DOCUMENT CONTROL	
Doc No. PR32_BCB_Bringelly EMS_WMP_R3- V1	
Reason for Revision: Conditions of Approval for SSD_5684 S16-18 Resubmission	
Issue Date: 3/09/2019	Review Date: 3/09/2020
Writer: T. Obrien	Reviewed: D.Cook

Bringelly Brickworks Water Management Plan

GLOSSARY AND ABBREVIATIONS

BoM	Australian Bureau of Meteorology
CoA	Conditions of Approval for SSD_5684,
CSR	CSR Limited
DP&E	Department of Planning & Environment
DPI Water	Department of Industry Water
EIS	Bringelly Brickworks Quarry Extension Environmental Impact Statement (Hyder Consulting, 5 September 2013)
EMS	Environmental Management Strategy
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	NSW Environment Protection Authority
OEH	NSW Office of Environment & Heritage
PIRMP	Pollution Incident Response Management Plan
PGH	PGH Bricks
POEO Act	Protection of the Environment Operations Act 1997
RTS	Bringelly Brickworks Quarry Extension Response to Submissions
Secretary, the	The Secretary of the DP&E
SSD	State Significant Development
TSP	Total Suspended Particulate Matter
VGT	VGT – Environmental Compliance Solutions Pty Ltd – Approved Consultant
WMS	Work method statements
WMP	Water Management Plan

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1 INTRODUCTION

1.1 Context

This Water Management Plan (WMP or Plan) forms part of the Environmental Management Strategy (EMS) for the Bringelly Brickworks (the facility) owned and operated by PGH Bricks and Pavers Pty Ltd (PGH). The Plan has been prepared following the approval of the Bringelly Brickworks Extension Project (SSD_5684) on 3 March 2015 and a Section 96(1A) modification application (MOD1), which was determined on 31 October 2016.

This WMP has been prepared to address the requirements of the Conditions of Approval (CoA) as updated following the determination of MOD1, the mitigation measures listed in the Bringelly Brickworks Quarry Extension Environmental Impact Statement (EIS) and all applicable legislation, licenses and permits.

All relevant environmental plans were prepared and submitted to the Department of Planning, Infrastructure and Environment (DPIE) in 2017, this plan represents an updated draft to reflect required amendments and onsite procedures.

1.2 Background

Bringelly Brickworks (the facility) is a clay/shale quarry and brick making facility located at 60 Greendale Road, Bringelly, on Lot 100 in DP 1203966 and comprises an area of approximately 104 hectares in the Camden Local Government Area. The facility has been in operation since 1968, and in its original form it had the capacity to process approximately 51,500 tonnes of bricks per annum.

In 2013, PGH prepared an Environmental Impact Statement (EIS) to assess the environmental impacts of an increase in production at the facility and continued extraction of the quarry to meet the anticipated demand for its brick products ('Bringelly Brickworks Extension Project', Application No. SSD_5684). The project was determined to be State Significant Development (SSD) under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and Clause 8 *State Environmental Planning Policy (State and Regional Development) 2011* (State and Regional Development SEPP).

A water quality assessment was completed as part of the EIS for the project by specialist water quality consultants, Hyder (2013). This assessment provided a quantitative assessment of potential water quality impacts associated with the project, including:

- Construction and operational impacts, with a focus on processing and water discharge;
- Reasonable and feasible mitigation measures to minimise water quality impacts; and
- Monitoring and management measures, in particular real-time water quality monitoring.

In February 2015 DPIE the Bringelly Brickworks Extension Project was approved with conditions on 3 March 2015.

PGH applied to the DPIE to modify SSD_5684 under Section 96(1A) of the *Environmental Planning and Assessment Act 1979* (EP&A Act), to provide for an increased raw material import limit to 321,000 tonnes per annum. MOD1 was approved by DPIE on 31 October 2016.

This plan has been drafted by VGT and PGH and prepared to comply with the requirements of the modified SSD_5684.

1.3 WMP Approval

The Conditions of Approval relevant to this WMP and how they are met by this plan are outlined in *Table 1*.

This WMP must have also been endorsed by the Plant Manager and National Environmental Manager prior to submission to the Secretary of the Department of Planning, Infrastructure and Environment (DPIE).

The WMP is required to be submitted to the Secretary of the DPIE for approval prior to commencing the development approved in SSD_5684, unless the Secretary agrees otherwise.

1.4 Consultation

As outlined in the CoA (refer *Table 1*), this Plan has been prepared in consultation with the EPA and DPIE- Water previously (refer to *Annexure to this report- Water Management Consultation and Correspondence*). A version of this Plan was provided to the EPA and NRAR on Tuesday, 17 September 2019 for comment. The EPA responded acknowledging receipt of this Plan. The NRAR also responded acknowledging receipt of this Plan.

The EPA stated in their correspondence that they do not approve or endorse the Plan as their role is to set environmental objectives for environmental management, not to be directly involved in the development of strategies to achieve those objectives. NRAR had no comment on the Water Management Plan

A previous draft plan has been submitted the DPIE post approval and comments were provided (see Annexure to this report- *Water Management Consultation and Correspondence*). An amended draft plan was submitted in August 2019 and further comments were in turn received from DPIE. The table below summarises these comments relevant to water management of the Site that require actions and where addressed in this report.

Table 1. DPIE Post Approval Environmental Management Plan Comments

Relevant Consent Condition	Comment (from Attachment A)	Where Addressed in this Report
a) Be prepared by a suitably qualified and experienced person/s approved by the Secretary;	Append evidence of approval	Appendix B
b) Be prepared in consultation with the EPA and DPIE Water	Further consultation required	Annexure to this report- Water Management Consultation and Correspondence
A Site Water Balance that: includes details of: • Quantity of water required to support operations; • sources and security of water supply; • water use and management on site;	See Section 4.9 and 4.10 – Please include specific section references to the Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries guidelines. Not satisfied	Section 4.9 & 4.10

Relevant Consent Condition	Comment (from Attachment A)	Where Addressed in this Report
• Reporting procedures; and • Measures to be implemented to minimise potable water use on site.	See Section 12.6 – Please include further details from conditions 4, 7 and 8 of Schedule 5. Not Satisfied.	Section 11.6
(ii) Surface Water Management Plan, that includes: • baseline data on surface water flows and quality in watercourses that could be affected by the development;	See Section 4.5 and 4.6 – Please include empirical baseline data within the report. Not Satisfied.	Section 4.5 & 4.6
• a description of the surface water management system on site including: o clean water diversion system;	See Figure 4 – Please clearly indicate clean water diversions on the figure. Not Satisfied.	Figure 3, Figure 4 & Figure 7
o erosion and sediment controls;	See Section 6 – Please provide further details of erosion and sediment controls including specific section references to the "Blue Book". Not Satisfied.	Section 6
o dirty water management system; and	See Figure 4 – Please clearly indicate dirty water flow directions on the figure. Not Satisfied.	Figure 3, Figure 4 & Figure 7
o water storages (addressing maximum harvestable rights if applicable);		

Relevant Consent Condition	Comment (from Attachment A)	Where Addressed in this Report
• A program to monitor and report on:		
o Any surface water discharges	See Section 8.1 and 8.2 – Please include water quality limits from the EPL in the WMP. Not Satisfied.	Section 8.1 & 8.2
o the effectiveness of the water management system;	See Section 12.6 – Please include specific requirements of consent condition. Not Satisfied.	Section 11.6
o surface water flows and quality in local watercourses; and	See Section 8.2 – Please include Appendix F and further details on how water quality in local watercourses will be monitored Not Satisfied.	Section 8.2 Appendix D
Other Comments		
Please update all references of "NOW" to "DPIE-Water"		Whole document
The Department requires clear statements i.e. replace "should" references with "will" etc.		Whole document
Several tables are mislabelled or omitted from the document.		Whole document
Table 13 has been cut off. Please amend.		Table 13

2 PURPOSE AND OBJECTIVES

2.1 Purpose

The purpose of this Plan is to describe how PGH proposes to manage potential water impacts generated by the facility. This document has been prepared to satisfy the SSD_5684 MOD1 conditions of consent requiring a Water Management Plan for Surface Water.

2.2 Objectives

The key objective of the WMP is to ensure that impacts to the downstream environment are minimised.

To achieve this objective, PGH will undertake the following:

- Ensure appropriate environmental controls and procedures are implemented to minimise the potential for adverse surface water quality impacts to identified sensitive receivers and the local community;
- Manage Water quality impacts, if they occur, through a systematic analysis of mitigation strategies;
- Ensure environmental management measures identified in *Table 14* are implemented to address the relevant CoA outlined in *Table 1*; and
- Ensure appropriate measures are implemented to comply with all relevant legislation and other requirements as described in *Section 3* of this WMP.

The principle objectives of this Water Management Plan are set out below;

- To minimise erosion and sedimentation from all active and rehabilitated areas, thereby minimising sediment ingress into surrounding surface waters
- To ensure the segregation of 'dirty' water from 'clean' water and manage 'dirty' water appropriately such that any discharge from the project site meets the relevant water-quality limits, including limits contained in the relevant guidelines and any limits imposed by specific project approvals. 'Dirty' water is defined as surface runoff from disturbed catchments. 'Clean' water is defined as surface runoff from catchments that are undisturbed or rehabilitated catchments.
- To minimise the volume of water discharged from the project site but, should the discharge of water prove necessary, ensure sufficient settlement time is provided prior to discharge or employ other means such as flocculants to ensure the water meets the objectives identified in the point above.
- To ensure any water used in the processing of materials is contained within the closed system on the site.
- To monitor the effectiveness of surface water and sediment controls and to ensure all relevant surface water quality criteria are met.
- To determine a water balance for the site based on current and projected usage.
- Develop a set of performance criteria and appropriate environmental management measures for the site.

3 ENVIRONMENTAL REQUIREMENTS

3.1 Relevant Legislation and Guidelines

3.1.1 Legislation

Legislation relevant to Water quality management includes:

- Environmental Planning and Assessment Act 1979 (EP&A Act);
- Protection of the Environment Operations Act 1997 (POEO Act);
- Water Act 1912;
- Water Management Act 2000;
- Sydney Water Act 1994;
- Protection of the Environment Operations Regulation 2000; and
- The Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011.

3.1.2 Guidelines and Standards

The main guidelines, specifications and policy documents relevant to this WMP include:

- Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales (Gazette no 54 of 12 March 2004 p 1150);
- Managing Urban Stormwater, Volume 2E, Mine and Quarries (Department of Environment and Climate Change, New South Wales, June 2008);
- DECC Managing Urban Stormwater - Soils and Construction V1 (2004); and
- The Australian and New Zealand Environment Conservation Council Guidelines (ANZECC guidelines).

3.2 Minister's Consent Conditions

This document has been prepared to satisfy the SSD_5684 MOD1 conditions of consent requiring a Surface Water Management Plan. The Conditions of Approval relevant to this WMP are listed in *Table 1*. A cross reference is also included to indicate where the condition is addressed in this WMP or other environmental management documents.

Table 1. Conditions of Approval relevant to the WMP

Condition	Requirement	Where Addressed in this plan
Schedule 3- **SOIL AND WATER** (General Note)	Under the Water Act 1912 and/or the Water Management Act 2000, the Applicant is required to obtain the necessary water licenses for the development, including in respect of the extraction and/or interception of groundwater.	Section 3.4
Schedule 3- **Water Supply** Condition 16	The Applicant shall ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of operations under the consent to match its available water supply to the satisfaction of the Secretary.	Section 4.8

Condition	Requirement	Where Addressed in this plan
Schedule 3- **Water Discharges** Condition 16 (EPL 1808)	The Applicant shall comply with the discharge limits in any EPL or with Section 120 of the POEO Act.	Section 3.3, 4.6 and 8
Water Management Plan Condition 18	The Applicant shall prepare and implement a Water Management Plan for the development to the satisfaction of the Secretary. This plan must: (a) be prepared by suitably qualified person/s approved by the Secretary;	Letter of Approval *Appendix B*
	(b) be prepared in consultation with the EPA and DPI Water;	Annexure to this report- Water Management Consultation and Correspondence
	(c) be submitted to the Secretary for approval within 6 months of the date of this consent, unless the Secretary agrees otherwise;	Submission and approval for this plan will be obtained prior to commencing operations.
	(d) include a Site Water Balance that: • Includes details of: o quantity of water required to support operations; o sources and security of water supply; o water use and management on site; o reporting procedures; and o measures to be implemented to minimise potable water use on site;	Section 5
	(e) include a Surface Water Management Plan, that includes: • baseline data on surface water flows and quality in the watercourses that could be affected by the development;	Section 4.5 and 4.6
	• a description of the surface water management system on site, including: o clean water diversions; o erosion and sediment controls; o the dirty water management system; and o water storages (addressing maximum harvestable rights if applicable);	Section 9/10 Section 6 Section 4, 54.9 Section 3.4, 5.3
	• performance criteria, including trigger levels for investigating any potentially adverse surface water quality impacts;	Section 9

Condition	Requirement	Where Addressed in this plan
	• a program to monitor and report on: o any surface water discharges; o the effectiveness of the water management system; and o surface water flows and quality in local watercourses;	Section 8
	• A plan to respond to any exceedances of the performance criteria.	Section 9
	(f) a Groundwater Management Plan, which includes: • baseline data on groundwater levels, yield and quality in surrounding aquifers; • groundwater assessment and performance criteria, including trigger levels for investigating potentially adverse groundwater impacts; • a program to monitor: o groundwater inflows to the quarry pit; and o impacts of the development on surrounding aquifers; • an analysis of the monitoring results to determine long-term water levels within the quarry • void; and • A plan to respond to any exceedances of the performance criteria.	Refer to GWMP – Separate Plan

3.3 Licenses and permits

The Environment Protection Authority (EPA) issued the Brickworks with licence number 1808. All Surface Water monitoring points, monitoring frequency and analytes required are outlined in the *Table 2* below (source EPL1808). Note EPL Point 1 is the discharge point from Dam 1 and EPL Point 5 is the discharge Point from Dam 5. EPL No. 1808 is currently in force for the scheduled activities undertaken by the facility and prescribes the permitted water quality loads and concentration limits. Prior to the commencement of construction or the extension of the quarry, a variation to EPL No. 1808 would be sought by PGH to reflect the changed and extended operations of the quarry, water quality criteria stipulated within the CoA.

Table 2. EPA Monitoring Requirements - Water Concentration Limits

POINT 1

Pollutant	Units of Measure	50 percentile concentration limit	90 percentile concentration limit	3DGM concentration limit	100 percentile concentration limit
Oil and Grease	milligrams per litre				10
pH	pH				6.5-8.5
Turbidity	nephelometric turbidity units				150

POINT 5

Pollutant	Units of Measure	50 percentile concentration limit	90 percentile concentration limit	3DGM concentration limit	100 percentile concentration limit
Conductivity	microsiemens per centimetre				1450
Oil and Grease	milligrams per litre				10
pH	pH				6.5-8.5
Turbidity	nephelometric turbidity units				150

M2.3 Water and/ or Land Monitoring Requirements

POINT 1

Pollutant	Units of measure	Frequency	Sampling Method
Oil and Grease	milligrams per litre	Weekly during any discharge	Grab sample
pH	pH	Weekly during any discharge	Grab sample
Turbidity	nephelometric turbidity units	Weekly during any discharge	Grab sample

POINT 5

Pollutant	Units of measure	Frequency	Sampling Method
Conductivity	microsiemens per centimetre	<24hrs prior to discharge	Grab sample
Oil and Grease	milligrams per litre	<24hrs prior to discharge	Grab sample
pH	pH	<24hrs prior to discharge	Grab sample
Turbidity	nephelometric turbidity units	<24hrs prior to discharge	Grab sample

3.4 Water Access Licence

The Water Management Act 2000 (WMA) identifies basic landholder rights and when access licenses are required. The harvestable water right is defined in terms of and equivalent dam capacity, the Maximum Harvestable Right Dam Capacity (MHRDC). Schedule 1 of the Water Management Regulation exempts certain classes of dam including those dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority to prevent the contamination of a water source. Therefore, as the on-site dams are used solely for the capture, containment and reticulation of drainage, consistent with best management practice to prevent impacts to Thompsons Creek, the dams are exempt from the need to obtain a licence under the WMA.

