters. • Financial loss.

Control Measures:

- Ensure all leachate is managed correctly (refer to **Workplace Procedure 1 – Leachate Management**).
- Ensure prolonged weather forecasts are considered to determine when a 1 in 25 year 24 hour rainfall event is possible and/or expected in order to ensure that dams are managed to ensure sufficient capacity is provided.
- Ensure that built up sediment is regularly removed from all basins, particularly the sedimentation basin to ensure their design capacity is maintained and the re-entrainment of sediment within the water column is kept to a minimum.
- Ensure that when required removal of stormwater contained within the sedimentation basin occurs to ensure sufficient capacity to contain the volume of stormwater generated in a 1 in 10 year 24 hour stormwater event over the disturbed area of the site.
- Ensure water required to be removed from onsite basins is reused for dust suppression or utilised as irrigation water within the undisturbed areas of the site when this is considered to be appropriate.
- In the event that a controlled release must occur to ensure containment for the volume of stormwater generated as a result of a 1 in 10 year 24 hour rainfall event falling over the disturbed area of the site, ensure this release is managed correctly. Refer to **Workplace Procedure 3 – Leachate Detention Basin Monitoring**.
- Inspect the respective basins regularly, particularly after rainfall events to ensure their structural integrity is maintained.
- Ensure basin is structurally integral (particularly after rainfall events) so that the storage of leachate does not result in uncontrolled releases to the receiving environment.
- If the integrity of a basin is found to be compromised, the Site Manager must be informed immediately.
- If the integrity of a basin is found to be compromised, repairs must be conducted immediately, by placing clay in the affected areas & compacting to the required impermeability.
- It the integrity of a check dam is found to be lacking then the replacement or addition of extra rocks must occur.
- Check dam spacing must be scrutinised to ensure efficacy of treatment.
- Ensure all uncontrolled releases of leachate are managed correctly. Refer to **Emergency Procedure 1 – Emergency Leachate Release**. This procedure must also be followed to ensure that leachate monitoring is conducted as required (i.e. half yearly).
- Ensure that the top half of the water column within basins is aerobic. Do not allow dissolved oxygen (DO) < 2 ppm or mg/l.
- If DO falls below 2 ppm activate aeration utilising an aerator.
- If rapid oxidation is required above what the aerator can induce, then consideration should be given to introducing hydrogen peroxide. **Given the hazardous nature of hydrogen peroxide, specialist help will be required when introducing it to the dam.**
- Ensure that every 6 months contained leachate is monitored for the insitu parameters listed in *Table 1* and *Table 2* contained in **Workplace Procedure 3**.

Record Keeping:

- Record incidental rainfall (refer to **Appendix 2**, **Form 3 – Daily Weather Conditions)**.
- Record all observations in relation to the performance of the respective basins and check dams (refer to **Appendix 2, Form 2 – Stormwater Performance**).
- Record any repairs or maintenance undertaken to basins or infrastructure including removal of built up sediment (refer to **Appendix 2, Form 1 - Daily Running Sheet)**.

- Record all reuse of stormwater as irrigation water, including the details of this activity (i.e. duration and volume removed) (refer to **Appendix 2, Form 1 - Daily Running Sheet)**.
- Record all adjustment made to basins (i.e. aeration) including details of these adjustments refer to **Appendix 2, Form 1 - Daily Running Sheet**).

Responsibility and Communication:

- It is the responsibility of the mine operator to report any variance from the control measures stated above to the Site Manager.
- The Site Manager is responsible for ensuring the maintenance of respective basins occurs and is conducted as required (i.e. the removal of sediment, reinstating design capacities).
- The Site Manager is responsible for ensuring adjustment are made to basins as required.
- The Site Manager is responsible for ensuring any repairs to the respective basins or ESC infrastructure are carried out promptly.
- The Site Manager is to promptly report to the Facility Manager any variance from the control measures that may or do result in an uncontrolled release to the receiving environment.
- The Site Manager is to promptly inform the EPA and AGL Macquarie of any variance from the control measures that result in an uncontrolled release to the receiving environment.

Relevant Legislation:

- *Protection of the Environment Operation Act 1997.*

Workplace Procedure 3 –Leachate Detention Basin Monitoring

Environmental Commitment:

- To ensure that half yearly leachate monitoring is conducted correctly.

Identification of Issues:	Potential Impacts:
• Leachate monitoring of the detention basin does not occur at half yearly intervals or as otherwise required prior to a release.	• Failure to demonstrate that release limits have been met prior to a release occurring. • Breach of permit conditions and possible enforcement action taken by the EPA.
• Leachate monitoring is not conducted for all required parameters.	• Failure in ability to demonstrate the quantities of contaminants released. • Breach of permit conditions and possible enforcement action taken by the EPA.
• Failure to take a water sample as part of leachate monitoring whereby laboratory analysis is required.	• Failure to verify the concentration of contaminants released. • Enforcement action taken resulting in a fine.

Control Measures:

- Ensure that half yearly leachate monitoring of the detention basin occurs.
- If no leachate is contained within the detention basin at the time of leachate monitoring, ensure photographs of the basin are taken to provide evidence of this as and when required.
- ½ yearly leachate monitoring must also include the parameters bulleted below:
- Dissolved Oxygen (DO);
- pH;
- Electrical Conductivity (EC);
- Redox Potential; and
- Turbidity / Total Suspended solids.
- Prior to an anticipated emergency release occurring the ranges and limits provided in *Table 1* below must be meet for the parameter listed.

Parameter	Units	Minimum	Maximum
pH	-	6.5	8.5

Table 1: Stormwater release limits

- Where practically possible, prior to an anticipated emergency release occurring, measure contained water for the insitu parameters listed in *Table 2* below.
- Where practically possible, prior to an anticipated emergency release occurring ensure that contained leachate is sampled so that if required, analysis for the parameters listed in *Table 3* below can occur.

Table 2:

Water Quality Parameter	Monitoring Frequency
Dissolved Oxygen (DO)	Regularly or at least every 6 months.
pH (field measured)	
Electrical Conductivity (EC)	
Redox Potential (Redox)	

Table 3:

Analyte	Monitoring Frequency
BOD	At least every 6 months.
COD	
Ammonia	
Nitrate	
Total Phosphorous	
Total Nitrogen	
Zinc	
Copper	
Mercury	
Selenium	
Lead	
Nickel	
Suspended Solids	

- If the monitoring prior to an anticipated emergency release indicates that the release limits outlined in *Table 1* above will not be achieved, the treatment of the water contained with basin should occur as described below. In addition water samples should be taken and retained in the event that additional testing of any stormwater released, may be required.
- **pH adjustment**
- To increase the pH such that it is within the release limit range (6.5 – 8.5) caustic soda or lime must be added to the dam.
- To reduce the pH, sodium bisulphite or sulphuric acid must be introduced. Prior to treatment, a bucket or jar test must be performed to determine the amount / litre that is required to

rectify. Ensure that a sample is taken as part of half yearly stormwater monitoring or when monitoring is conducted prior to an emergency release.