The site does however surface water licences;

1. WAL 26259 = 150 ML
2. WAL 26257 = 6.5 ML
3. WAL 25987 = 152.5 ML

In addition there are 4 bores (drilled in the EIS) licenced in perpetuity for monitoring under 10BL605770. Only 3 of these are functioning.

4 EXISTING ENVIRONMENT

4.1 Site Location and Overview

The project site is currently used for quarrying, brick production and associated activities. The brickworks and quarry are located on an approximately 385.55 hectare property owned by PGH Limited, which is located at 60 Greendale Road, within the Camden local government area and is approximately 55 km southwest of the Sydney central business district (Refer to *Figure 1*).

The brick making facility along with various administration buildings, a finished brick storage yard, staff car park and internal road network is generally contained within the northern part of the project site (refer to *Figure 2*), and is set back approximately 200 m from Greendale Road.

Existing quarrying activities have substantially altered the natural landform, with various voids and elevated stockpiles present in the active, north-western part of the project site. Other significant landforms on the site include the raw material stockpiles to the south of the brickworks, as well as unusable materials stockpiles along the western boundary of the site. The underlying topography of the operational footprint on the project site is relatively flat, and the land slopes to the south toward Thompsons Creek.

4.2 Geology and Soils

Geology in the region is comprised of a mix of Triassic and Quaternary age deposits. The Project site is underlain by the lower 75 metres to 150 metres of the Bringelly Shale which comprises claystone, siltstone, laminite and sandstone. The base of the sequence in this area is defined by the Cobbity Claystone, a thin (maximum six centimetres) persistent layer of weathered tuff. Alluvial sands and gravels derived from surrounding rocks are present along streams such as Thompsons Creek and Bardwell Gully. *Section 6.1* provides further detail on the soil type in the area. The soils and subsoils of the area is slightly acidic (pH approximately 4-5).

The soil on the project site is classified generally as having moderate salinity potential, apart from the Thompsons Creek zone which is classified as having high salinity potential.

4.3 Topography

The surrounding topography varies from moderately undulated to hilly with a high density of low order streams to the southwest, to gently undulate with a lower density of streams to the east. The topography of the site is generally gently sloping to the south and west in the direction of Thompsons Creek.

The quarry area of the site has an elevated topography with the highest point towards the northwest corner at 113m AHD. A constructed bund runs along the western boundary north to south of the site which gently slopes downwards towards the east-south-east. The lowest point runs along the eastern side of the site and is characterised by Thompsons Creek.

The north-eastern area of the site is dominated by the brickworks, product stockyard, storage facilities and administration buildings. South of the brickmaking plant is a raw materials stockpile yard, adjacent to which lie settlement ponds Dams 4 and 5. The south–eastern area of the site next to Thompsons Creek is currently leased as farmland for livestock grazing.

Thompsons Creek with a catchment area of approximately 1.6 km^2 has its source to the southwest of the project site. The creek flows eastwards past the southern boundary of the mine, after which it turns northwards flowing along the eastern boundary of the brick making facility and carpark. It then passes under Greendale Road before joining South Creek approximately 4km further downstream. South Creek is a tributary of the Hawkesbury River.

A 6 metres high earth bund has been constructed along the eastern side of the brickmaking facility which has the dual purpose of attenuating production noise as well as providing flood immunity to the brickworks site from Thompsons Creek. The site is also outside the 1%AEP flood extent. The area surrounding the project site is predominately used for agriculture to the west and south of the site with agricultural land with some rural residential development to the north and east.

4.4 Climate

The Badgerys Creek AWS (Site Number 067108) is the closest Bureau of Meteorology (BoM) weather station to the facility. The site commenced operation in 1995, is located approximately 4.5 kilometres due north of the facility (33° 54' S 150° 43' 48" E) and records monthly climatic statistics. A summary of climate statistics from the Badgerys Creek AWS station is presented in *Table 3*.

Table 3. Monthly Climate Statistics Summary – Badgerys Creek AWS (BoM 2018 Averaged Annual since recorded)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean max. temperature (oC)	30.1	28.8	26.9	24.1	20.7	17.8	17.4	19.2	22.6	24.9	26.4	28.5
Mean min. temperature (oC)	17.1	17.1	15.3	11.5	7.7	5.6	4.1	4.7	7.7	10.4	13.5	15.5
Mean rainfall (mm)	79.4	98.5	81.3	49.4	38.3	61.8	23.6	36.8	32.3	51.4	69	57.1
Mean number of days of rain >= 1 mm	7	7.3	7.4	5.7	4	5.4	3.9	3.5	4.6	5.5	6.9	6.6
Mean number of days of rain >= 10 mm	2.3	2.6	2.8	1.3	1.1	1.6	0.6	1	1	1.7	2.3	1.6
Mean 9am relative humidity (%)	73	80	83	76	80	84	81	72	66	62	69	69
Mean 9am wind speed (km/h)	9.4	8.7	8.4	9.8	9.6	9.1	9.6	10.6	11.7	11.8	11	9.8
Mean 3pm relative humidity (%)	49	55	55	52	53	56	50	44	44	45	50	48
Mean 3pm wind speed (km/h)	17.9	15.9	14.5	14.4	13.9	13.7	15.4	17.8	19.2	19.9	18.9	18.5

A review of the climatic data presented in *Table 3* indicates the following trends:

- On average, January is the hottest month of the year and July is the coldest month of the year, with mean maximum and minimum temperatures being 23.95 °C and 10.85 °C respectively.
- Rainfall data indicates that February is the wettest month of the year and July is the driest month of the year, with average falls of 56.5mm.
- Mean 9am humidity levels range from 62% in October to 84% in June. Whilst mean 3pm humidity levels range from 44% in August and September to 56% in June.
- Mean 9am wind speeds range from 8.4 km/h in March to 11.8 km/h in October. Mean 3pm wind speeds range from 13.7km/h in June to 19.9km/h in October.

On an annual basis, winds are most dominant from the south-southwest, with a lesser frequency of winds from the southwest. In spring and summer, the wind distribution is similar to the annual distribution with a higher frequency of easterly winds occurring. During autumn and winter, winds from the south- southwest are most predominating. The annual average wind speed is 1.6m/s and the annual percentage of calms is 24.2%.

4.5 Hydrology and Waterbodies

The project site is located within the Hawkesbury-Nepean catchment, which is the largest catchment within the Sydney area, covering an area of approximately 21,400 square kilometres. It falls directly within the upper reaches of the South Creek sub-catchment, which encompasses most of the Cumberland Plain of Western Sydney.

The South Creek sub-catchment covers an area of approximately 620 square kilometres, comprising small rural residential and urban areas. The upper South Creek sub-catchment lies within Camden City Council's Local Government Area and includes (from west to east) Thompsons Creek, Lowes Creek, Rileys Creek, Kemps Creek and Bonds Creek (WMA Water, 2012). The project site rises within the south western portion (146m AHD) and falls toward Bardwell Gully and Thompsons Creek in the north (76m AHD).

4.5.1 South Creek

The project site is located within the upper portion of South Creek catchment. The confluence of South Creek and Thompsons Creek is located 3.5 kilometres to the north east of the project site. South Creek is regarded as one of the most degraded sub-catchments in the Sydney region.

The hydrological regime of the catchment has been greatly altered through vegetation clearance and an increase in impervious areas through the urbanisation of the catchment. This in turn has led to changes in catchment geomorphology and a reduction in water quality. Water quality is impacted by both point and diffuse sources of pollution, including sewage treatment plants, industrial discharges in the lower reaches of the catchment, and runoff from land uses such as market gardens, grazing lands and urban and stormwater runoff.

The Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011, established under the Water Management Act 2000, covers the project site and the South Creek catchment. The plan splits the South Creek Catchment into two management zones, being the Upper South Creek management zone, within which the project site is located, and the Lower South Creek management zone. The Upper South Creek Management Zone supports 88 surface water licences with a peak daily demand of 43.85 mega litres per day. Water is used to support irrigation and stock watering.

4.5.2 Thompsons Creek

Thompsons Creek is a tributary of South Creek and forms the eastern boundary of the project site. It is classified as a second order ephemeral (intermittently flowing) stream using the Strahler stream classification system (Strahler 1952). Thompsons Creek crosses the eastern and southern boundaries of the study area directly south of the existing brickworks quarry [1].

Thompsons Creek flows in a northerly direction adjacent to the eastern boundary of the project site and discharges directly into South Creek. The dam at the south eastern corner of the project site (known as Dam 6), located within the headwaters of Thompsons Creek has a capacity of 50 mega litres.

Thompsons Creek drains rural, rural residential and urban areas and has poor environmental health. Inspections of this watercourse (by VGT and Kleinfelder) found that it has been impacted by erosion, weed outbreaks, channel modification, litter and poor water quality.

PGH holds an EPL (Ref 1808) to discharge from the Outlet of Dam 5 into Thompsons Creek. This is currently achieved by pumping from the Dam 5 Outlet to Dam 6. PGH are proposing to discharge directly from Dam 5 to Thompson's creek following the implementation of a water treatment system (refer to *Figure 10*).

4.5.3 Bardwell Gully

Bardwell Gully is a small drainage channel that flows into Thompsons Creek in a northerly direction from central northern boundary of the project site. The gully drains northwards, under Greendale Road, before diverting eastwards and converging with Thompsons Creek, approximately one kilometre to the north east of the project site. The gully drains Greendale Road, rural and residential areas and has a highly degraded environmental condition.

4.6 Water Quality

Discharges from the project site are subject to an EPL issued under the POEO Act. The EPL sets water concentration limit values for the project site for Dam 1 and Dam 5, the latter being located in the headwaters of Thompsons Creek. Water quality limit values specified in the EPL are shown in *Table 2*.

Surface water quality in and around the site is characterised by high conductivities. High levels of conductivity are likely to be directly influenced by the presence of clays and shales that exhibit a very high salinity potential. Conductivity levels have been observed to increase during dry periods as results of evaporation processes.

All discharges from the site eventually drain to South Creek. A baseline water quality study for South Creek catchment was undertaken by Sydney Water to establish the baseline environmental conditions. The study highlights the following attributes for water quality in the Upper South Creek Catchment (Hassan et al, 2009):

- Nutrient concentrations for all sites, including tributaries of South Creek were found to be higher than the recommended concentrations for protection of aquatic ecosystems.
- Chlorophyll-values higher than the guideline values for most upper South Creek monitoring locations.
- Faecal coliforms and Enterococci exceed the ANZECC primary contact recreational water quality guidelines at almost all sites. Possible sources of pollution include stormwater discharges, agricultural activities and pre-existing bacterial population in the slopes and sediments of the catchment.
- Dissolved oxygen saturation levels were generally low and below the guideline value for the majority of sites.
- Turbidity levels were very high at most of the sites of the South Creek indicating poor land and riparian management.

The above findings indicate that South Creek is a highly degraded system whereby water quality is impacted by a diverse range of land uses including rural, grazing, market gardening, intensive agriculture as well as both urban and industrial uses. The South Creek Catchment has also been identified as a highly saline catchment. Upper South Creek, Lowes Creek and Kemps Creek conductivities are in the order of 500 to 600µS/cm whilst downstream monitoring locations at South Creek average 900µS/cm[1].

Kleinfelder were engaged by PGH to assist in the variation of the EPL in 2015 (see *Appendix E*). The variation included an increase in the limit on the conductivity of water discharged to Thompsons Creek. Monitoring of the creek was undertaken to provide baseline data which is reproduced in the table below.

Table 4. Thompsons Creek Baseline Water Quality Data

Date Sampled / Analyte	28/2/2015	13/2/2015	27/02/2015
pH (on-site measurement)	6.52	6.79	7.19
Conductivity (µS/cm)	2,900	2,700	2,900
Total Dissolved Solids (mg/L)	1,580	1,830	1,800
Total Suspended Solids (mg/L)	17	10	18
Turbidity (NTU)	15.9	18.0	39.2
Hydroxide Alkalinity as CaCO3 (mg/L)	<1	<1	<1
Carbonate Alkalinity as CaCO3 (mg/L)	<1	<1	<1
Bicarbonate Alkalinity as CaCO3 (mg/L)	152	191	206
Total Alkalinity as CaCO3 (mg/L)	152	191	206
Sulphate as SO4 (mg/L)	10	24	<10
Chloride (mg/L)	699	935	940
Calcium (mg/L)	40	46	50
Magnesium (mg/L)	61	81	84
Sodium (mg/L)	408	633	540
Potassium (mg/L)	19	18	13
Oil & Grease (mg/L)	<5	6	<5

From the results above it was concluded that Thompsons Creek is naturally saline and the EPL was amended accordingly.

Background water quality data from Bardwell Gully has not been undertaken to date due to the ephemeral nature of the watercourse. Similarly, background monitoring on the flows of both creeks has not been undertaken to date although it is expected the ephemeral nature of the watercourses may not yield an abundance of data.

Monitoring of the creeks water quality and flows will commence with the approval of this plan.

4.7 Water Quantity

The Bringelly brick making facility utilises approximately **15,000KL per annum** of Potable water. Potable water Consumption is recorded monthly in Envizy. The site also has a capacity of over 400,000m^3 of dam storage onsite in order to utilise harvested Stormwater for processing and dust control. Sections 4 and 5 provide further detail on individual dam quantities, storage and flows.

4.8 Sources and Security of Water Supply

Water is sourced from 6 dams and potable mains water for the project site. Potable water is purchased by the site for use in the brickmaking factory due to water quality issues and suitability for processing from onsite Sections 4 and 5 provide further detail on individual dam quantities, storage and flows. The total volume of water held on the site including Dam 6 is more than sufficient for the dust mitigation and potential watering of rehabilitation.

4.9 Water Management on Site

The project site's drainage systems have been designed to minimise uncontrolled off-site discharges. The local catchments that currently contribute flows over the approved project site are shown in *Figure 3*.

Runoff from the temporary raw material and unusable material stockpiles, western brick product storage area and material storage facility is directed to Dams 1 and 2 at the northern end of the site for removal of coarse and fine solids respectively through settlement and flocculation. Dam 1 is a licensed discharge point, discharging settled water to Bardwell Gully that in turn discharges to Thompsons Creek.

Runoff from the raw material stockpile area located south of the brickworks is directed to Dams 4 and 5.

Runoff from a catchment area of 26.6 hectares to the west of the project site, of which 4.8 hectares is located within the existing quarry footprint currently drains towards and is captured within the existing quarry. Pit (quarry) water collected in the quarry and runoff from raw material stockpiles and operational areas around the brickmaking facility is transferred to Dam 4 and Dam 5 for removal of coarse and fine solids. Flocculent is added to water via a dosing pit during the process of pumping water from the quarry pit to Dam 4. Water from Dam 5 outlet is currently discharged to Thompsons Creek following testing against EPL water quality criteria. Water discharges intermittently from Dam 6 into Thompsons Creek, usually following heavy rainfall events.

Sewerage at the site is collected and treated in an on-site bio-cycle system. Treated effluent is removed from site by a licenced waste removal contractor.

The EPL and consent conditions place no stipulation on the design capacity of the sediments dams. According to best practice however, the Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries guidelines has been used in the EIS and this document. Sediment basins are designed for a 90th percentile, 5 day rainfall event assuming a non-sensitive receiving environment for a 20 day management period as set out in *Table 6.1* of Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries guidelines for disturbance greater than 3 years in duration.

The operation of the existing stormwater management system and catchments is summarised below.

4.9.1 Dam 1 Catchment

Runoff of 6.0Ha from the roof of buildings on the site is collected to a dedicated drainage system. Although the catchment is considered clean water and Dam 1 is an EPL discharge point, the water is often not of sufficient quality to release from the dam. Generally water collected in Dam 1 is transferred (Siphoned or pumped) to the Quarry void or Dam 4 for treatment prior to discharge via Dam 5. Any overtopping or non-compliant discharges from Dam 1 need to be reported to the EPA and logged in WHSE Live.

Plate 1.: Dam 1

4.9.2 Dam 2 Catchment

Runoff (2.8Ha) from the production area drains to Dam 2, which when full, overflows into Dam 1. If required, water can be removed for dust suppression via water cart hose. Due to its small catchment size this dam does not require regular management. The dam is currently full of vegetation (Mainly Phragmites australis) as shown in *Plate 2*.

Plate 2.: Dam 2

4.9.3 Dam 3 (Quarry Pit) Catchment

Runoff from 27 Ha (of which 4.8Ha is on neighbouring land to the west) of the catchment area to the west of the site drains towards and is largely captured within the existing quarry void (Dam 3). The overland flows that are captured within the quarry are pumped out before the commencement of each quarrying campaign if required. The clay material required for brick production is excavated in two campaigns per year.

Plate 3.: Dam 3 (Quarry Pit)

4.9.4 Dam 4 Catchment

There are currently three water inflows to Dam 4. Runoff from 11.4 Ha from the stockpile storage area drains towards Dam 4. Overland flows collected in the quarry and Dam 1 are also pumped to the north west of Dam 4, when required, for de-sedimentation. The configuration of the dam ensures that all dirty water from the stockpile area is retained in this dam. The Dam is covered in thick bulrush (Thypha orientalis). Flocculent is added at the north eastern end of dam 4 to assist with further de-sedimentation. The dam 4/5 pump is used to cycle the water from the northern end of dam 4, through the bulrush and back towards the south – where the outlet pipe is. Once suitable, the content of dam 4 is transferred into dam 5.

Plate 4.: Dam 4

4.9.5 Dam 5 Catchment

There is currently one inflow to Dam 5. Flocculent is added (manually) to the water directly to Dam 5 and as it is pumped out from Dam 4. It is expected that this process will soon be automated utilising an in-situ water treatment system. The treated water then flows from the south of Dam 5 to the northern EPL discharge point at Thompsons Creek once it has met EPL water criteria. Any non-compliant discharges from Dam 5 need to be reported to the EPA and logged in WHSE Live.

Plate 5.: Dam 5

4.9.6 Dam 6 Catchment

Runoff from a clean water catchment of 125.8Ha is collected in Dam 6 which then overtops via a spillway into Thompsons Creek. Dam 6 has a capacity of 50ML.

Plate 6.: Dam 6

4.9.7 Former Effluent Irrigation Area

An existing bio-cycle treatment plant is situated on the site, but is no longer used for treatment, only for storage of the sewerage within its holding tanks. Periodically (based on the level in the holding tanks) the sewerage is then pumped out by a tanker and transported to a local sewerage treatment works. Currently no irrigation of effluent or discharge from the site takes place.

4.10 Water Use

Any surface water collected on the site within the sedimentation dams, other than that used for dust suppression, is eventually returned to the downstream environment after meeting water quality requirements. In this sense disruption to downstream flows is minimised.

PGH Bricks & Pavers currently uses water for dust suppression sourced from the Pit or Dam 4, 5 and 6 the water is used to fill a water truck which provides dust suppression throughout the site. It is estimated that this form of re-use equals approximately 4,500kL per year.

PGH Bricks & Pavers does not currently re-use the surface water captured in the pit for process water in the brickmaking facility or use the water for irrigation on the site. To date potable water (approximately 8,000kL per annum) has been used due to concerns that the sediment and high salinity may adversely affect supply lines and brick quality.

4.11 Water Transfer

Water Trucks can be filled from the Quarry Pump diversion, the Dam 5 Discharge Pump or the Dam 6 standing pipe. Once the standing pipe flowmeter has been installed, the Dam 6 pipe will be the primary collection point for water trucks. If water must be collected from another point; the details of the release must be logged in accordance with *Section 4.12* of this document (*Flow Logging*) – with volume estimated by the capacity of the water truck. This information must then be forwarded to the process engineer / site environmental manager by email at the end of the month.

Dam 1 and Treatment Dams 4 and 5 will always be emptied to their lowest level in readiness for future inflows, particularly heavy rain events. If testing confirms the water quality in Dam 1 at the outlet is within the limits specified in *Table 2*, the EPL permits discharge (overflow). In practice, Dam 1 is not permitted to overflow and is syphoned from Dam 1 into the quarry sump or Dam 4. If in extreme circumstances overflow does occur, water must be tested weekly for its overflow duration.

4.12 Flow Logging

All water taken for use or released from site must be recorded in a site based spreadsheet. In order to comply with regulatory requirements, PGH must record the time and date of release commencement and conclusion, as well as volume released and a calculation of flow rate. The two primary release points where flow must be logged are:

- Water release from Dam 5; and
- Water collection by water trucks for dust suppression.

The pump at Dam 4/5 has a totaliser which will be used for this recording. A flowmeter is currently being investigated for the standing pipe at Dam 6, used for filling up water trucks. All flows leaving site must be quantified.

4.13 Water Treatment

The controls implemented in *Section 8* ensure that limits for pH, conductivity and oil & grease can be achieved. Due to loading with sediment during flow into the Quarry, storm water can require treatment for turbidity to ensure compliance prior to discharge. Onsite Water will be treated using the following method (refer to *Figure 10*):

- Storm water is pumped from the Quarry or Dam 1 to Treatment Dam 4. From there, the water is:
    - Recycled through Dam 4 before transfer to Dam 5 using the Treatment Dams Pump or
    - Pumped directly from Dam 4 to Dam 5

- A flocculent additive, is dosed at a rate of up to 100 mL/min into:
    - Dosing Point 1 – inlet of the Treatment Dams Pump in Dam 4 (primary) or
    - Dosing Point 2 – discharge sump of treatment dam 5
- Operation of the Dosing Pump is described in WI 4743-0000-002 Water Treatment & Flocculent Dosing Pump.
- Dam 4 extends around the back of Dam 5 to protect Dam 5 from contamination from stormwater running off the stockpile area. Some overflow may run across the dividing wall (from Dam 4 into Dam 5) but this would be controlled by effective dam level management.
- After treatment the water at the inlet to the Treatment Dam Pump in Dam 5 is tested for turbidity and other concentration limits. When results are below the concentration limit, the water can be discharged to Dam 6 and logged in accordance *Section 4.12*.

This method has proven effective for achieving suitable turbidity levels. The Dams must be de-silted periodically as depths diminish to less than 1 m, as verified during the monthly inspections.

While it is anticipated that the use of coagulation/flocculation, vegetation, and sediment control to manage water quality is sufficient to satisfy discharge limits, a more advanced in-situ water treatment system is proposed for Licence Discharge point 5.

The feasibility of in-situ water treatment is being investigated to improve existing stormwater treatment facilities.

5 Site Water Balance

5.1 Overview

A water balance model, reproduced here, was undertaken by Hyder Consulting Pty Ltd for the EIS which was based on a single 'worst case scenario' for both the existing and fully developed condition (prior to any potential backfilling or rehabilitation) for the project site. The objective of the water balance modelling was to assess the ability of the project site to provide on-site water detention and to understand potential changes in surface water drainage.

Under direction from the 'Blue Book' and EPL requirements, the model investigated the following:

- Estimate the required capacity to contain runoff generated at each catchment during a 90th percentile 5 day rainfall event.
- Ensure that the discharge of water flowing from the disturbed part of the site is limited to 1 to 2 times during the year for a critical historical 10 year period.
- Demonstrate that the frequency and quantity of discharges for the developed condition is equal to or less than the existing conditions.

5.2 Modelling Assumptions

The following assumptions and inputs were applied during the development of the water balance model:

- The developed condition scenario is defined when the water storage area within the quarry is limited to cell 'B' (smallest storage) and once the quarry has been fully extracted i.e. at the end of the 30 year quarry life when cells A-I have been fully extracted this also reflects the worst case scenario where the minimum storage and maximum catchment area is reflected.
- A 90th percentile 5 day rainfall design event was applied to the model to ascertain the minimum storage requirements of each stormwater attenuation structure (dam), to capture runoff from the rainfall event, (refer to *Table 5*).
- To ensure a conservative and realistic assessment is being carried out, 20mm of rainfall will be applied prior to the 5 day 90th percentile rainfall event. It is industry standard practice is followed to provide wetting of the catchment and allows the dams retain some water, as in practice the dams generally have carryover of water from previous flood events .i.e. they are rarely dry.
- To understand how the system operates under both wet and dry conditions, both the existing and developed condition scenarios were modelled with application of a daily time step for a 10 year period, 1979 to 1989.
- Rainfall runoff was calculated using the AWBM model.
- For the 5 day rainfall simulation, a 90th percentile daily rainfall of 22.6mm was calculated from the BOM data. The rainfall data was then transformed to runoff using the AWBM for estimation of the required on-site stormwater retention volumes.

5.3 Dam Capacities and the Design Storm Event

5.3.1 Existing Site

As per the 'Blue Book' the onsite stormwater dams aims to contain all of the sites runoff triggered by a 5 day 90th percentile rainfall event with a 20 day management period. The 20 day management period capacity is defined as 170% the volume required for the design storm for a 5 day management period. The calculated capacities for the 5 day management period (from the EIS) and for the 20 day management period (applied to the EIS estimations) for the existing site are shown in the *Table 5* below.

Table 5. Dam Capacities and DSE.

Dam	Catchment Area (Ha)	Dam Capacity (m3)	Dam Volume Required for 5 day management period (m3)	Dam Volume Required for 20 day management period (170%) (m3)	Notes
1	6	3,180	1,701	2,892	Dam 2 overflows to Dam 1
2	2.8	700	700	700	
3	26.6	346,100	6,640	11,237	
4	8.4	3,350	>3,350	>3,350	Dam 4 overflows to Dam 5
5	3	3,020	>3,020	>3,020	
6	125.8	50,000	35,038	59,565	

Note: the design storm event is assumed to be the 90th percentile, 5 day rainfall event.

As can be seen from the table above it was deduced in the EIS that Dam 4 and 5 currently did not have sufficient capacity for the design storm event even for the 5 day management period. All other dams have sufficient capacity. Since then, the configurations of Dam 4 and 5 have been modified and Dam 4 now has sufficient capacity for the design storm as shown in *Table 6* below.

5.3.2 Developed Site

VGT consulting provided updated calculations of dam capacities for the site. The developed site includes a diversion for clean water runoff collected from the western off-site catchment (Catchment 7) through the installation of the New Dam 7 (as shown in *Figure 6*). This dam diverts clean water from the active pit where it will entrain sediment, into Bardwell Gully via controlled discharge without the risk of scouring the stream. As above the calculated capacities for the 5 day management period (from the EIS) and for the 20 day management period for the existing site are shown in the *Table 6* below.

Table 6. Calculated Capacities.

Dam	Catchment Area (Ha)	Dam Capacity (m^3)	Dam Volume Required for 5 day management period (m^3)	Dam Volume Required for 20 day management period (170%) (m^3)	Notes
1	3.1	3,180	950	1,600	Dam 1 is currently pumped into Dam 3 as required but can be diverted to Dam 4 for treatment prior to discharge.
2	Dam 2 will be eliminated during excavation of Cell D				
3	31.2	381,500	13,000	22,000	-
4	11.8	9,375	3,700	6,300	Dam 4 may surcharge to Dam 5.
5		3,020	-	-	Dam 5 will be managed via an automated water treatment system.
6	120.7	50,000	35,038	-	Dam 6 is considered clean water and any overflow is permissible
7	7.4	2,480	2,180	3,700	Dam 7 overflow will divert to Dam 3 (Quarry Pit Sump)

Dam 4 has sufficient capacity for the design event but will have an emergency overflow with riprap stabilisation to accommodate emergency discharge during very heavy rain events to Dam 5. Dam 7 has

sufficient capacity for the design storm event with a 5 day management period. It is estimated that it may take approximately 7 days to discharge this clean water and whilst the dam does not have sufficient capacity for a 20 day management period, it is unlikely that the time taken to manage the dam would be more than 20 days. In any event, any overflow will be directed to the Quarry Pit Sump.

All other dams have sufficient capacity.

5.3.3 10 Year Simulation

Modelling was performed for the EIS and by VGT consulting for a critical 10 year period (1979-1989) was undertaken to determine the frequency of overflows within the nominated period. This ten year period was selected as it contained the wettest and driest years in any consecutive 10 year period on record.

The results was compared to the Managing Urban Stormwater- Soils and Construction, Volume 2E Mines and Quarries indicative average annual sediment basin overflow frequency for the design storm event (*Table 6.2* of volume 2E). Basins designed for the 90th percentile storm event would be envisaged to have an annual average overflow frequency of 2-4 spills per year.

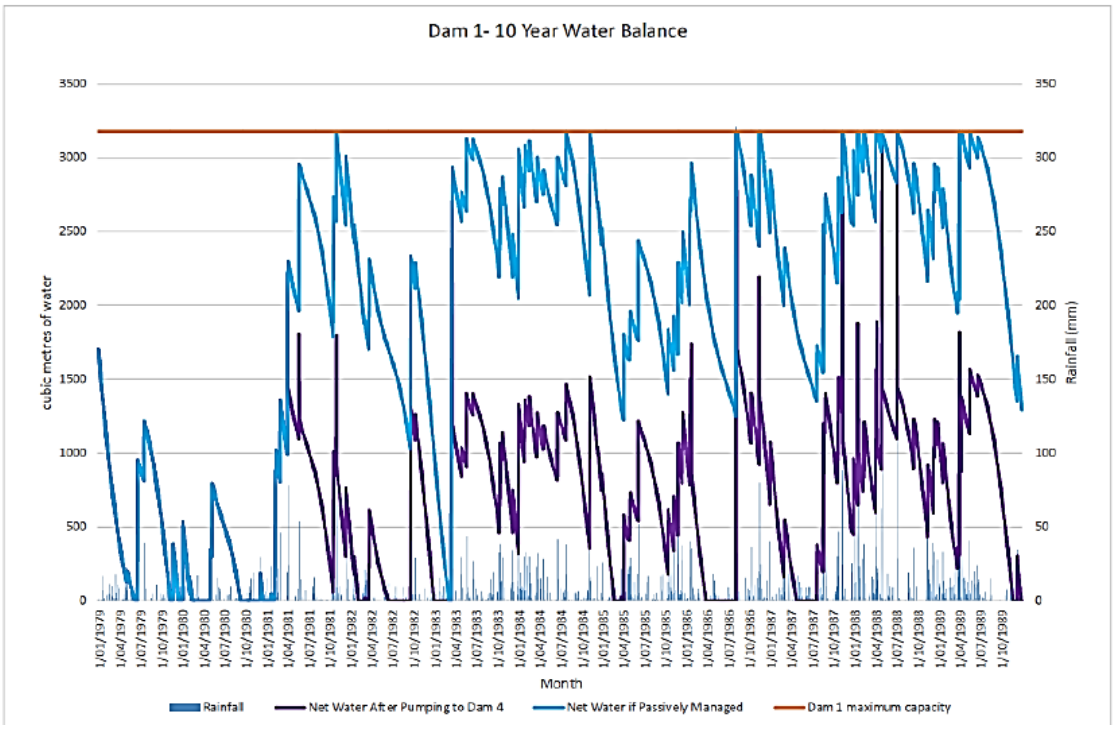
5.3.4 Dam 1

Modelling in the EIS, shows that Dam 1 overflows as soon as the storage volume reaches its maximum capacity of 3,180m3. It also shows that a range of 2-8 overflows per year is expected for all scenarios investigated. It was assumed in the EIS that the catchment for Dam 1 was clean water however, at present the brick storage area catchment for Dam 1 is contributing sediment to the dam through vehicle movements. Therefore the dam is currently managed by pumping excess water to either the Quarry Pit Sump or Dam 4 for treatment and discharge. As the dam will now be managed as a dirty water dam, and Dam 7 will not be constructed as proposed in the EIS, the water balance was reviewed.