- All emergency releases must occur via the designated release point.
- Ensure that in the event of an emergency release **Emergency Procedure 1 – Emergency Stormwater Release** is followed.

Record Keeping:

- Record all stormwater monitoring conducted (refer to **Appendix 2**, **Form 1 - Daily Running Sheet**). As part of this recording ensure that a record is made of compliance with the release limits if a release occurs. Any exceedance of the release limits must be reported to the EPA.
- Record all samples taken for laboratory analysis (refer to **Appendix 2**, **Form 1 - Daily Running Sheet**).

Responsibility and Communication:

- It is the responsibility of onsite employees to report any variance from the control measures stated above to the Site Manager.
- The Site Manager is responsible for ensuring all monitoring of leachate is conducted as and when required.
- The Site Manager is responsible for ensuring the release limits are met prior to a release and that treatment of leachate occurs as and when required.
- The Site Manager is responsible for notifying the Facility Manager of any variance from the control measures.
- The Site Manager is responsible for notifying the EPA of any releases that occur which have not met the r release limits or where leachate monitoring of the water released has not occurred prior to this release.

Relevant Legislation:

- *Protection of the Environment Operation Act 1997.*

Workplace Procedure 4 – Erosion and Sediment Control Procedure

Environmental Commitment:

- To ensure that Sediment and Erosion controls are implemented and maintained to minimise erosion and release of sediment offs site.

Identification of Issues:	**Potential Impacts:**
• Poor maintenance of Erosion and Sediment Controls.	• Contaminated water is released as a result of a crack or gap in a dam. • Excessive erosion of disturbed areas. • Excessive sediment loading in sediment dams. • Potential 'clean water' mixing with contaminated water. • Contravention of a permit condition & possible enforcement action by EPA.
• Inadequate drainage control developed for the site.	• Increased risk of rill and gully erosion • Discharge of waters off site from areas other than designated points. • Contravention of a permit condition & possible enforcement action by EPA.
• On site sediment traps (rock filter traps, sediment weirs etc.) inadequately sized.	• Excess sediment in concentrated flows. • Contaminated water is released (spills) from site due. • Contravention of a permit condition & possible enforcement action by EPA.
• Onsite sediment basins have been inadequately sized.	• The containment capacity provided within onsite basins is insufficient to contain the volume of stormwater generated over the disturbed area of the site in a 1 in 10 year 24 rainfall event. • Wilful non-compliance of permit conditions & enforcement action by EPA.
• Onsite sediment basins have not been maintained correctly (i.e. excess sediment removed) and their containment capacity is reduced below the required volume	• The containment capacity provided within onsite basins is insufficient to contain the volume of stormwater generated over the disturbed area of the site in a 1 in 10 year 24 rainfall event. • TSS levels exceed site release limits. • Wilful non-compliance of permit conditions and enforcement action by EPA.
• Inadequate Stabilisation & rehabilitation of disturbed areas	• Excessive erosion of disturbed areas • Fail to meet rehabilitation performance criteria • Non-compliance with permit conditions.

Control Measures:

- Ensure all Erosion and Sediment Controls are adequately maintained (refer to **Appendix 2, Form 5 – ESC Checklist**).
- Ensure adequate drainage controls are identified, implemented which allow for effective reduction of flow velocity and erosion.
- Ensure Sediment traps are adequately sized, positioned and designed for a 1 in 10 year 24 hour rainfall event.
- Ensure Sediment basins are adequately sized and designed.
- Ensure that built up sediment is regularly removed from the sedimentation basins to ensure their design capacity is maintained and the re-entrainment of sediment within the water column is kept to a minimum.
- Ensure disturbed areas are minimised and rehabilitated as soon as practicable.
- Ensure rehabilitation of disturbed areas meets a performance target of 90% ground cover (photographic evidence to be maintained).

Record Keeping:

- **Form 5 – ESC Checklist** has been completed following rainfall events.
- Record the need for additional ESCs.
- The performance of ESCs to maintain erosion and sediment transport at a minimum must be recorded (refer to **Appendix 2**, **Form 2 – Stormwater Performance**).
- Record installation of any additional ESCs (refer to **Appendix 2**, **Form 1 - Daily Running Sheet**).
- Maintain photographic evidence of rehabilitation works and ground cover performance.

Responsibility and Communication:

- The Site Manager is responsible for ensuring monitoring of ESC is conducted.
- The Site Manager in responsible for ensuring ESCs are implemented in accordance with the ESCP.
- The Site Manager is responsible for ensuring that ESC's are maintained in accordance with the ESCP.
- It is the responsibility of onsite employees to report any variance or additional control measures required to the Site Manager
- It is the responsibility of onsite employees to report all non-conforming ESCs to the Site Manager.

Relevant Legislation:

- *Protection of the Environment Operations Act 1997.*

3 Emergency Procedures

<table>
<tr><th colspan="2"><u>Emergency Procedure 1 – Emergency Leachate Release</u></th></tr>
<tr><td colspan="2"><u>Environmental Commitment:</u>

• To ensure that any unanticipated emergency releases of leachate to the receiving environment are minimised and/or prevented from causing environmental harm.

Note: Anticipated Emergency stormwater releases are permitted to occur following rainfall in excess of a 1 in 25 year 24 hour AEP rainfall event.</td></tr>
<tr><td><u>Identification of Issues:</u></td><td><u>Potential Impacts:</u></td></tr>
<tr><td>• A lack of observation has resulted in poor maintenance of the basin whereby water is released as a result of a crack or gap in the basin wall or spillway.</td><td>• Leachate is released as a result of a crack or gap in the basin.
• Contravention of a permit condition & possible enforcement action by EPA.</td></tr>
<tr><td>• Rainfall results in a release from detention basin when it should not have (i.e. rainfall event is < 1 in 25 year 24 hour rainfall event) due to an inadequate containment storage volume being afforded.</td><td>• Unknown quality of water being released.
• Contravention of a permit condition & possible enforcement action by EPA.</td></tr>
<tr><td>• Leachate releases from the detention basin prior to the monitoring and sampling of the water being released.</td><td>• Unknown quality of water released with an inability to quantify harm (if any). Wilful contravention of a permit condition & enforcement action by EPA.</td></tr>
<tr><td>• The detention basin has not been maintained correctly (i.e. excess sediment removed) and the containment capacity is reduced below the required volume.</td><td>• The containment capacity provided within onsite basins is insufficient to contain the volume of leachate generated over the disturbed area of the site up to and including a 1 in 25 year 24 hour rainfall event.
• Wilful non-compliance of permit conditions and enforcement action by EPA.</td></tr>
<tr><td>• The site has not been managed correctly resulting in significant erosion occurring. Minimal time is available for treatment and a release of turbid water occurs.</td><td>• Excessive contamination of onsite basin(s) and stormwaters.
• Increased maintenance and associated costs of onsite basins.
• Release of excessively turbid waters.
• Contravention of a permit conditions & possible enforcement action by EPA.</td></tr>
<tr><td colspan="2"><u>Control Measures:</u>

• Refer to onsite PIRMP for further information surrounding emergency management.