Under the developed site, with the preferred option of diverting clean water from Dam 7 offsite and not into Dam 1, it will have more than enough capacity for the 5 day 90th percentile design storm event. The 10 year critical period water balance indicates that on average the dam would be expected to overflow twice per year if passively managed.

These periods when the dam is expected to overflow correspond to storm events greater than the design criteria i.e. rainfall greater than 42.6mm over 5 days (from the Blue Book). If the dam is pumped to the Quarry Pit Sump or to Dam 4 the number of overflows per year would be reduced even further. As stated in the Blue Book above the overflow frequency when passively managed is in line with that expected for a dam designed to the 90th percentile, 5 day storm event of between 2-4 spills per year.

Graph 1: Dam 1 Ten Year Water Balance



5.3.5 Dam 2

Runoff (2.8Ha) from the production area drains to Dam 2, which when full, overflows into Dam 1.

Dam 2 will be eliminated during excavation of Cell D.

5.3.6 Dam 3 (Quarry Pit)

With a capacity of 381,500 m^3, modelling from the EIS indicates that no overflow from the quarry pit would occur during the ten year period.

5.3.7 Dam 4

Modelling for Dam 4 has been undertaken by VGT Consulting including recent modification and deepening.

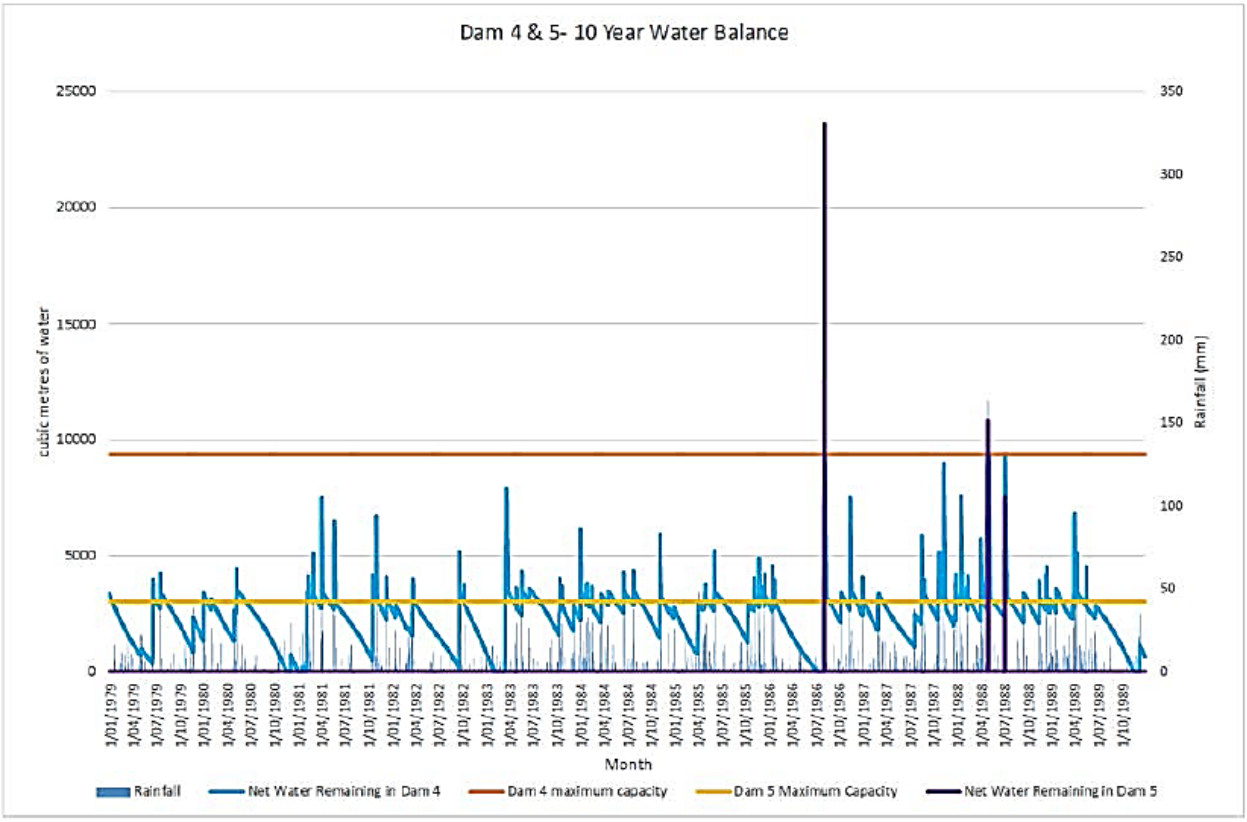
5.3.8 Dam 5

Modelling for Dam 4 has been undertaken by VGT.

The discharge rate is assumed to be 1,800L per minute using the current pump. This may change once the proposed automatic flocculation system is installed and the discharge rate of the new system is known. The EPL discharge point will not change. Water is assumed to be drawn from these dams for dust suppression at a rate of 10 cubic metres per day on average. In reality, water may be drawn from any of the site dams, including the clean water Dam 6 in the south, as required. If insufficient water is held on site for dust suppression, it may also be sourced from potable water.

The model also assumes that water from Dam 1 is pumped into Dam 4 when the volume if Dam 1 exceeds the capacity required to hold the design storm event. Dam 5 was also assumed to be maintained as an empty dam. Over the ten year critical period the model suggests that Dam 4 will overtop into Dam 5 on average 3 times. Of those times Dam 5 also would have overflowed into Thompsons Creek. These were periods of intense rainfall and flooding outside of the design storm criteria and the impact on the downstream environment would have been negligible. It is concluded that the proposed changes to the water management system will reduce the risk of the onsite dams overtopping resulting in uncontrolled discharge.

Graph 2: Dam 4 & 5, 10-year Water Balance



6 Erosion Control

Generally the site is prone to moderate erosion but these are limited to the exposed worked areas of the quarry. Eroded soils and sediment are captured within the pit sump and do not leave the site. Slopes are kept moderate where possible in the pit to reduce the erosion hazard.

6.1 Soil Types

The soil landscapes of the Penrith 1:100 000 sheet were mapped by Bannerman and Hazelton (1990). There are three different soil landscapes mapped within the area of the project site: the residual soil landscape Blacktown, the alluvial soil landscape South Creek, and the erosional soil landscape Luddenham.

Soils generally consist of Red, Brown and Yellow Podzolic on the undulating shale hills and rises, with mainly Red and Brown Podzolic Soils on the Upper Slopes, and Yellow Podzolic soils on lower slopes. The plains include stagnant ponded areas, with mainly Yellow Podzolics on the footslopes, and Soloths on the plains. Structured Plastic Clays or Structured Loams form on the flat to gently sloping alluvial plains in and immediately adjacent to drainage lines. Red and Yellow Podzolic soils are most common on terraces with small areas of Structured Grey Clays, Leached Clay and Yellow Solodic soils (OEH, 2012). Important site physical characteristics (from the EIS) are identified in the table below used to calculate soil erosion rates and sediment dam capacities.

Table 7. Soil Constraints and Characteristics

Constraint/Opportunity	Value
Rainfall Erosivity	2,400
Soil Erodibility Factor	0.05
Slope length. Gradient factor	3.1
Calculated Soil Loss	242 tonnes/ha/yr
Disturbed Site Area	28 ha approximately

Sediment retention basins are designed using the Type D Soils calculations (*Blue Book Section 6.3*). This includes the sediment storage zone calculation using the estimated soil loss for the site over two months. The likely soil loss is calculated with the Revised Universal Soil Loss Equation (RUSLE- *Appendix A1 of the Blue Book*). The values of the other RUSLE factors are: P of 1.3 and the C are assumed to be 0.5.

6.2 General Instructions

The control of erosion and sedimentation at Bringelly will focus on source reduction measures. In general these measures will include:

- Reading the Water Management Plan with any engineering plans and any other plans or written instructions issued in relation to development at the subject site.
- Ensuring contractors undertake all soil and water management works as instructed in this specification and constructed following the guidelines stated in the "Blue Book" (see *Appendix F* for standard drawings).
- Inform all subcontractors of their responsibilities in minimising the potential for soil erosion and pollution to downslope areas.

6.3 Works Sequence

All works are to be undertaken following the Mine Operations Plan (MOP) in the following sequence.

- Topsoil in new cells will be surveyed, mapped and the texture, thickness and quality described prior to stripping. Topsoil and overburden not for immediate use will be stockpiled in appropriate disturbed areas and limited to 2 metres in height and revegetated with temporary ground cover species, mulching or chemical stabilisers or binders if they are to remain in place for more than 30 days. A minimum of 70 percent cover is required for both mulch and vegetative covers.
- Construct earth banks (Stormwater Collection Drains) to divert as much clean water as possible and capture the dirty water in new cells (see *Appendix F* for standard drawings).
- Undertake extraction activities in the new cell.
- Rehabilitate lands in exhausted cells with topsoil and overburden and revegetate.
- Install barrier fencing to limit access to rehabilitated areas.
- Ensure management practices are carried out to minimise areas being affected by wind and water erosion.

6.4 Erosion Control Instructions

The soil erosion hazard on the site will be kept as low as practicable by minimising disturbance. Some ways of doing this are outlined in *Table 8*. Extraction will take place within a defined work area and materials will be transported only within the site for processing. Entry to land not involved directly in the extraction process will be prohibited and will be managed as natural grassland or woodland as appropriate. Vehicular access to the site will be limited to that essential for extraction or rehabilitation.

Table 8. Limitations to Access

Landuse	Access Limitations	Comments
Extraction	Land disturbances (pre-strip) will not occur more than 1-2 month prior to an active extraction campaign.	All site workers will clearly recognise these areas and they will be clearly marked — suitable materials include barrier mesh, sediment fencing, etc. The project manager will determine their actual location on site. They can vary in position to conserve existing vegetation best while being considerate of the needs of efficient works activities.
Access Roads	Roads and tracks are limited to a width that are the minimum necessary to allow safe operation of heavy equipment	
Remaining Lands	Land disturbances are prohibited except for essential management works.	

Rehabilitation means:

Achieving a C-factor (Revised Universal Soil Loss Equation) of less than 0.1 should ensure water quality is protected by reducing the risk of erosion and through vegetation, paving, armouring, etc. as soon as practicable after extraction activities cease. It should be noted that the cover factor, C, is the ratio of soil loss from land under specified crop or mulch conditions to the corresponding loss from continuously tilled, bare soil. A C-factor of 1.0 corresponds to that of bare soil. While C-factors are likely to rise to 1.0 during the work's program, they should not exceed those given in *Table 9* within the specified times.

Table 9. Maximum acceptable C-factors at nominated times during works

Lands	Maximum C-Factor	Remarks
Waterways and other areas subjected to concentrated flows, post construction.	0.05	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows. Flows are limited to those indicated in "Blue Book". Foot and vehicular traffic are prohibited in these areas.
Stockpiles, post clearance	0.1	Applies after ten working days from completion of formation.
All lands, including waterways and stockpiles during construction	0.15	Applies after 20 working days of inactivity, even though works might continue later.

The required C factors can be achieved in the short term (temporary protection for up to six months) with either:

- a suitable soil binder in areas of sheet flow, e.g. topsoil stockpiles
- jute mesh or Geo fabric covering;
- a temporary vegetative cover.
- Any soil binders applied will be employed following the manufacturer's instructions.

A suggested listing of suitable plant species is shown in *Table 10*. Before sowing, additional tests will be undertaken to assess the requirements of ameliorants such as lime to help plant growth.

Table 10. Plant Species for Temporary Cover

Sowing Season	Seed Mix
Autumn/Winter	Oats @ 40kg/Ha Japanese Millet @ 10kg/Ha
Spring/Summer	Oats @ 20kg/Ha Japanese Millet @ 20kg/Ha

While ever the C-factor is higher than 0.1, maintain the lands in a condition that resists removal by wind. This can be achieved by keeping the soil moist (not wet) by sprinkling with water and where practicable, leaving the surface in a cloddy state. Notwithstanding the above, schedule works so that the duration from the conclusion of land shaping to completion of final stabilisation is less than 10 days on slopes steeper than 30 per cent and 20 days on slopes less steep than 30 per cent.

Lands planted recently with grass species will be watered regularly until an effective cover has properly established and plants are growing vigorously. Follow-up seed and fertiliser will be applied as necessary in areas of minor soil erosion and/or inadequate vegetative protection. Where practicable, foot and vehicular traffic will be kept away from all recently stabilised areas.

Topsoil is to be stripped in a moist condition to avoid pulverisation and dust and topsoil stockpiles are not to exceed 2m in height with a minimum crest width of 2m. They will be seeded with a temporary vegetation cover if stockpiles are to remain longer than 30 days. Stockpiles are to be located at least five metres from areas of likely concentrated or high velocity flows, especially drainage lines and access roads. If necessary, earth banks or drains will be constructed to divert localised run-on. Soil materials are to be replaced in the same order they are removed from the ground. It is particularly important that all subsoils are buried and topsoils remain on the surface at the completion of works. Earth batters can have maximum gradients of 2(H):1(V) during the works program but will be laid back to lower grades

before the rehabilitation program starts. Final batter gradients will not exceed 3:1. All waterways, drains, spillways and outlets will be constructed to be stable in accordance with the "Blue Book" for soils with high erodibilities (see *Appendix F* for standard drawings).

6.5 Post Closure

The impact of the proposed final landform on surface water is not expected to be significant. The flatter profile of the area post closure compared to the existing site will potentially reduce erosion from runoff from the area. The extent to which the area is woodland or grassland could also impact on the runoff volumes. The Surface Water Management Plan will remain in place until the water quality from the site meets the target objectives for the area. With the use of vegetation and reduced slopes it is expected that there will be limited risk of impacts on surface water post closure.

7 Surface Water Impacts

7.1 Catchment Surface Flow Volumes

The development has the potential to impact on annual flow volumes (i.e. yield) due to the need to control runoff from disturbed areas, including quarry extraction areas and processing areas.

Table 11 indicates the approximate catchment areas for South Creek and Thompsons Creek upstream of their confluence prior to the project, existing and with the maximum operational disturbance.

Table 11. Predicted Impacts on Catchments

Catchment	Total Catchment Area (Ha)*	Modified Catchment as percentage of Existing Catchment
Bardwell Gully prior to development	275	114%
Bardwell Gully Existing	240	100%
Bardwell Gully with maximum disturbance	233	97%
Thompsons Creek prior to development	178	106%
Thompsons Creek Existing	167	100%
Thompsons Creek with maximum Disturbance	167	100%
Total South Creek Catchment	62,000	99.989%

The total South Creek Sub-catchment into which Bardwell Gully and Thompsons Creek flow covers some 620 square kilometres (approx. 62,000Ha). The total loss of flow to the South Creek catchment in the fully developed state compared to the existing state is negligible.

The loss of base flow will be offset in the medium to long term through the release of surplus water that complies with the target release criteria for the quarry in terms of the EPL.

Discharge rates to Thompsons Creek via the Dam 5 (EPL Point 5) and Dam 1 (EPL Point 1) are regulated by the pump capacity which is currently 1,800L/min (1.8 m^3/sec). This rate is much less than the 1-year, time of concentration (tc) flow rate for the estimated total catchment of 407Ha (above the confluence of both streams) of approximately 21m^3/sec (calculated using the 'Blue Book') and would have negligible impact on the stability of downstream watercourses. It should be noted that it is best practice to design drains to contain the 10-year tc flow rate.

Using the existing pump system to discharge Dam 5 with a volume of 3,020 m^3 (3,020,000L) it would take approximately 28 hours. Dam 1 with a volume of 3,180 m^3 would take approximately 29 hours to discharge into Thompsons Creek.