• Ensure all stormwater is managed correctly (refer to Workplace Procedure 1 – Leachate Management).
• Ensure that the detention basin is managed correctly (refer to Workplace Procedure 2 – Leachate Detention Basin Management).</td></tr>
</table>

- Ensure excess sediment is removed from the sedimentation and detention basin as required to ensure leachate containment capacity is maintained.
- Ensure all leachate management infrastructure required is installed as required (refer to **Workplace Procedures 1 and 2**).
- Ensure all leachate management infrastructure is maintained correctly (refer to **Workplace Procedures 1 and 2**).
- As the disturbed area of the site increases ensure progressive rehabilitation occurs.
- If increases in the disturbed area of the site occur, ensure the containment capacity of onsite basins also increases in line with the increased area of disturbance. Ensure that containment capacity exists on site for the volume of leachate that will be generated over the disturbed area of the site up to and including a 1 in 25 year 24 hour rainfall event.
- Ensure that as the activity progresses significant erosion and generation of excessively turbid stormwater is avoided.
- In the event that an emergency release to the receiving environment is occurring the Site Manager must be notified that this is occurring.
- In the event of an anticipated emergency release contained stormwater must be monitored for the insitu parameters listed in *Table 1* below.

Table 1:

Water Quality Parameter	Monitoring Frequency
Dissolved Oxygen (DO)	As required upon an emergency release.
pH (field measured)	
Electrical Conductivity (EC)	
Redox Potential (Redox)	

- In the event of an anticipated emergency release a sample should be obtained so that if analysis for the parameters listed in *Table 2* below is required, it can be.

Table 2:

Analyte	Monitoring Frequency
BOD	As required upon an emergency release..
COD	
Ammonia	
Nitrate	
Total Phosphorous	
Total Nitrogen	
Zinc	
Copper	
Mercury	
Selenium	

Lead	
Nickel	
Suspended Solids	

- In the event of an anticipated emergency release the Site Manager is responsible for ensuring that appropriate actions are taken to safely obtain a sample that is representative of the release.
- The Site Manager is responsible for ensuring that steps are taken promptly to minimise any uncontrolled releases to the receiving environment. Such measures may include the prompt plugging and repair of bund walls, dam wall or spill way or if observation determines prompt attention is required, removal of sediment within in sedimentation and detention basins or redirection of stormwater to minimise erosion and sediment transport.

Record Keeping:

- Record all estimated volumes of any anticipated emergency release (refer to **Appendix 2**, **Form 4 – Emergency Release Notification Form**).
- In the event of an emergency release from the detention dam obtain readings for dissolved oxygen (DO), electrical conductivity (EC), redox potential and pH from the dam. Use **Form 4 – Emergency Release Notification Form (**refer to **Appendix 2**) for recording data.
- Note any observations made when performing monitoring (refer to **Appendix 2**, **Form 4 – Emergency Release Notification Form**).
- Use **Form 4 – Emergency Release Notification Form (**refer to **Appendix 2**) to report information about the release to EPA.

Responsibility and Communication:

- It is the responsibility of onsite employees to report any variance from the control measures stated above to the Site Manager.
- All emergency releases that have the potential to cause material environmental harm must be brought to the attention of EPA by telephone as soon as practicable after becoming aware that there has been an emergency release.
- The Site Manager is responsible for notifying the EPA immediately upon becoming aware that an emergency release has occurred or is likely to occur which has the potential to cause material environmental harm.
- The Site Manager is responsible for notifying EPA in the first instance; however, in the absence of the Site Manager, an onsite employee must do so.

Relevant Legislation:

- *Protection of the Environment Operations Act 1997.*

Appendix 2

Forms and Checklists

Forms

Form 1 - Daily Running Sheet

Date and initials	Time	Description of daily events Include extraordinary events such as noncompliance or emergencies. This should link with information contained in other forms.

Form 2 – Stormwater Performance

Date/initials	Amount of Rainfall (mm)	Performance of Internal Drains Any cracks or blockages evident?	Performance of basins at collecting and containing stormwater	Performance of hardstand pad Any ponding or pooling evident?	Any erosion (including bund and basin walls and spill way)?

Form 3 – Daily Weather Conditions

Date	**Description of Weather** **Note**: Incorporate any changes throughout the working day and include previous night time conditions.

Form 4 – Emergency Release Notification Form

Note: In the event of an uncontrolled release the EPA must be called on 131555 and advised by telephone of the basic information regarding this release. The information on this form must be completed as soon as possible following such a release. All details must be completed and the form faxed to EPA to the number advised when reporting by telephone.

Date and time of the uncontrolled release: ……../……../…… ……am/pm	**Approximate volume of the uncontrolled release or area affected?** ……..litres/m^2
Is the uncontrolled release presenting any immediate safety risk to others? Of the receiving environment **Action(s) taken:** ……... ……... ……...	**Suspected cause of the uncontrolled release:** …… …… …… ……
Name and contact phone number of the Site Manager responsible: ……... **(Mobile) ……...** **(Landline) ……**	**Location of the uncontrolled release:** **Location description……** ……..... …….....
Have any samples been collected? YES / NO Collect a sample in a sample container or take a photograph of the release. Ensure sample is marked with the date, time and name of the person taking sample. Ensure sample is handed to the Site Manager.	**Have any actions been taken to minimise/mitigate the environmental effects of the uncontrolled release incident?** ……..... ……..... **Has this action been successful?** Not at all / Somewhat / Prevented further release(s)