7.2 Downstream Water Users

The Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011, established under the Water Management Act 2000, covers the project site and the South Creek Catchment. The plan splits the South Creek Catchment into two management zones, being the Upper South Creek management zone, within which the site is located and the Lower South Creek management zone. The Upper South Creek Management Zone supports 88 surface water licences with a peak daily demand of 43.85 mega litres per day. Water is used to support irrigation and stock

watering. As stated above the base flow loss to the Upper South Creek Management Zone will be offset in the medium to long term through the release of surplus water from the site[1].

7.3 Riparian and Ecological Values of the Watercourses

The riparian woodland that occurs along Thompsons Creek to the east of the existing quarry is in poor condition and loosely meets the criteria for the EEC River flat Eucalypt Forest. It is also unlikely that aquatic habitats would contain any threatened fish species listed in the FM Act or EPBC Act. Thompsons Creek, mapped as Key Fish Habitat by DPI, was assessed to be in a degraded condition. The proposal would not result in any direct impacts to the creek according to the EIS[1].

From the EIS:

> *'The project will not have any significant impacts on the existing condition of nearby watercourses, including Thompsons Creek, Bardwell Gully and South Creek. These systems are characterised by degraded environmental conditions as previously outlined in this section.'*

There will be no increase in the frequency of discharges over and above current levels and therefore no additional impacts on riparian environments, including geomorphology and environmental flows.'

7.4 Flooding

A small portion of the site, to the east adjacent to Thompsons Creek is potentially impacted by Probable Maximum Flood Levels and the five per cent Annual Exceedance Probability (AEP) event. A bundwall with a maximum height of six metres has been constructed for visual and noise mitigation along this eastern boundary, extending from the brickmaking facility to the raw material storage area and finishing adjacent to Dam 6.

This bund also serves to prevent flood waters entering the site from Thompsons Creek. The brickmaking facility, material storage facility and quarry cells are largely located outside Council identified flood prone areas and are not considered being at risk from flooding. The project is also unlikely to impact on the natural functioning of the floodplain.

8 Monitoring and Maintenance

8.1 Surface Water Quality

Surface water must be sampled at Licenced Discharge Points 1 and 5 according to the following condition in line with the Environment Protection Licence 1808:

- Point 1 – Weekly during any discharge
- Point 5 – <24 hrs prior to discharge.

Samples must be analysed for pH, conductivity, turbidity and oil & grease using the following methods.

- pH and Conductivity

  pH and Conductivity are measured using the TPS WP81 pH and Conductivity Meter. The TPS WP81 pH and Conductivity Meter will be calibrated weekly prior to measurement. Refer to WI 4743-0000-003 pH and Conductivity Meter for instructions on calibration and testing. Sampling data is recorded in the Dam Test Spreadsheet and reported on the PGH website.

- Turbidity

  Turbidity is measured using the TPS WP88 Turbidity Meter. The TPS WP88 Turbidity Meter will be calibrated when a " * " replaces the decimal point on the digital display of the meter. Refer to WI 4743-0000-004 Turbidity Meter for instructions on calibration and testing. Sampling data is recorded in the Dam Test Spreadsheet and reported on the PGH website.

- Oil & Grease

  The routine test for Oil & Grease is a visual check. No evidence of Oil & Grease is considered to be <10 mg/L. If Oil & Grease is detected at the sampling point, water from the point is to be sampled and tested.

All Sampling data is recorded in the Dam Test Spreadsheet and reported on the PGH website and in the EPL Annual return.

Monitoring of Thompsons Creek upstream and downstream and Bardwell Gully will be undertaken monthly for the same analytes or prior to discharge to that watercourse.

PGH will undertake sampling within 24 hours prior to discharge for Point 5 and samples weekly from Point 1 as required by the EPA licence. There will be no changes to this procedure. Monitoring of the surface water outside the EPL Licence Points and the watercourses may be undertaken from time to time such as the other sediment dams in and out of the pit. The results of all monitoring are recorded and assist in the compilation of the Annual Rehabilitation Report to the DPIE-RG, The Annual Review to the DPIE and to the EPA in the Annual Return.

Water quality limits from the EPL are reproduced in *Section 3.3, Table 2*.

8.2 Surface Water Flows

The following management checks on the surface water flows will be undertaken monthly and recorded on the Monthly Stormwater Management System Inspection checklist, see *Appendix D*.

- Visual check of stability and operation of all banks, ponds, channels and spillways to be undertaken monthly. Affecting any necessary repairs.
- Visually check the discharge points into Thompsons Creek and Bardwell Gully to ensure that the discharge does not cause erosion or scouring of the creeks. Effecting any necessary repairs
- Drains and culverts for both clean water and dirty water will be examined for vegetation cover and blockages and maintenance will be performed to ensure they are working as designed.

- Diversion bund walls will be inspected regularly to assess the integrity and effectiveness. Maintenance will be performed when required.
- Removal of spilled materials from hazard areas, including lands closer than five metres from areas of likely concentrated or high velocity flows, especially waterways and access roads.
- Ensuring that rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate.
- Constructing additional erosion and /or sediment control works as might become necessary to ensure the desired water quality control is achieved

There are no requirements in the EPL to record flows, however discharge volumes and estimated flow rates from the site will be recorded and reproduced in the Annual Review. Flows in Thompsons Creek and Bardwell Gully will be noted during the monthly checks.

8.3 Dam Management and Maintenance

Sediment dams will be managed using the following:

- Level indicators will be installed in dams with relevant marks located on the peg to indicate the amount of sediment load in the dam (see *Table 12* for volumes).
- All sediment basins will be maintained by de-silting when the capacity is diminished.
- Sediment dams and clean water dams will be visually assessed for water quality and volumes on a regular basis or as required after high rainfall events.
- If discharge is required, the visual assessment will be followed by sampling and testing of the water quality prior to discharge to ensure water quality criteria are met. In the case of the modified Dam 5 treatment system, the water quality parameters will be automatically monitored via in line monitors. The dams will also be periodically manually sampled tested as well as regular calibration of the monitoring equipment.
- The EPA limits of pH 6.5 – 8.5, oil and grease less than 10 mg/L, Conductivity less than 1,450µS/cm and turbidity of less than 150 NTU in the discharged water will be adopted (unless modified by the EPA).
- Ensuring that rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate.
- Constructing additional erosion and /or sediment control works as might become necessary to ensure the desired water quality control is achieved

8.4 Sediment Load Calculations

Trigger levels for the de-silting of sediment dams have been developed by VGT and are provided in *Table 12* below. Desilting is required when the remaining dam capacity cannot hold the design storm event volume.

The equivalent depth of silt in the dam this equates to have been estimated below in order to allow marking posts to be installed in the dams. Dam 6 and 7 are not included as they are assumed to be a clean water dams that no longer influence the water management system of the site. Dam 2 is also not included as it will be incorporated into the new extraction areas in Cell D. Dam 3, the quarry pit sump, is also not included due to the very large capacity and the requirement to mine within the pit. Dam 5 has not been estimated as it is not used as a primary catchment dam.

Table 12. Trigger Levels for De-silting Dams[1]

Dam #	Dam(M^2)*	Dam Volume Required for 20 day management period (170%) (m3)	Sediment Dam Maximum Capacity (m3)	Maximum volume of silt that may be contained before design Capacity exceeded (m3)	Depth of Silt(m)
Dam 1	4,100	1,431	3,180	1,749	0.4
Dam 4	3750	6,101	9,375	3,274	0.9

Note: the design storm event is assumed to be the 90th percentile, 5 day rainfall event.

In accordance with the results in the table above, Dam 1 will be installed with a marked post indicating that when the depth of silt has reached 0.4m above the base of the dam. Similarly a post will be installed in Dam 4 indicating when the depth of silt has reached 0.9m from the base of the dam. Dam 5 will have a similar post installed as the depth of silt before the capacity is compromised is assumed to be similar to Dam 4.

9 Performance Criteria

Table 13. Performance Criteria and Trigger Action Response Plan

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
Water discharged from the site is consistent with the baseline hydrological conditions of the surrounding environment	Total volume of water discharged from the site to be as close as possible to the natural volumes expected.	Significant changes to volume of water discharged harms ecological communities downstream.	Sediment dams are not emptied to return to design storm capacity within the 20 day management period.	Review water management procedures to ensure that the dams can be emptied to the design storm capacity within the 20 day management period.	Annual review report/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Flow rate of the discharged water to not exceed that expected by natural flow rates expected predevelopment.	Significant changes to flow rates of water discharged erode creeks or otherwise harm ecological communities downstream.	Flow rates for controlled discharge exceed those in Section 5 for a 1 in 10 year ARI storm for the catchments pre-development.	Review discharge procedures and capacity of pipes and pumps used to discharge water to ensure flow rates are not exceeded.	Annual review report/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
Sediment to be contained on site	Sediment Dams are sized according to the 'Blue Book' Criteria for a 5 day 90th percentile storm event with 20 day management period (see Table 5)	Sediment is not contained within the sediment dams and is observed as uncontrolled discharge exiting the site due to incorrect dam sizing.	Sediment dams reach capacity and are at risk of overtopping after a 5 day rainfall event of 42.6mm. Uncontrolled discharge is observed leaving the site from the sediment dams after a 5 day rainfall event of 42.6mm.	Emergency pumping from sediment dams at risk of overtopping to Dam 3 to be undertaken. Dam sizes are to be verified against current catchments. Dams are to be enlarged if required to meet the required capacity. Review of the SWMP to be undertaken.	Annual review report/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Sediment Dam capacity is maintained at a level sufficient for the design 5 day 90th percentile storm event with 20 day management period (see Table 5)	Sediment is not contained within the sediment dams and is observed exiting the site as uncontrolled discharge due to dams having diminished capacity as requiring desilting or dam not emptied from previous storm event.	Sediment retained in sediment dams exceeds that calculated (and pegged with markers onsite) as the maximum volume before desilting is required as Listed in Table 12.	Once this level has been reached the dams will be desilted.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
	All surface water received over exposed surfaces prone to sediment entrainment is flows to the dirty water management system.	Surface water received over exposed surfaces prone to sediment entrainment that egresses off site as no sediment dam or drains provided for disturbed catchments.	Expansion of the quarry or changes to the mining sequence that may impact the current water management system.	Review of site and SWMP to determine water management requirements. No work will commence in new areas or changes to the mining sequence until the SWMP is reviewed and appropriate water management structures are constructed.	Environmental Management Report/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Constructed drains/pipes direct sediment laden water to the sediment dams and clean water around the site.	Sediment leaves the site due to the failure to construct suitable drains/pipes to contain the design storm event to direct dirty water to the sediment dams. Excessive clean water is diverted onto the site and sediment dam capacity for dirty water is impacted causing overtopping of dams	Clean or dirty water drains/pipes observed to be blocked or damaged. Inspection during rainfall events shows dirty water egressing the site via drain overflow. Inspection during rainfall events shows additional drains/pipes required to redirect dirty water to sediment dams. Inspection during rainfall events shows additional drains required to redirect clean water around the site.	Blocked or damaged drains/pipes are to be repaired. Drains sizes are to be checked by onsite measurements to ensure compliance with Blue Book calculations i.e. All drains will be designed for the 1 in 10 year design storm event. Install additional drains/pipes as required.	Annual review report photographic evidence Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
	Sediment Dam spillways and earth embankments are vegetated and stable for the design storm event.	Sediment leaves the site due to the failure of the dam wall or spillway due to not being designed for the design storm flows. Sediment leaves the site due to the erosion of the dam wall or spillway.	Inspection during a 5 day rainfall event of <42.6mm shows overtopping of the sediment dams. Erosion or tunnelling on the dam walls observed. Dam wall failure. Inspections shows dam walls (earth embankments) are not adequately vegetated and spillways protected from erosion adequately.	Spillways to be measured to check if complies with Blue Book calculations i.e All spillways to be designed for the 1 in 100 year design storm event. Dam walls and batters to be measured to ensure they are not too steep i.e.>3H:1V Replace vegetation on eroded surfaces if required. Repair dams as required.	Annual review report & photographic evidence/Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
Erosion is minimised	Rehabilitation slopes are designed to minimise the effects of erosion according to the Blue Book	Excessive sediment builds up in sediment dams. Re-vegetation unable to establish. Loss of topsoil for rehabilitation.	Slopes in rehabilitated areas observed to be greater than 3 horizontal to 1 vertical. Slope lengths exceed 20m before a catch drain is installed for a 3H:1V batter. Slope lengths exceed 35m before a catch drain is installed for a 4H:1V batter. Slope lengths exceed 60m before a catch drain is installed for batters >4H:1V. Visual inspection shows evidence of excessive rilling or gullying on rehabilitation slopes. Visual inspection shows established rehabilitated areas lose vegetation coverage or are unable to establish adequate vegetation coverage i.e. <60% coverage. Visual inspection shows spread topsoil on areas awaiting revegetation is eroding.	Install catch drains or earth banks on slopes where slope lengths exceed recommendations. Review rehabilitation areas to determine where slopes and catch drains need maintenance or repair or reworking. Reseeding/replant areas that require increased vegetation cover. Replace/ rework topsoil as required.	Annual review report & photographic evidence/Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
	Revegetation whether temporary or permanent is undertaken as soon as practicable to reduce the exposed surface area.	Excessive sediment builds up in sediment dams. Re-vegetation unable to establish. Loss of topsoil.	A C-factor (Revised Universal Soil Loss Equation) of less than 0.1 is not achieved on rehabilitated surfaces i.e. equivalent of 60% coverage by vegetation.	Review rehabilitation areas to determine where revegetation requires maintenance or repair.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Long term topsoil stockpiles and overburden stockpiles are protected from erosion within 10 days of formation.	Excessive sediment builds up in sediment dams. Loss of topsoil for rehabilitation.	A C-factor (Revised Universal Soil Loss Equation) of less than 0.1 is not achieved on rehabilitated surfaces i.e. equivalent of 60% coverage by vegetation	Review topsoil and overburden stockpiles to determine where maintenance or repair is required.	Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
	Access to rehabilitated areas and works areas are limited to necessary vehicles and personnel	Erosion of rehabilitation areas due to tracks by vehicles or feet. Disturbance and erosion of areas outside the quarry extraction footprint.	Monthly visual inspections show evidence of vehicle tracks or earthworks outside of approved works areas or within rehabilitation areas.	Repair damage to rehabilitation areas or areas outside the quarry extraction footprint. Ensure adequate signage and/or barrier fencing is erected to limit traffic access to sensitive areas Review staff training to ensure personnel are aware of 'no go' areas.	Monthly inspection reports & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
	Tracks suitable for access or pedestrian usage will not be subject to excessive use or erosion.	Excessive sediment builds up in sediment dams.	Visual inspection indicates excessive road / track erosion and deterioration.	Slopes of major tracks <10° or have cross drains/banks installed. Where unsuitable soils are present, tracks to be stabilised with crushed bricks, concrete, gravel or similar.	Monthly inspection reports & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP
Water discharged from the site is consistent with the baseline ecological and geomorphic conditions of the surrounding environment	Water quality monitoring results show that the discharge is non-polluting.	Significant changes to quality of water discharged harms ecological communities downstream.	Water Quality does not meet the objective of Section 120 of the Protection of the Environment Operations Act 1997. In particular Monitoring Point 1 and 2 shows water quality parameters outside the EPL criteria of pH between 6.5 and 8.5, turbidity <150mg/L and O&G <10mg/L(none visible). Conductivity <1450µS/cm for Point 5.	Discharge is to cease immediately. Sediment dams are to be treated as appropriate to ensure the water to be discharged meets the EPL criteria Discharge will not recommence until the quality of the water is sufficient.	PIRMP Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP

Objective	Performance Indicator	Potential Adverse Outcome	Trigger Level	Actions to be Implemented	Evidence/ Reference
	Fuel and oil storage is bunded and spill kits are accessible. No spills of hydrocarbons occur.	Releases of hydrocarbons changes quality of water discharged and harms ecological communities downstream.	Hydrocarbon spill occurs that has not been contained and contaminants observed to enter the water management system. Water Quality does not meet the objective of Section 120 of the Protection of the Environment Operations Act 1997. In particular Monitoring Point 1 and 2 shows water quality parameters outside the EPL criteria of O&G <10mg/L (none visible).	Discharge is to cease immediately. Sediment dams are to be treated as appropriate to ensure the water to be discharged meets the EPL criteria Discharge will not recommence until the quality of the water is sufficient. All hydrocarbon spills are to be cleaned up. Procedures for handling hydrocarbons to be revised and updated if required. Staff and contractors to be re-trained in the handling of hydrocarbons.	PIRMP Spill Response Training Annual review report & photographic evidence/ Managing Urban Stormwater- Soils and Construction- Volume 2E Mines and Quarries & SWMP

10 Environmental Management Measures

Specific surface water management measures identified in the EIS, CoA and EPL have been interpreted and generally reproduced in *Table 14*. The management measures identified in this table are to be implemented to mitigate or manage impacts identified. Relevant responsibility and references for each have been identified in the corresponding columns below.

Table 14. Environmental Management Measures

#	Management Measure	Responsibility	Frequency	Reference
General				
G1	An environmental consultant with appropriate qualifications for the task will be engaged to help review and implement surface and ground water management plan and measures for the Project.	Environmental Consultant Environmental Manager Operations Manager	As required	VGT Consultant Correspondence
G2	All relevant individuals will read the WMP with any engineering plans and any other plans or written instructions issued in relation to development at the project site.	Operations Manager Site Engineers Contractors	As required	WMP (This Plan)
G3	Implement Water Management Procedures and regularly review to ensure relevance and compliance with internal and external requirements.	Operations Manager Site Engineers Contractors	At least annually	Water Management Procedures
G3	Ensuring contractors undertake all soil and water management works as instructed in this specification and constructed following the guidelines stated in the "Blue Book" and internal procedures.	Operations Manager Site Engineers Contractors	As required	Water Management Procedures
G4	Inform all subcontractors of their responsibilities in minimising the potential for surface and ground water quality impacts, spills etc. through site induction and toolbox talks.	Environmental Manager Operations Manager	At least annually	Induction
G5	Annual Review of this plan and relevant procedures	Operations Manager Environmental Manager	At least annually	WMP (This Plan)

#	Management Measure	Responsibility	Frequency	Reference
Surface water Management				
SW1	Undertake Water quality, flow and consumption monitoring as per the requirements of the EPL and this Plan	Environmental Manager Site Engineer Site Staff & Contractors	Monthly	EPL, WMP (This Plan) ENVIZY CSR environmental database.
SW2	Investigation of options for the reuse of water stored on-site for beneficial use in order to increase the on-site water extraction regime, improve on-site storage capacity and reduce discharges to Thompsons Creek. Key potential uses will include using water from the Quarry Pit, Dams 4, 5 and 6 for dust suppression activities associated with routine operations and extraction campaigns	Environmental Consultant Environmental Manager Operations Manager	As required	WMP (This Plan)
SW3	Investigation and implementation of a mechanical /automatic dosing and testing point at Discharge point 5.	Environmental Consultant Environmental Manager	As required	WMP (This Plan)
SW4	Stabilisation and controls for temporary stockpiles in accordance with Section 9 controls to minimise the risk of erosion.	Operations Manager Site Engineers Contractors	As required	WMP (This Plan)
SW5	Use of flocculants in sediment basins to increase sediment removal rates as per procedure 4743-0000-001.	Operations Manager Site Engineer Site Staff	As required	Water Management Procedures
SW6	Routine maintenance and inspection of dams, drains, sediment basins and bunds. Including sediment level checks, once levels have been reached dams will be desilted. Blocked or damaged drains/pipes/dams are to be repaired where required.	Operations Manager Site Engineer Site Staff & Contractors	As required	WMP (This Plan)
SW7	Activities with the potential to reduce or contaminate local water quality (including refuelling, vehicle servicing, concrete washout, storage of fuels and hazardous materials,) will be undertaken within appropriately bunded or surfaced areas.	Operations Manager Site Engineer Site Staff & Contractors	As required	Water Management Procedures / PIRMP

#	Management Measure	Responsibility	Frequency	Reference
SW8	PGH will undertake water quality sampling as per the requirements of EPL 1808.	Environmental Consultant Environmental Manager Operations Manager	As required	WMP (This Plan)
SW9	All Fuel and oil storage will be appropriately bunded with spill kits are accessible. All hydrocarbon spills are to be cleaned up and reported as per PIRMP. Procedures for handling hydrocarbons and spills to be revised and updated if required	Environmental Manager Operations Manager Site Engineer Site Staff & Contractors	As required	WMP (This Plan)
SW10	Staff and contractors to be trained in the handling of hydrocarbons, spills and PIRMP annually.	Environmental Manager Operations Manager Site Engineer Site Staff & Contractors	Annually	WMP (This Plan)/Induction/ Spill Training
Soil Erosion, Sediment and Drainage Control Measures				
SE1	Construct earth banks or Stormwater Catch to divert as much clean water as possible and capture the dirty water in new cells, cleared ground or on slopes where slope lengths exceed recommendations.	Operations Manager Site Engineer	As required	Section 6
SE2	Review rehabilitation areas to determine where revegetation requires maintenance or repair.	Environmental Manager Operations Manager Site Engineer Site Staff & Contractors	Annually	Section 6
SE3	Review topsoil and overburden stockpiles to determine where maintenance or repair is required.	Environmental Manager Operations Manager Site Engineer Site Staff & Contractors	Annually	Section 6

#	Management Measure	Responsibility	Frequency	Reference
SE4	Install erosion and sediment controls where required, ensure maintenance and include in regular inspections of the site.	Operations Manager Site Engineer Site Staff Contractors	As required	Section 6
SE5	Staff and contractors to be trained in the Erosion and Sediment controls annually.	Environmental Manager Operations Manager Site Engineer Site Staff & Contractors	Annually	WMP (This Plan)/Induction/ ERSED Training

11 Compliance Management

11.1 Inspections

Weekly inspections and daily visual observations by the Plant Manager (or delegate) of surface water quality conditions and controls will occur throughout the operational lifetime of the facility.

11.2 Training

All employees and contractors working on site will undergo site induction training, which will cover issues relating to water quality management, including:

- Existence and requirements of this Plan;
- Relevant legislation;
- Bringelly Brickworks operational hours;
- Location of Spill kits;
- All other water quality management measures that need to be implemented to minimise impact to surface and ground water;
- Location of sensitive receivers; and
- Incident and Complaints reporting.

11.3 Complaints & Enquiries Procedure

All community inquiries and complaints related to the facility's activities will be referred to a community information line (02 4774 8751). A postal address, PGH Bricks, Locked Bag 1345, North Ryde BC NSW 1670) and email address has been provided for receipt of complaints and enquiries. Information to be recorded will include location of complainant, time of occurrence of alleged complaint, perceived source, prevailing weather conditions and similar details that could be utilised to assist in the investigation of the complaint.

An initial response acknowledging a complaint will be provided within 24 hours of a complaint being received. A further detailed response, including steps taken to resolve the issue(s) that led to the complaint, will be provided within 10 days. All reasonable endeavours will be made to resolve and close off complaints. The complainants will be kept informed of when they will receive a response.

Information on all complaints received, including how they were addressed, whether resolution was reached and whether mediation was required or used will be included in a complaint register.

Complaints and the subsequent action(s) taken by PGH will be reported at each subsequent Community Consultative Committee meeting.

11.4 Incident Management

PGH will immediately notify the Secretary and any relevant agencies when an incident has occurred. More specifically, where the following conditions are not met a water incident shall be raised and reported accordingly:

1. On review of Water quality monitoring data, an exceedance is recorded above the criteria stipulated in *Section 9*; and
2. Within seven days of the declaration of an incident, a report documenting the facts of the incident must be submitted to the Secretary. This report is to document the findings of the incident investigation, attempt to identify the cause and nature of the exceedance.

11.5 Audit

Audits (both internal and external) and reporting will be undertaken to assess the effectiveness of environmental controls, compliance with this WMP, CoA and other relevant approvals, licenses and guidelines.

11.6 Reporting

The effectiveness of the water management system will be assessed in an annual review and audits as required by consent conditions. Additional reviews will be undertaken in the form of an Annual Rehabilitation Report (ARR) as required by the Mine Lease conditions. In addition Water usage and quality data will be provided in the EPL annual Return and internally through ENVIZY.

These reviews will report on the progress towards performance criteria as outlined in *Table 13*. Where an action response has been implemented, details of the action and any results obtained will be included in the ARR. The ARR's will be submitted to the DPIE- Resources and Geoscience until the Mining Lease has been relinquished.

In Addition to the ARR's, and Annual Review of the environmental performance will be undertaken and submitted to DPIE by the end of September each year to the satisfaction of the Secretary in accordance with Schedule 5-Condition 4 of the CoA.

The Secretary will be notified immediately of any incidents and a report will be provided to the Secretary as discussed in *Section 11.4.*

Audits (routinely conducted every 3 years after the initial 12 monthly audit) will also be submitted to the Secretary.

PGH will provide regular reporting on the environmental performance of the development on its website.

As part of the measurement of the effectiveness of the water management system, PGH will assess the following:

- Water imported, water use, volumes stored and any discharges from the site and report results or changes to the balance;
- Water quality results for compliance and trends;
- Water flows within Thompsons Creek and Bardwell Gully as well as surface water flows on the site;
- Identifying non-compliances and actions taken to ensure compliance;
- Discrepancies between the predicted and actual impacts of the development; and
- Measures that may be undertaken to improve the environmental performance of the development.

12 Review and Improvement

Continuous improvement of this WMP will be achieved through the ongoing evaluation of environmental management performance against environmental policies, objectives and targets.

The continuous improvement process is designed to:

- Identify areas of opportunity for improvement of environmental management and performance;
- Determine the cause or causes of non-conformances and deficiencies;
- Develop and implement a plan of corrective and preventative action to address any non- conformances and deficiencies;
- Verify the effectiveness of the corrective and preventative actions;
- Document any changes in procedures resulting from process improvement; and
- Make comparisons with objectives and targets.

Inspections, monitoring, auditing and management reviews may result in the need to update or revise this WMP.

13 References

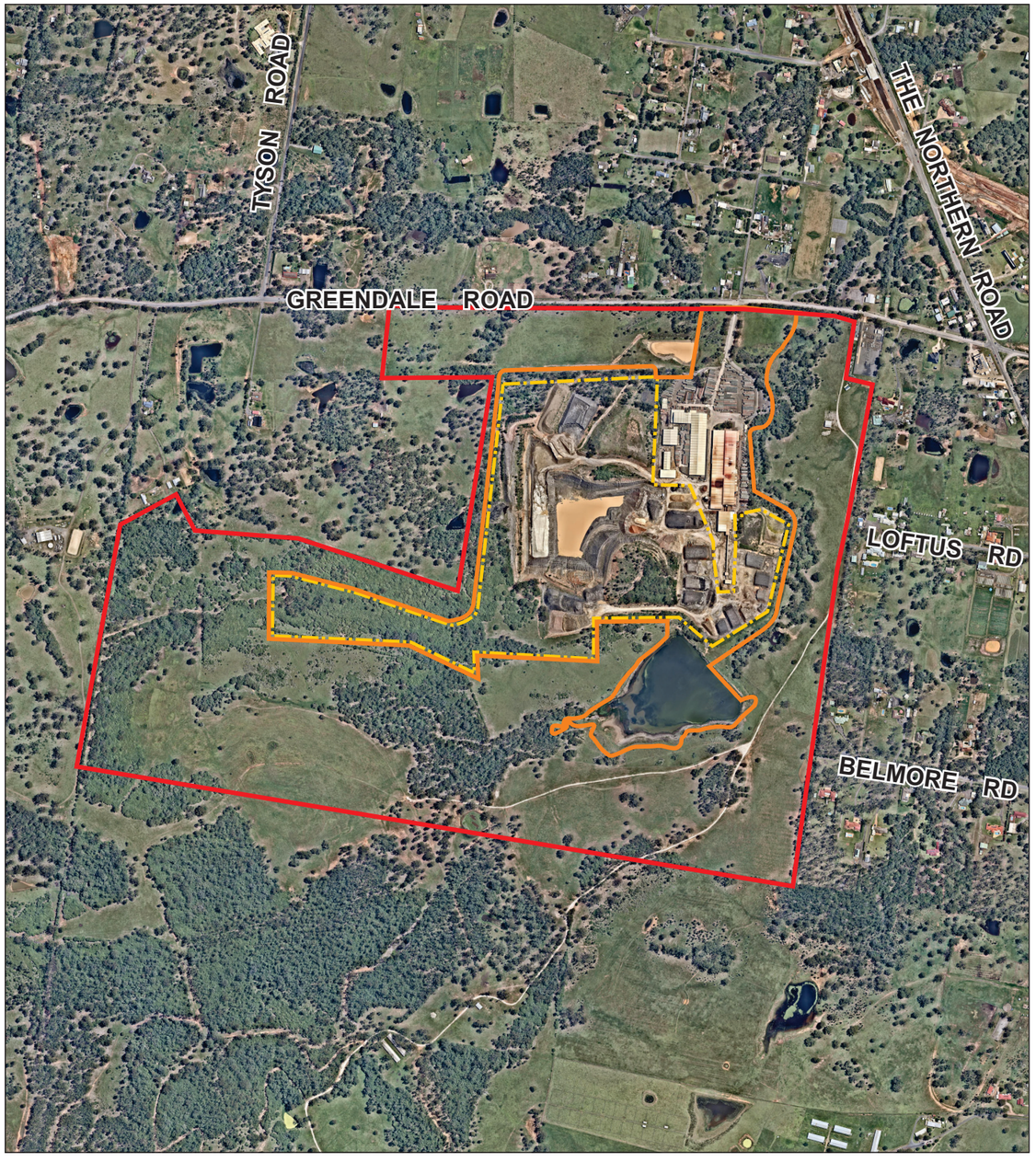
1. VGT: Surface Water Management Plan for Bringelly Quarry(ML1731 (Act 1992) - February 2018
2. Golder and Associates – Groundwater Impact Assessment (2013)
3. Hyder Consulting - Bringelly Brickworks and Quarry Expansion ENVIRONMENTAL IMPACT STATEMENT Volumes 1 & 2 -5 September 2013
4. Kleinfelder Water Management Plan PGH Bricks & Pavers Bringelly - 28 October 2016
5. DECC, 2008, the Blue Book – Volume 2D.
6. Landcom, 2004, Managing Urban Stormwater: Soils and Construction – Volume 1 and 2 (4th edition).
7. Western Sydney Regional Organisation of Councils, 2004, Draft Salinity Code of Practice.
8. NOW Guidelines for Controlled Activities.
9. ANZECC Guidelines for Fresh and Marine Water Quality.
10. ANZECC Guidelines for Water Quality Monitoring and Reporting.
11. Water Management Act 2000.