Form 5 – ESC Checklist

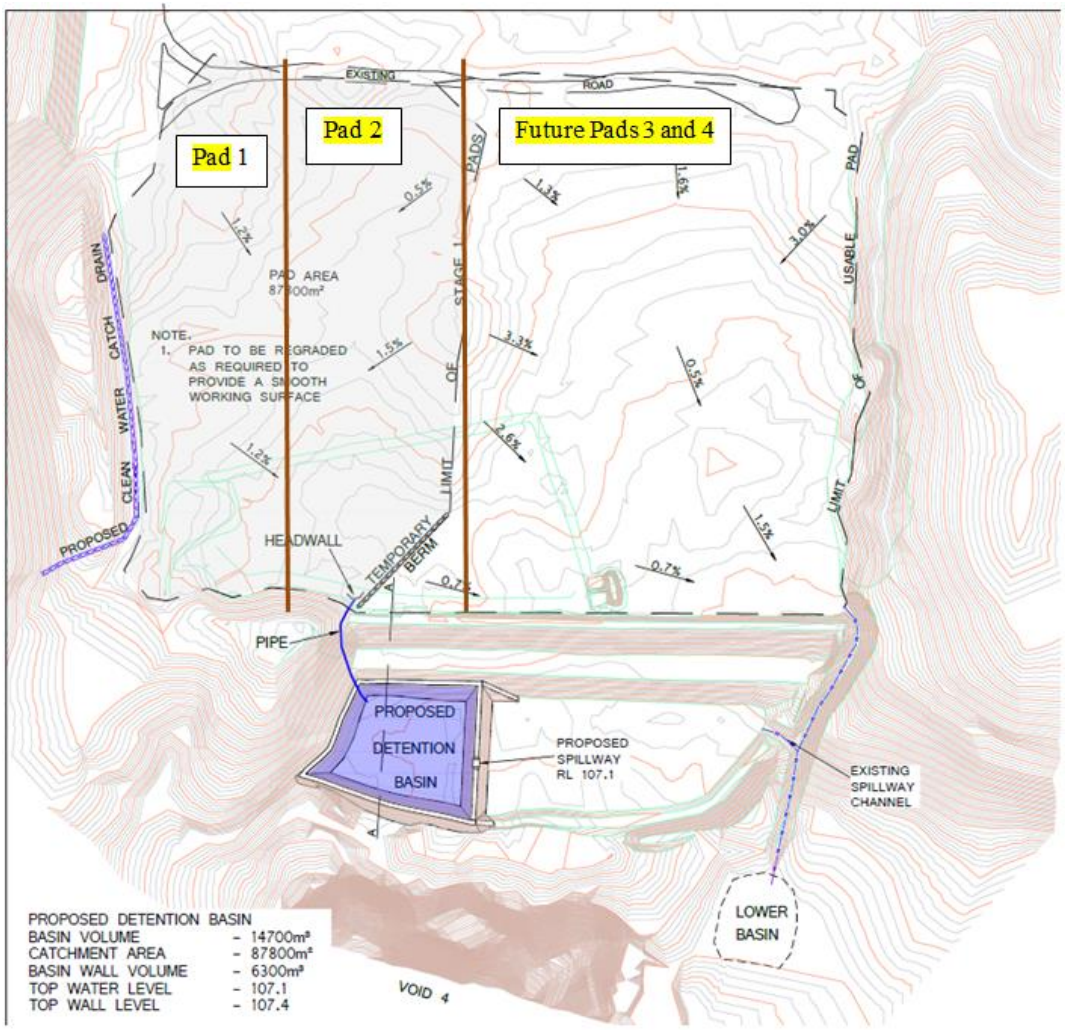
#	Item	Finding
1	Stockpile locations clearly identified and located away from protected vegetation and overland flow paths.	
2	Stockpiles located at least 5m away from top of watercourse banks.	
3	Adequate up-slope drainage controls (if necessary) and down-slope sediment controls placed adjacent to stockpiles.	
4	Temporary access roads/tracks identified, with appropriate drainage/erosion controls specified.	
5	*Temporary Watercourse Crossings* identified and protected.	
Drainage Control		
	Item	**Finding**
7	Temporary drainage controls designed to the appropriate standard and hydraulic analysis provided.	
8	Hydraulic analysis indicates appropriate flow velocities.	
9	Hydraulic analysis indicates appropriate flow capacity.	
10	Flow from "clean" external catchments diverted around/through site in a non-erosive manner.	
11	Internal "dirty" water drainage lines identified and directed to sediment controls.	
12	All site drainage inflow and outflow points identified.	
13	All water discharges from the site at legal points of discharge.	

14	All water discharges through stabilised outlets onto stable land.	
15	Maximum spacing of drains on long, open soil slopes is appropriate for the gradient and soil type.	
16	Appropriate flow velocity controls (e.g. *Check Dams*) or scour controls (e.g. turf or *Erosion Control Mats*) specified.	
17	*Catch Drains* or Flow Diversion Banks located at top of cut and fill batters.	
18	Rock *Check Dams* not specified in shallow (i.e. < 500mm deep) drains.	
19	Water flow is appropriately conveyed down constructed earth slopes (e.g. through *Slope Drains* or *Chutes*).	
20	All *Slope Drains* and *Chutes* have stabilised inlets and outlets.	
21	Appropriate drainage controls on unsealed roads and access tracks.	
22	Overland flow appropriately controlled around *Temporary Watercourse Crossings*.	
	Erosion Control	
23	The erosion control standard is consistent with the rainfall erosivity, environmental risk, and clay content of exposed soil.	
24	The erosion control standard is consistent with the requirements of regulatory authority.	
25	Specified stabilisation measures are appropriate for the soil slope (gradient).	

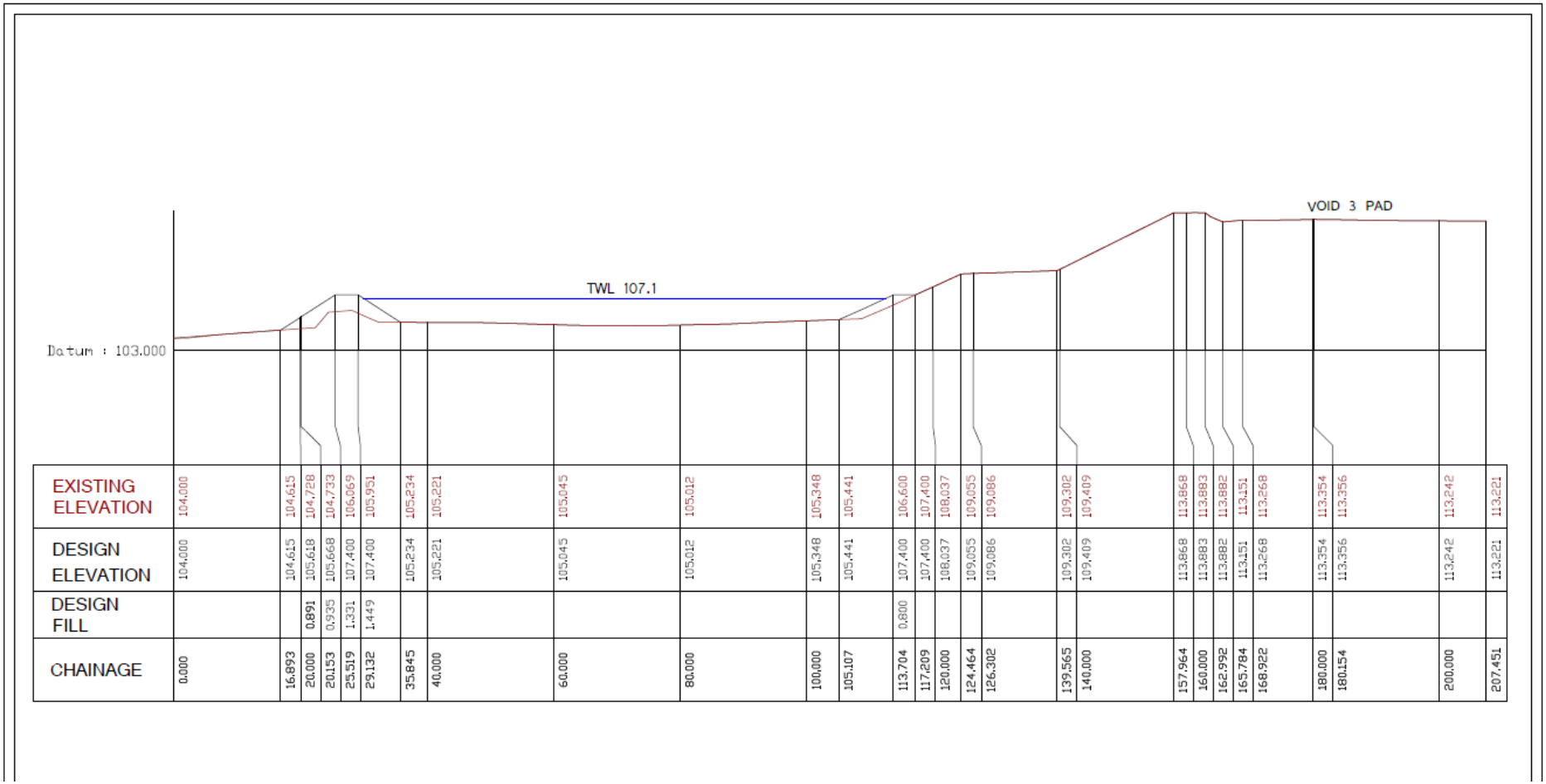
26	Appropriate drainage controls installed to minimise mulch being washed off the slope/site.	
	Sediment Control	
27	Location of all sediment control measures clearly shown on ESCP.	
28	Sediment Traps are appropriately sized and designed.	
29	All Sediment Basins have: (a) Stable inflow conditions. (b) Inlet baffle (if required). (c) Minimum 3:1 length to width, otherwise baffles installed. (d) Suitable access for de-silting and maintenance. (e) Stabilised emergency spillway and energy dissipater. (f) Stabilised batters/embankments. (g) Safety or exclusion fencing (as required). (h) Operating conditions and water quality standards specified.	
30	ESC specialist review of basin selection & design	
	Site Rehabilitation	
31	**Areas of progressive rehabilitation identified in ESCP**	
32	**Rehabilitation measures have been implemented in accordance with the design specification.**	

Appendix 3

Figures

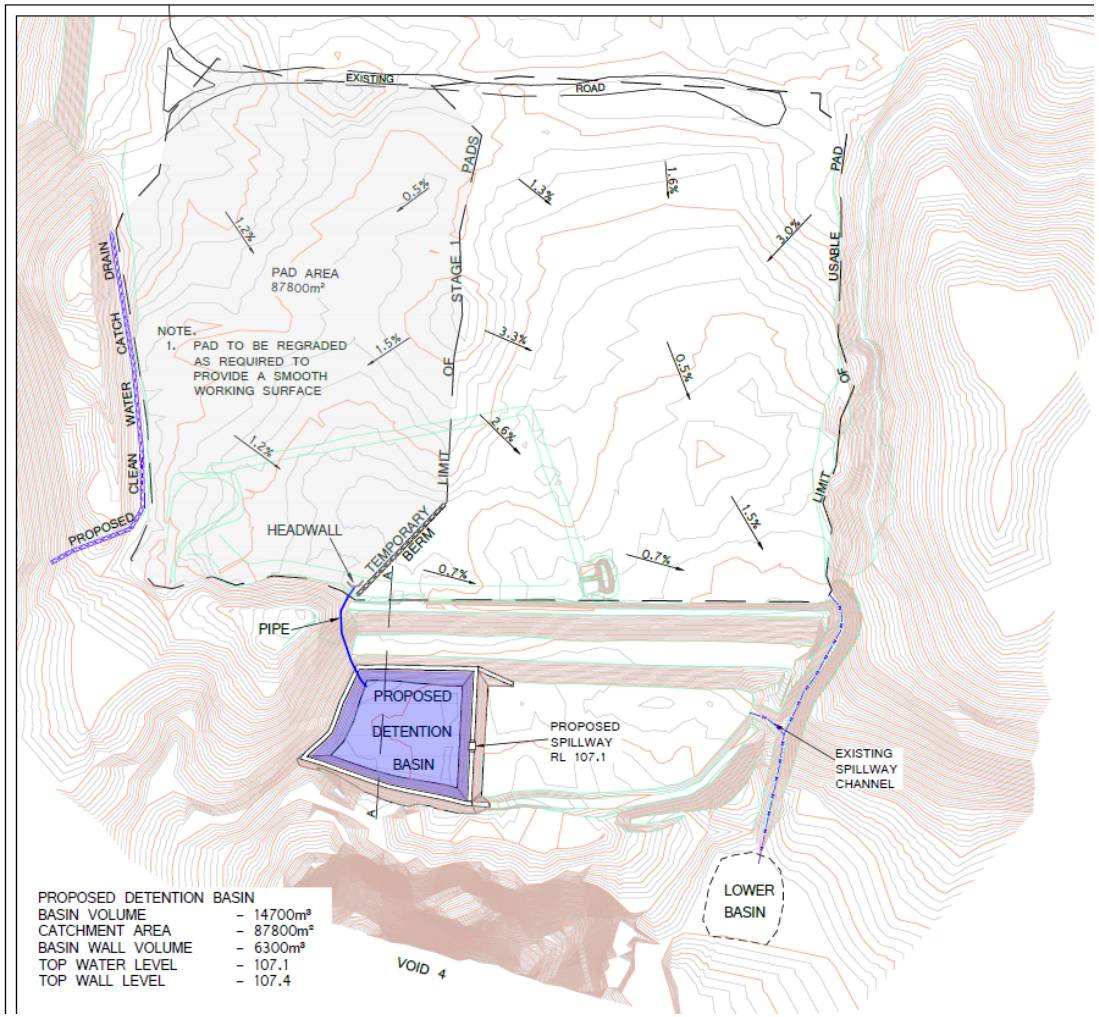


Appendix 3 - Figure 1: Layout of the Hardstand

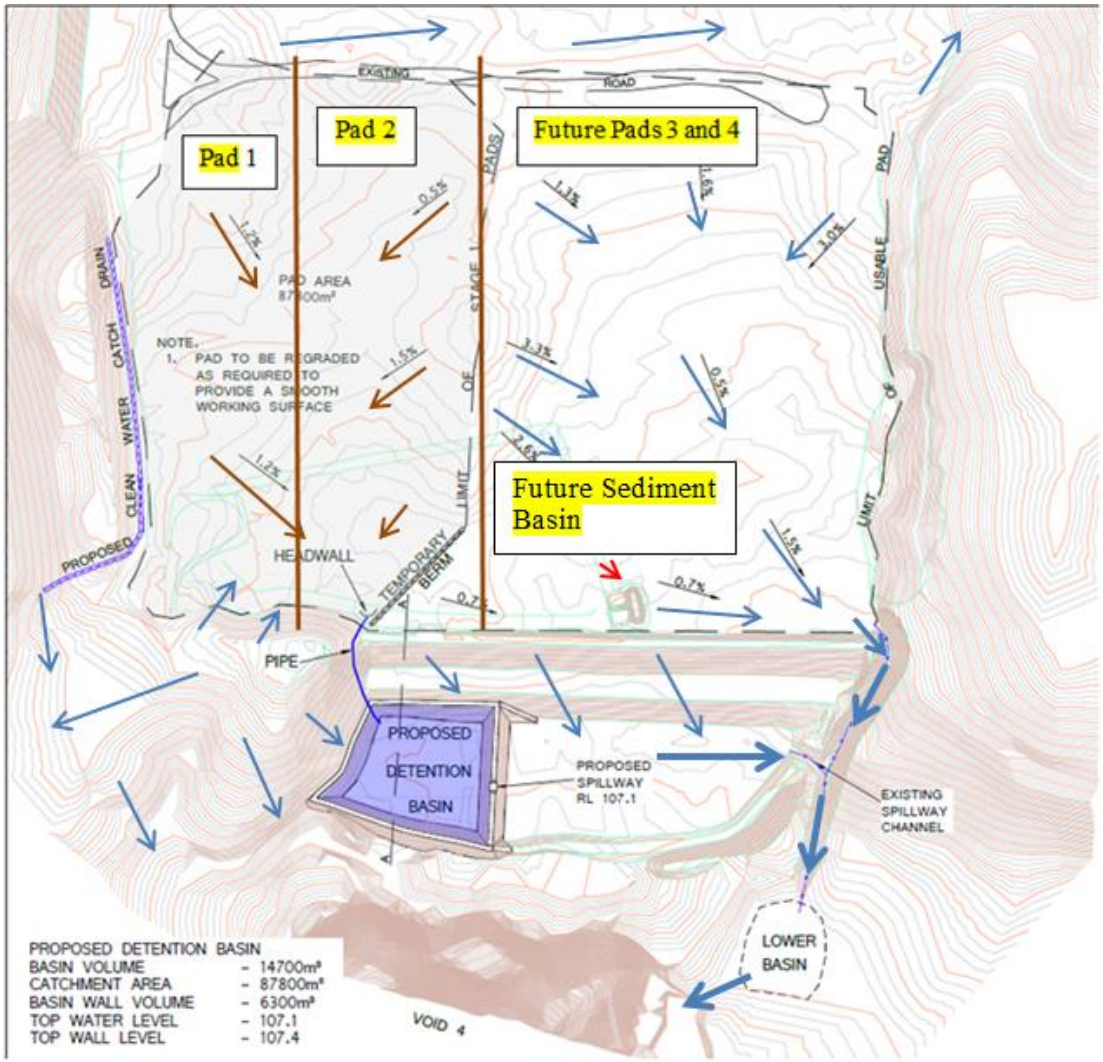


EXISTING ELEVATION	104.000		104.615	104.728	104.733	106.069	105.951	105.234	105.221		105.045		105.012		105.348	105.441	106.600	107.400	108.037	109.055	109.086		109.302	109.409		113.868	113.883	113.882	113.451	113.268		113.354	113.356		113.242	113.221
DESIGN ELEVATION	104.000		104.615	105.618	105.668	107.400	107.400	105.234	105.221		105.045		105.012		105.348	105.441	107.400	107.400	108.037	109.055	109.086		109.302	109.409		113.868	113.883	113.882	113.451	113.268		113.354	113.356		113.242	113.221
DESIGN FILL				0.891	0.935	1.331	1.449										0.800																			
CHAINAGE	0.000		16.893	20.000	20.153	25.519	29.132	35.845	40.000		60.000		80.000		100.000	105.107	113.704	117.209	120.000	124.464	126.302		139.565	140.000		157.964	160.000	162.992	165.784	168.922		180.000	180.154		200.000	207.451

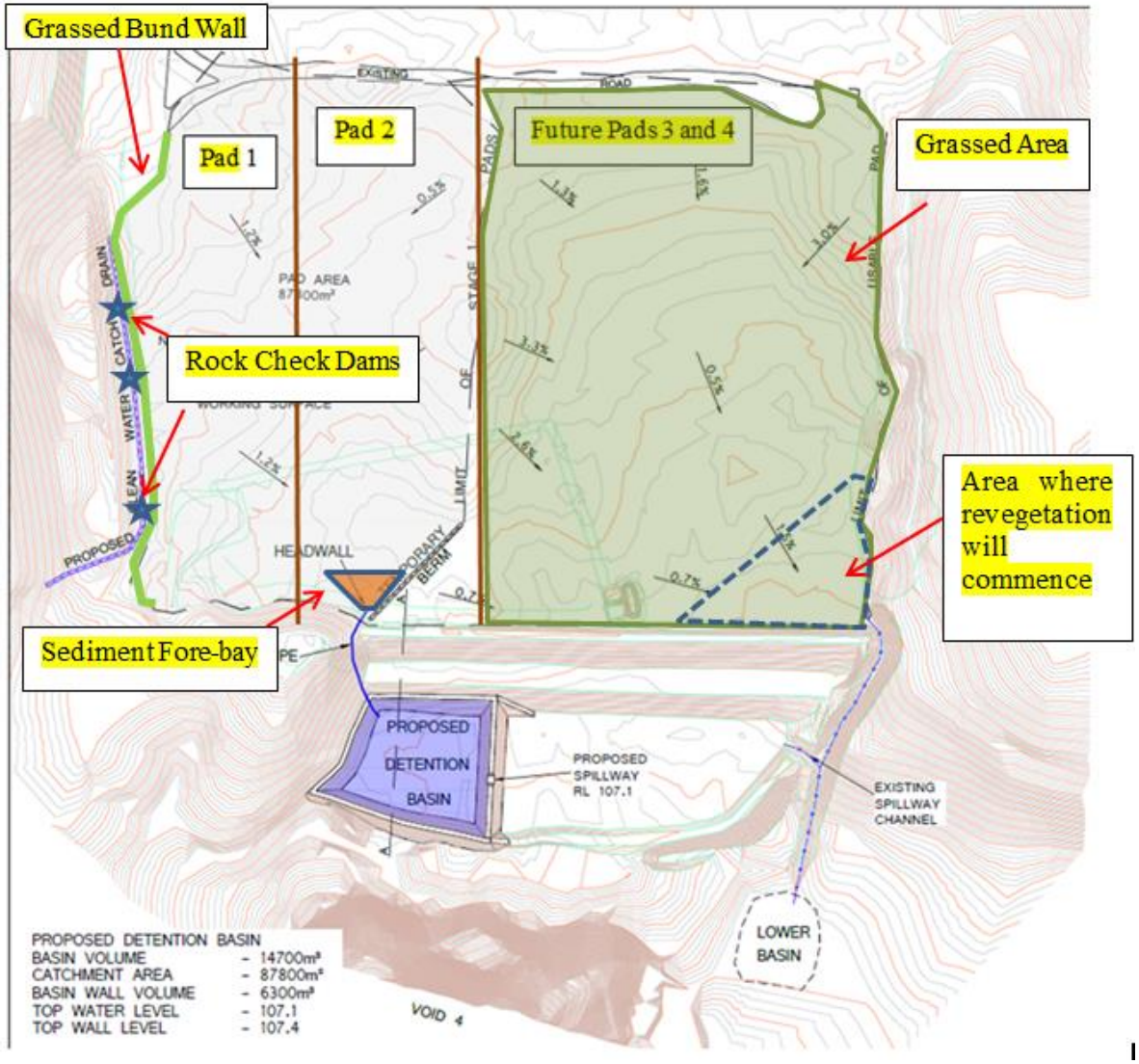
Appendix 3 - Figure 2: Cross Sections of Hardstand Pads and Detention Basin



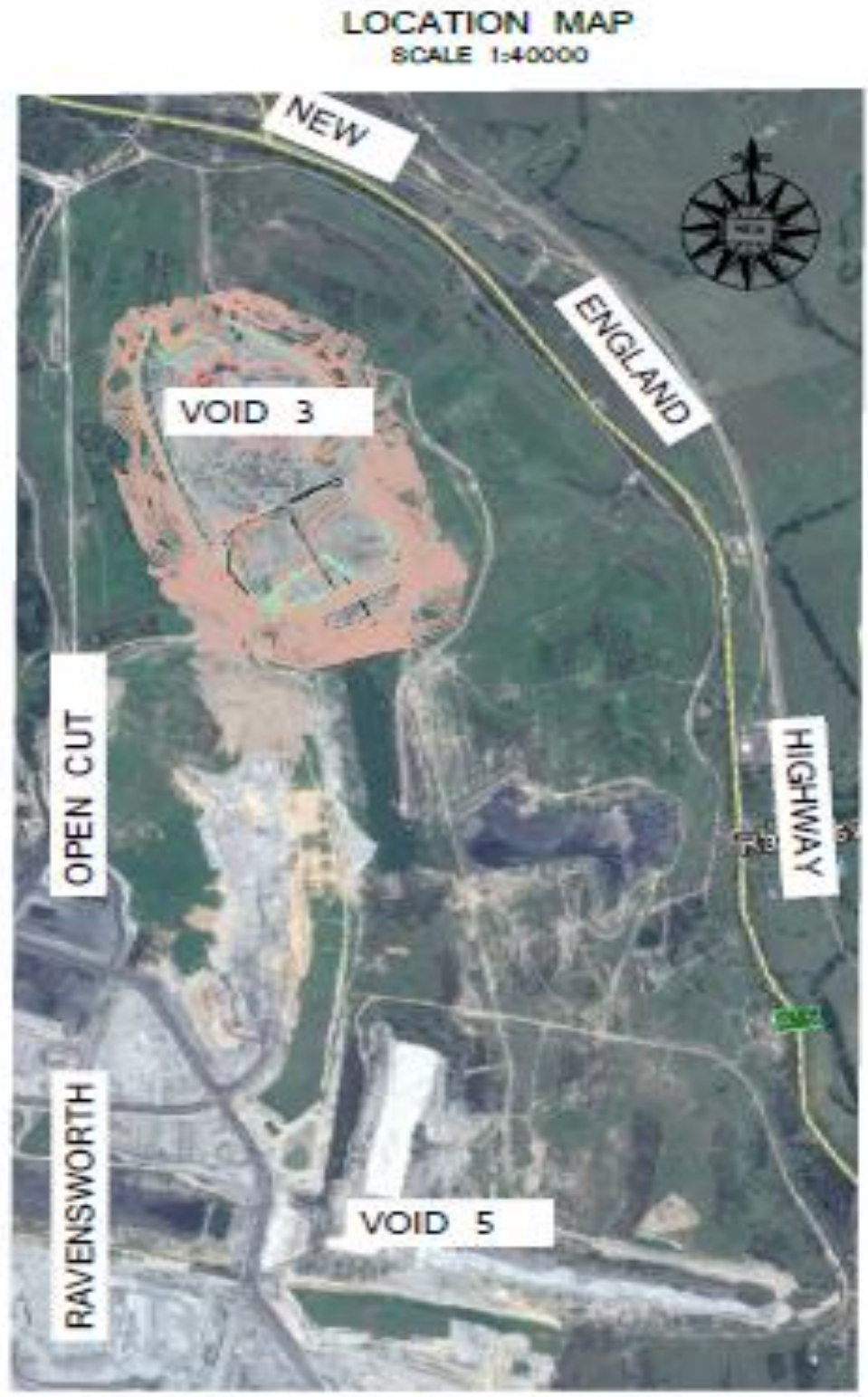
Appendix 3 - Figure 3: Gradient of Hardstand



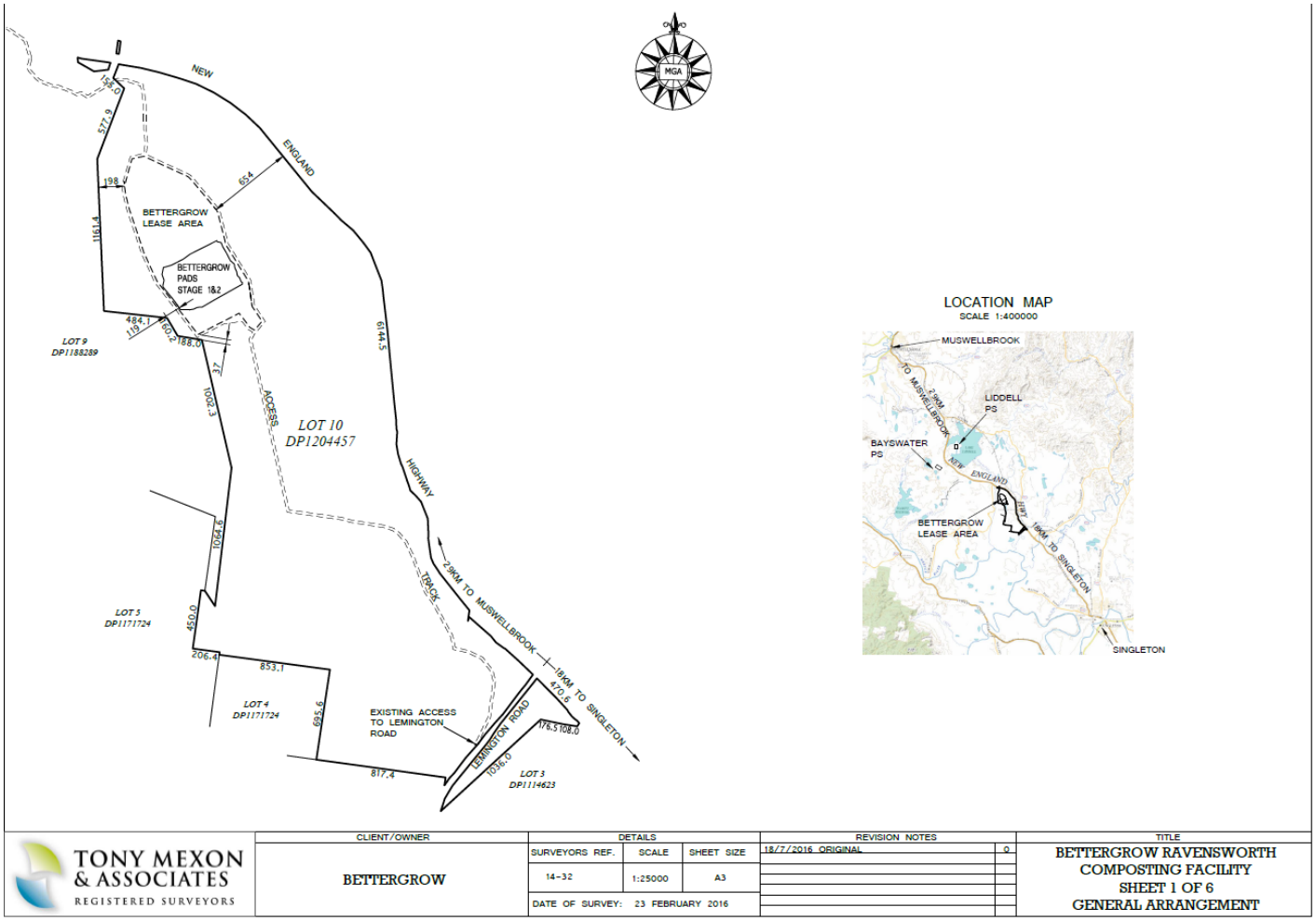
Appendix 3 - Figure 4: Stormwater Flow Diagram



Appendix 3 - Figure 5: Erosion and Sediment Control Plan



Appendix 3 - Figure 6: Location Map



Appendix 3 - Figure 7: Depicting Lease Area

Appendix 4

Density and Permeability Results

ABN: 50 103 355 531
VALLEY CIVILAB
Geotechnical, Testing & Engineering Services
Unit 3, 62 Sandringham Ave, Thornton NSW 2322 P (02) 4966 1844 F (02) 4966 1855
www.valleycivilab.com.au

Moisture Density Relationship Report

Client :	**Better Grow**	Report Number:	**P815 - 1/1**
Address :	**48 Industry Road, Vineyard, NSW, 2765**	Report Date :	**9/03/2016**
Project Name :	**Coal Reject Permeability**	Order Number :	
Project Number :	**P815**	Test Method :	**AS1289.5.2.1**
Location:	**Ravensworth Open Cut Mine , Ravensworth**	**Page 1 of 1**	

Sample Number :	S16-452	SAMPLE LOCATION	
Sampling Method :	Sampled by Client	Ravensworth Open Cut Mine	
Sampled By :	Sampled by Client		
Date Sampled :	18/02/2016		
Date Tested :	23/02/2016		
Material Type :	Coal Reject Material	Test Number :	-
Material Source :	Ravensworth Open Cut Mine	Lot Number :	-
Remarks :	-	Moisture Method :	AS1289.2.1.1

Maximum Size (mm) :	19.0	**Maximum Dry Density (t/m³) :**	**1.92**
Oversize Dry (%) :	4.4	**Optimum Moisture Content (%) :**	**8.5**
Oversize Density (t/m³) :	2.41		

NATA

Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

APPROVED SIGNATORY

James Wyatt - Technician - Quarry Materials
NATA Accreditation Number
14975

Document Code RF124-7

FALLING HEAD PERMEABILITY REPORT

Client:	Valley Civilab Pty Ltd	**Source:**	S16-452 Coal Reject Material - Ravensworth
Address:	Unit 3/62 Sandringham Avenue, Thornton NSW 2322	**Sample Description:**	Silty GRAVEL
Project:	P815	**Report No:**	B26401-FHP
Job No:	S16079	**Lab No:**	B26401 (S9222)

Test Procedure:

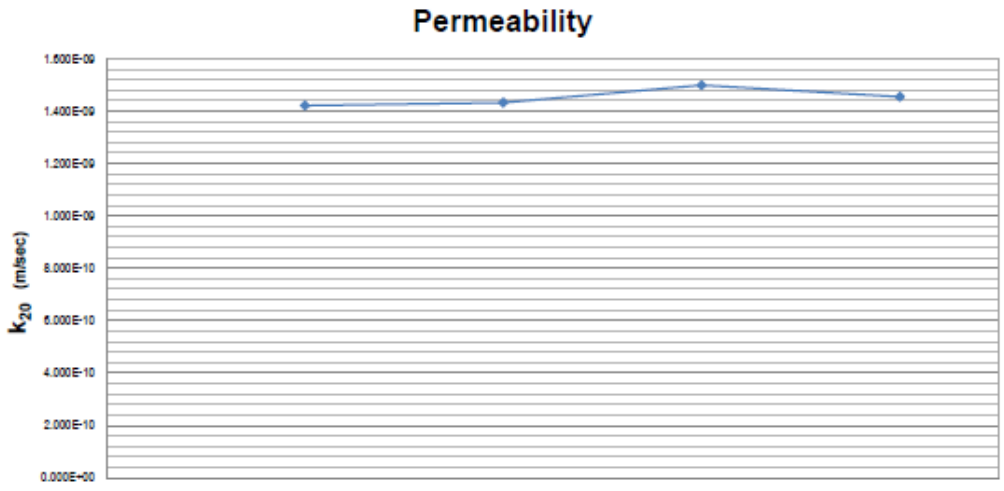
- ☑ AS1289 6.7.2 Soil strength and consolidation tests - Determination of a soil - Falling head method for a remoulded specimen
- ☐ AS1289 5.1.1 Soil compaction and density tests - Determination of the dry density/moisture content relationship of a soil using standard compactive effort
- ☑ AS1289 5.2.1 Soil compaction and density tests - Determination of the dry density/moisture content relationship of a soil using modified compactive effort

Sampling:	Sampled by Client	**Date Sampled:**	18/02/2016
Preparation:	Prepared in accordance with the test method		

RESULTS

Standard Maximum Dry Density (t/m³)	**1.92**	Hydraulic Gradient	**0.0**
Optimum Moisture Content (%)	**8.5**	Surcharge (kPa)	**0.0**
Placement Moisture Content (%)	**8.6**	Head Pressure Applied (kPa)	**0.0**
Moisture Ratio (%)	**101.6**	Standard Compaction	**Modified**
Placement Dry Density (t/m³)	**1.88**	Percentage Material Retained/Sieve Size (mm)	**0 % on 19**
Density Ratio (%)	**98.1**	Sample Height and Diameter (mm)	**104 x 149.3**

PERMEABILITY $k_{(20)}$ = **1.45E-09** (m/sec)



NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Bradley Morris

9/03/2016

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
3 Watt Drive
Bathurst NSW 2795

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