Appendix A: Figures

Plan of:	Bringelly Clay Mine Surface Water Management Plan - Site Location	***Location:***	Bringelly Clay Mine Off Greendale Road, Bringelly, NSW	***Source:***	nearmap - Image Date 12/01/2019 & Google Maps 2019	***Our Ref:***	8006_BR_SWMP_C001_V0_F1.cdr
Figure:	ONE	***Council:***	Camden Council	***Survey:***	N/A	***Plan By:***	JD
Sheet:	1 of 1	***Tenure:***	ML 1731	***Projection:***	N/A	***Project Manager:***	TO
Version/Date:	V0 10/09/2019	***Client:***	PGH Bricks & Pavers Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton

N

vgt
Environmental Compliance Solutions Pty Ltd



Approx Scale: 0 5 10km

Approx Scale: 0 250m

Legend

- Cadastral Boundary
- Project Approval Boundary
- Authority Boundary *(ML 1731)*

Plan of:	Bringelly Clay Mine Surface Water Management Plan - Site Layout	***Location:***	Bringelly Clay Mine Off Greendale Road, Bringelly, NSW	***Source:***	Photomapping 2015 & nearmap - Image Date 12/01/2019	***Our Ref:***	8006_BR_SWMP_C002_V0_F2.cdr
Figure:	TWO	***Council:***	Camden Council	***Survey:***	Photomapping 2015	***Plan By:***	TO/JD
Sheet:	1 of 1	***Tenure:***	ML 1731	***Projection:***	MGA	***Project Manager:***	TO
Version/Date:	V0 5/09/2019	***Client:***	PGH Bricks & Pavers Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton

N

0 30 60 90 120 150m

vgt
Environmental Compliance Solutions Pty Ltd

288400 E 288600 E TYSON ROAD 288800 E 289000 E 289200 E 289400 E 289600 E MEDWAY RD 289800 E 290000 E 290200 E

GREENDALE ROAD

6242200 N
6242000 N
6241800 N
6241600 N
6241400 N

Dam 1
Backwell Gully
Dam 2
Brick Storage Area
Brick Storage Area
Thompsons Creek
Raw Material Stockpile Area
Existing Brickworks
Quarry Pit Sump
Dam 3
Pooled Water
Raw Material Stockpile Area
Dam 4
Dam 5
Raw Material Stockpile Area
Box Feeder
Raw Material Stockpile Area
Raw Material Stockpile Area
Thompsons Creek
Dam 6
LOFTUS RD
BELMORE RD

LEGEND	
	Cadastral Boundary
	Authority Boundary *(ML 1731)*
	Project Approval Boundary
	Water Management
	Road
	Contour

Plan of:	Bringelly Clay Mine Surface Water Management Plan - Existing Water Management	***Location:***	Bringelly Clay Mine Off Greendale Road, Bringelly, NSW	***Source:***	Photomapping 2015 & nearmap - Image Date 12/01/2019	***Our Ref:***	8006_BR_SWMP_C003_V0_F3.cdr
Figure:	THREE	***Council:***	Camden Council	***Survey:***	Photomapping 2015	***Plan By:***	TO/JD
Sheet:	1 of 1	***Tenure:***	ML 1731	***Projection:***	MGA	***Project Manager:***	TO
Version/Date:	V0 5/09/2019	***Client:***	PGH Bricks & Pavers Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton

N

0 30 60 90 120 150m

vgt
Environmental Compliance Solutions Pty Ltd

288400 E 288600 E 288800 E 289000 E 289200 E 289400 E 289600 E 289800 E 290000 E 290200 E

6242200 N
6242000 N
6241800 N
6241600 N
6241400 N

GREENDALE ROAD
TYSON ROAD
MEDWAY RD
LOFTUS RD
BELMORE RD
Bardwell Gully
Thompsons Creek
Thompsons Ck

EPL1
EPL5
Water Treatment & Monitoring Point
GW01
GW02
GW03
GW04

Dam 1
Dam 2
Dam 3
Dam 4
Dam 5
Dam 6
Quarry Pit Sump Dam 3
Pooled Water
Proposed New Dam (7) Extent

Cell A
Cell B
Cell C
Cell D
Cell E
Cell F
Cell G
Cell H

Raw Material Stockpile Area
Brick Storage Area
Existing Brickworks
Box Feeder

LEGEND

Feature/Domain			
	Project Approval Boundary		Direction of Flow *(Clean Water)*
	Major/Minor Road		Clean Water Diversion System
	River/Major Drainage Line	Mining Tenement	
	Proposed New Dam 7		Authority Boundary *(ML 1731)*
	Direction of Flow *(Dirty Water)*		Area of Disturbance
	Stormwater Pipe	Primary Domains *(Operational)*	
	Pump Line		Water Management
E	Transmission Line	Catchments	
GW04	Groundwater Bore Location		Dam 1 Catchment
	Extraction Point for Dust Control		Dam 2 Catchment
EPL	Discharge Point *(EPL)*		Dam 3 Catchment
	Water Treatment & Monitoring Point		Dam 4 & 5 Catchment
	Contour		Dam 6 Catchment

VGT Environmental Compliance Solutions Pty Ltd 4/30 Glenwood Drive, Thornton NSW 2322 PO Box 2335, Greenhills NSW 2323 ph: (02) 4028 6412 email: mail@vgt.com.au www.vgt.com.au ABN: 26 621 943 888

Plan of:	Bringelly Clay Mine Surface Water Management Plan - EIS Preferred Option	***Location:***	Bringelly Clay Mine Off Greendale Road, Bringelly, NSW	***Source:***	Photomapping 2015 & nearmap - Image Date 12/01/2019	***Our Ref:***	8006_BR_SWMP_C004_V0_F4.cdr
Figure:	FOUR	***Council:***	Camden Council	***Survey:***	Photomapping 2015	***Plan By:***	TO/JD
Sheet:	1 of 1	***Tenures:***	ML 1731	***Projection:***	MGA	***Project Manager:***	TO
Version/Date:	V0 5/09/2019	***Client:***	Boral CSR Bricks Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton

N

0 30 60 90 120 150m

vgt Environmental Compliance Solutions Pty Ltd

288400 E 288600 E 288800 E 289000 E 289200 E 289400 E 289600 E 289800 E 290000 E 290200 E

6242200 N 6242000 N 6241800 N 6241600 N 6241400 N

GREENDALE ROAD

TYSON ROAD

MEDWAY RD

LOFTUS RD

BELMORE RD

Bardwell Gully

Thompsons Creek

Thompsons Ck

Dam 1

Dam 4

Dam 5

Dam 6

Dam 7

Pooled Water

Quarry Pit Sump Dam 3

Cell A

Cell B

Cell C

Cell D

Cell E

Cell F

Cell G

Cell H

Cell I

Raw Material Stockpile Area

Brick Storage Area

Existing Brickworks

Box Feeder

LEGEND			
Feature/Domain		Mining Tenement	
	Cadastral Boundary		Authority Boundary *(ML 1731)*
	Project Approval Boundary		Area of Disturbance
	Major/Minor Road		
	River/Major Drainage Line		
	Direction of Flow *(Clean Water)*	Primary Domains *(Operational)*	
	Direction of Flow *(Dirty Water)*		Water Management
	Stormwater Pipe	Catchments	
	Pump Line		Dam 1 Catchment
	Clean Water Diversion System		Dam 3 Catchment
E	Transmission Line		Dam 4 & 5 Catchment
	Contour		Dam 6 Catchment
			Dam 7 Catchment

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Plan of:	Bringelly Clay Mine Surface Water Management Plan - Existing Western Catchment Management	***Location:***	Bringelly Clay Mine Off Greendale Road, Bringelly, NSW	***Source:***	Photomapping 2015	***Our Ref:***	8006_BR_SWMP_C005_V0_F5.cdr
Figure:	FIVE	***Council:***	Camden Council	***Survey:***	Photomapping 2015	***Plan By:***	TO/JD
Sheet:	1 of 1	***Tenures:***	ML 1731	***Projection:***	MGA	***Project Manager:***	TO
Version/Date:	V0 25/09/2019	***Client:***	PGH Bricks & Pavers Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton

vgt Environmental Compliance Solutions Pty Ltd

N

0 30 60 90 120 150m

288400 E 288600 E 288800 E 289000 E 289200 E 289400 E 289600 E 289800 E 290000 E 290200 E

6242200 N 6242000 N 6241800 N 6241600 N 6241400 N

TYSON ROAD GREENDALE ROAD MEDWAY RD BELMORE RD

Culvert Culvert Dam Bardwell Gully Bardwell Gully Dam Upper Dam Pooled Water Dam 1 Dam 2 Brick Storage Area Brick Storage Area Raw Material Stockpile Area Cell D Cell C Cell E Cell B Quarry Pit Sump Cell A Cell F Cell G Cell H Cell I Stockpile Area Box Feeder Raw Material Stockpile Thompsons Creek Thompsons Ck

LEGEND	
	Existing Catchment to Culvert
	Culvert Dam Catchment
	Bardwell Gully Dam Catchment

Stormwater Pipe Calculation Assumptions

- The design storm is a 1 in 10 year ARI event.
- It is assumed that all the dams are full to capacity at the commencement of the design storm event as a worst case scenario.
- The Time of Concentration (T_c) has been halved as the worst case scenario for an equivalent of an urban catchment.
- The Storm Intensity has been calculated from BOM IFD online data for a 10 year ARI event.
- The gradient of the pipe has been assumed to be 1 in 14.
- The existing culvert consists of two pipes of 0.58m diameter each.
- The calculation used to determine the pipe dimeter is from the www.roof-gutter-design.com.au website and is based on the Australian Plumbing Code AS/NZS 3500.3:2015.

Table 1. Existing Catchments to Greendale Road Culvert

Catchment	Area (ha)	Time of Concentration (T_c) Halved (mins)	Storm Intensity (mm/Hr)	Flow (L/sec)	Pipe Diameter Required (mm)	Calculated Inlet Area (m^2)	Actual Total Inlet Area (m^2)
Culvert Dam Catchment	6.996	-	-	-	-	-	-
Bardwell Gully Dam Catchment	6.853	-	-	-	-	-	-
Total	**13.849**	**11**	**107**	**4117**	**720**	**0.407**	**0.528**

LEGEND			
Feature/Domain		Mining Tenement	
	Cadastral Boundary		Authority Boundary *(ML 1731)*
	Project Approval Boundary		Area of Disturbance
	Major/Minor Road	Primary Domains *(Operational)*	
	River/Major Drainage Line		Water Management
	Direction of Flow	Catchments	
	Stormwater Pipe		Dam 1 Catchment
	Pump Line		Dam 2 Catchment
	Transmission Line		Dam 3 Catchment
	Contour		Dam 4 & 5 Catchment
			Dam 6 Catchment

Plan of:	Bringelly Clay Mine Surface Water Management Plan - Direct Diversion of Dam 7 to Bardwell Gully	***Location:***	Bringelly Clay Mine Off Greendale Road, Bringelly, NSW	***Source:***	Photomapping 2015	***Our Ref:***	8006_BR_SWMP_C006_V0_F6.cdr
Figure:	SIX	***Council:***	Camden Council	***Survey:***	Photomapping 2015	***Plan By:***	TO/JD
Sheet:	1 of 1	***Tenures:***	ML 1731	***Projection:***	MGA	***Project Manager:***	TO
Version/Date:	V0 5/09/2019	***Client:***	PGH Bricks & Pavers Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton

vgt Environmental Compliance Solutions Pty Ltd

N

0 30 60 90 120 150m

288400 E 288600 E 288800 E 289000 E 289200 E 289400 E 289600 E 289800 E 290000 E 290200 E

6242200 N 6242000 N 6241800 N 6241600 N 6241400 N

TYSON ROAD GREENDALE ROAD MEDWAY RD BELMORE RD

Culvert Culvert Dam Bardwell Gully Dam Proposed Pipe Upper Dam

Bardwell Gully Thompsons Creek Thompsons Ck

Dam 1 Dam 2 Brick Storage Area Brick Storage Area Raw Material Stockpile Area Cell A Cell B Cell C Cell D Cell E Cell F Cell G Cell H Cell J Pooled Water Quarry Pit Sump Stockpile Area Box Feeder

LEGEND	
	Existing Catchment to Culvert
	Culvert Dam Catchment
	Bardwell Gully Dam Catchment
	Upper Dam Catchment
	Proposed Pipe

LEGEND			
Feature/Domain		Mining Tenement	
	Cadastral Boundary		Authority Boundary *(ML 1731)*
	Project Approval Boundary		Area of Disturbance
	Major/Minor Road	Primary Domains *(Operational)*	
	River/Major Drainage Line		Water Management
	Direction of Flow	Catchments	
	Stormwater Pipe		Dam 1 Catchment
	Pump Line		Dam 2 Catchment
	Transmission Line		Dam 3 Catchment
	Contour		Dam 4 & 5 Catchment
			Dam 6 Catchment

Stormwater Pipe Calculation Assumptions

- The design storm is a 1 in 10 year ARI event.
- It is assumed that all the dams are full to capacity at the commencement of the design storm event as a worst case scenario.
- The Time of Concentration (T_c) has been halved as the worst case scenario for an equivalent of an urban catchment.
- The Storm Intensity has been calculated from BOM IFD online data for a 10 year ARI event.
- The gradient of the pipe has been assumed to be 1 in 14.
- The existing culvert consists of two pipes of 0.58m diameter each.
- The calculation used to determine the pipe dimeter is from the www.roof-gutter-design.com.au website and is based on the Australian Plumbing Code AS/NZS 3500.3:2015.

Table 1. Proposed Catchments to Greendale Road Culvert

Catchment	Area (ha)	Time of Concentration (T_c) Halved (mins)	Storm Intensity (mm/Hr)	Flow (L/sec)	Pipe Diameter Required (mm)	Calculated Inlet Area (m^2)	Actual Total Inlet Area (m^2)
Culvert Dam Catchment	6.996	-	-	-	-		-
Bardwell Gully Dam Catchment	6.853	-	-	-	-		-
Upper Dam Catchment	6.441	-	-	-	-		-
Total	**20.290**	**12**	**104**	**5862**	**825**	**0.534**	**0.528**

Plan of:	Bringelly Clay Mine Surface Water Management Plan - Proposed Water Management	***Location:***	Bringelly Clay Mine Off Greendale Road, Bringelly, NSW	***Source:***	Photomapping 2015 & nearmap - Image Date 12/01/2019	***Our Ref:***	8006_BR_SWMP_C007_V0_F7.cdr
Figure:	SEVEN	***Council:***	Camden Council	***Survey:***	Photomapping 2015	***Plan By:***	TO/JD
Sheet:	1 of 1	***Tenures:***	ML 1731	***Projection:***	MGA	***Project Manager:***	TO
Version/Date:	V0 5/09/2019	***Client:***	Boral CSR Bricks Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton

N

0 30 60 90 120 150m

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288400 E 288600 E 288800 E 289000 E 289200 E 289400 E 289600 E 289800 E 290000 E 290200 E

6242200 N
6242000 N
6241800 N
6241600 N
6241400 N

GREENDALE ROAD
TYSON ROAD
MEDWAY RD
LOFTUS RD
BELMORE RD
Bardwell Gully
Thompsons Creek
Thompsons Ck

Dam 1
Dam 4
Dam 5
Dam 6
Dam 7
Pooled Water
Quarry Pit Sump Dam 3
Proposed Dam 7 Wall
Discharge Point
Controlled Discharge Pipe
Pipe to Dam 4 When Required

Cell A
Cell B
Cell C
Cell D
Cell E
Cell F
Cell G
Cell H
Cell I

Raw Material Stockpile Area
Brick Storage Area
Existing Brickworks
Box Feeder

LEGEND

Feature/Domain		Mining Tenement	
	Cadastral Boundary		Authority Boundary *(ML 1731)*
	Project Approval Boundary		Area of Disturbance
	Major/Minor Road	Primary Domains *(Operational)*	
	River/Major Drainage Line		Water Management
	Direction of Flow	Catchments	
	Stormwater Pipe		Dam 1 Catchment
	Pump Line		Dam 3 Catchment
	Clean Water Diversion System		Dam 4 & 5 Catchment
E	Transmission Line		Dam 6 Catchment
	Contour		Dam 7 Catchment

Plan of:	Bringelly Clay Mine Surface Water Management Plan - Detail of Dam 7 Controlled Discharge	***Location:***	Bringelly Clay Mine Off Greendale Road, Bringelly, NSW	***Source:***	Photomapping 2015	***Our Ref:***	8006_BR_SWMP_C008_V0_F8.cdr
Figure:	EIGHT	***Council:***	Camden Council	***Survey:***	Photomapping 2015	***Plan By:***	TO/JD
Sheet:	1 of 1	***Tenures:***	ML 1731	***Projection:***	MGA	***Project Manager:***	TO
Version/Date:	V0 5/09/2019	***Client:***	PGH Bricks & Pavers Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton

N

0 10 20 30 40 50m

vgt Environmental Compliance Solutions Pty Ltd

289000 E | 288400 E | 289400 E

6242200 N | 6241800 N

Energy Dissipator

Alternate Discharge Point RL 97m

Energy Dissipator

Discharge Point at RL 100m

Gully

Bardwell

Pump

Dam Spillway

Proposed New Dam (7) Extent

RL98

Pooled Water Above Main Pit

Dam

Quarry Pit Sump

Dam Wall to be Constructed Within Spillway to the Main Pit

LEGEND	
Feature/Domain	
	Cadastral Boundary
	Project Approval Boundary
	Major/Minor Road
	River/Major Drainage Line
	Western Catchment
	Offset Area
	Dam Wall
	Access Road
	Pipe To Discharge Point
	Pipe To Alternate Discharge Point
	Dam Spillway
Mining Tenement	
	Authority Boundary *(ML 1731)*
Primary Domains *(Operational)*	
	Water Management
	Extent of Current Wetlands

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Plan of:	Bringelly Clay Mine Surface Water Management Plan - Existing Dam 4 & 5 Management
Figure:	NINE
Sheet:	1 of 1
Version/Date:	V0 5/09/2019

N

0 4 8 12 16 20m

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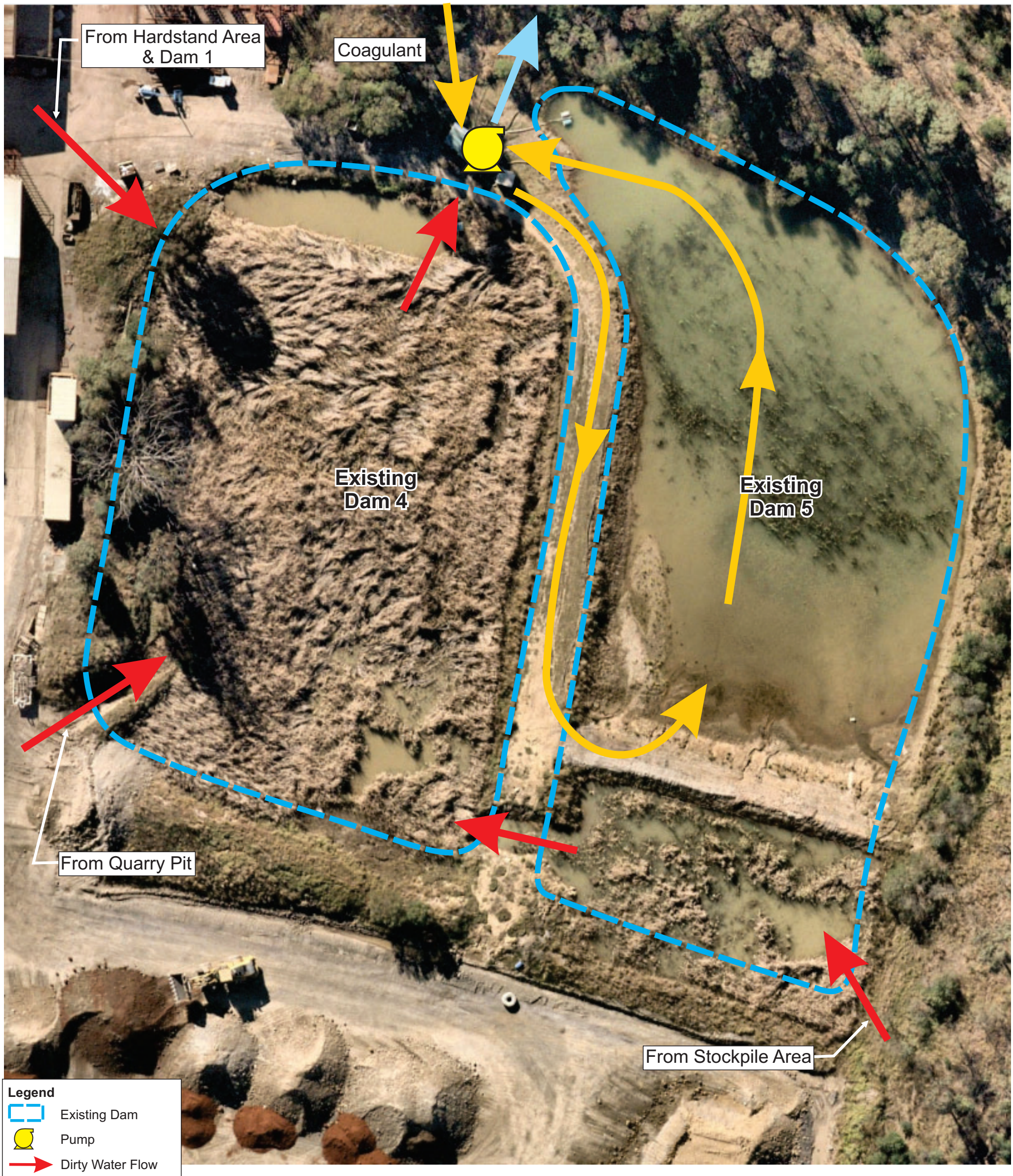
Location:	Off Greendale Road, Bringelly, NSW	***Source:***	nearmap - Image Date 23/07/2019	***Our Ref:***	8006_BR_SWMP_C009_V0_F9.cdr
Council:	Camden Council	***Survey:***	N/A	***Plan By:***	JD
Tenures:	ML 1731	***Projection:***	N/A	***Project Manager:***	TO
Client:	PGH Bricks & Pavers Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



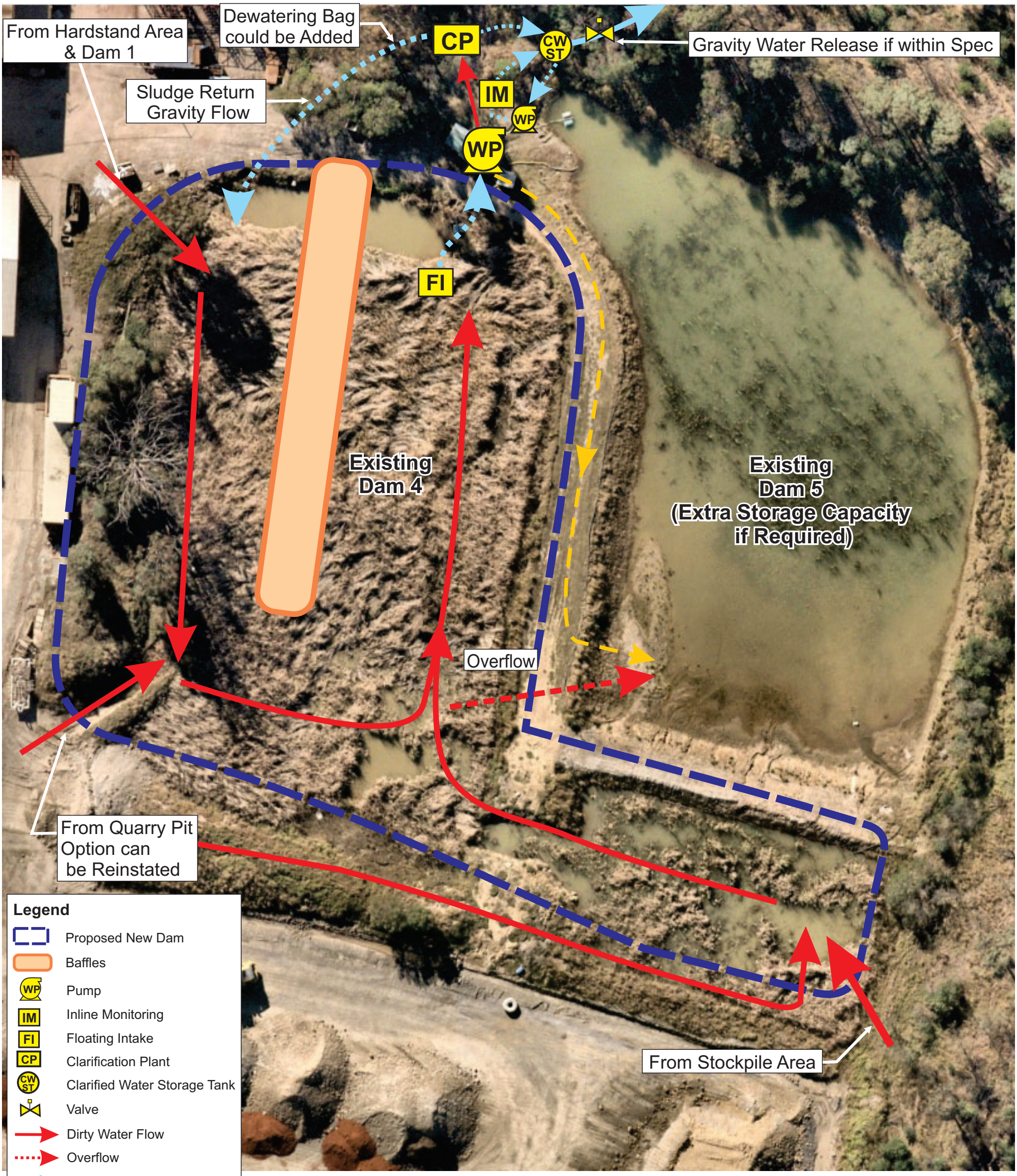
Plan of:	Bringelly Clay Mine Surface Water Management Plan - Proposed Dam 4 & 5 Management
Figure:	TEN
Sheet:	1 of 1
Version/Date:	V0 5/09/2019

N

0 4 8 12 16 20m

vgt
Environmental Compliance Solutions Pty Ltd

Location:	Off Greendale Road, Bringelly, NSW	***Source:***	nearmap - Image Date 23/07/2019	***Our Ref:***	8006_BR_SWMP_C010_V0_F10.cdr
Council:	Camden Council	***Survey:***	N/A	***Plan By:***	JD
Tenures:	ML 1731	***Projection:***	N/A	***Project Manager:***	TO
Client:	PGH Bricks & Pavers Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton



Plan of:	Bringelly Clay Mine Surface Water Management Plan - Water Sampling Locations	***Location:***	Bringelly Clay Mine Off Greendale Road, Bringelly, NSW	***Source:***	Photomapping 2015 & nearmap - Image Date 12/01/2019 & Kleinfelder File Name 20154511.001A dwg Figure 4	***Our Ref:***	8006_BR_SWMP_C011_V0_F11.cdr
Figure:	ELEVEN	***Council:***	Camden Council	***Survey:***	Photomapping 2015	***Plan By:***	SK/JD
Sheet:	1 of 1	***Tenures:***	ML 1731	***Projection:***	MGA	***Project Manager:***	TO
Version/Date:	V0 5/09/2019	***Client:***	Boral CSR Bricks Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton

N

0 30 60 90 120 150m

vgt
Environmental Compliance Solutions Pty Ltd

GREENDALE ROAD
MEDWAY RD
LOFTUS RD
BELMORE RD
Bardwell Gully
Thompson Creek Downstream
Thompson Creek Upstream
Thompsons Creek
Dam 1 Discharge
Dam 1
EPL1
Dam 2
Brick Storage Area
Brick Storage Area
Raw Material Stockpile Area
Existing Brickworks
EPL5
Dam 5 Discharge
Dam 4
Dam 5
Dam 5
Quarry Pit Sump Dam 3
Dam 3
Pooled Water
Raw Material Stockpile Area
Box Feeder
Raw Material Stockpile Area
Raw Material Stockpile Area
Dam 6
Dam 6 Discharge

288400 E 288800 E 289000 E 289400 E 289600 E 289800 E 290000 E 290200 E

6242200 N
6242000 N
6241800 N
6241600 N
6241400 N

LEGEND	
	Cadastral Boundary
	Authority Boundary *(ML 1731)*
	Road
	Contour
	Water Sampling Location

Appendix B: Consultant Approval

Planning and Assessment
Energy and Resource Assessments
Contact: Jack Murphy
Phone: 8217 2016
Email: jack.murphy@planning.nsw.gov.au

Mr Greg Thomson
Director
VGT Environmental Compliance Solutions Pty Ltd
PO Box 2334
Greenhills NSW 2323

Dear Mr Thomson,

Bringelly Brickworks Extension (SSD 5684)
Appointment of a Suitably Qualified and Experienced Person

I refer to your letter dated 2 September 2019 requesting the Secretary's endorsement of a suitably qualified and experienced person to prepare the Water Management Plan for the Bringelly Brickworks Extension (SSD 5684).

The Department has reviewed the credentials of Ms Tara O'Brien of VGT Environmental Compliance Solutions Pty Ltd and agrees she is a suitably qualified person. In accordance with condition 18 of Schedule 3 of SSD 5684, the Secretary endorses Ms Tara O'Brien to prepare the above document.

Should you have any enquiries in relation to this matter, please contact Jack Murphy.

Yours sincerely,

Howard Reed 2.9.19
Howard Reed
Director Resource Assessments
as the Secretary's nominee

Appendix C: EPL

Environment Protection Licence

Licence - 1808

Licence Details	
Number:	1808
Anniversary Date:	01-June

Licensee
BORAL CSR BRICKS PTY LIMITED
LOCKED BAG 1345
NORTH RYDE NSW 1670

Premises
BRINGELLY
LOT 2 GREENDALE ROAD
BRINGELLY NSW 2556

Scheduled Activity
Ceramic Works
Crushing, Grinding or Separating
Extractive Activities
Mining for Minerals

Fee Based Activity	Scale
Ceramics production	> 50000-200000 T produced
Crushing, grinding or separating	> 100000-500000 T processed
Land-based extractive activity	> 100000-500000 T extracted, processed or stored
Mining for minerals	> 100000-500000 T produced

Region
Metropolitan - Illawarra
Level 3, NSW Govt Offices, 84 Crown Street WOLLONGONG NSW 2500
Phone: (02) 4224 4100
Fax: (02) 4224 4110
PO Box 513 WOLLONGONG EAST
NSW 2520

Environment Protection Licence

Licence - 1808

Environment Protection Licence

Licence - 1808

Environment Protection Licence

Information about this licence

Dictionary

A definition of terms used in the licence can be found in the dictionary at the end of this licence.

Responsibilities of licensee

Separate to the requirements of this licence, general obligations of licensees are set out in the Protection of the Environment Operations Act 1997 ("the Act") and the Regulations made under the Act. These include obligations to:

- ensure persons associated with you comply with this licence, as set out in section 64 of the Act;
- control the pollution of waters and the pollution of air (see for example sections 120 - 132 of the Act);
- report incidents causing or threatening material environmental harm to the environment, as set out in Part 5.7 of the Act.

Variation of licence conditions

The licence holder can apply to vary the conditions of this licence. An application form for this purpose is available from the EPA.

The EPA may also vary the conditions of the licence at any time by written notice without an application being made.

Where a licence has been granted in relation to development which was assessed under the Environmental Planning and Assessment Act 1979 in accordance with the procedures applying to integrated development, the EPA may not impose conditions which are inconsistent with the development consent conditions until the licence is first reviewed under Part 3.6 of the Act.

Duration of licence

This licence will remain in force until the licence is surrendered by the licence holder or until it is suspended or revoked by the EPA or the Minister. A licence may only be surrendered with the written approval of the EPA.

Licence review

The Act requires that the EPA review your licence at least every 5 years after the issue of the licence, as set out in Part 3.6 and Schedule 5 of the Act. You will receive advance notice of the licence review.

Fees and annual return to be sent to the EPA

For each licence fee period you must pay:

- an administrative fee; and
- a load-based fee (if applicable).

Environment Protection Licence

The EPA publication “A Guide to Licensing” contains information about how to calculate your licence fees. The licence requires that an Annual Return, comprising a Statement of Compliance and a summary of any monitoring required by the licence (including the recording of complaints), be submitted to the EPA. The Annual Return must be submitted within 60 days after the end of each reporting period. See condition R1 regarding the Annual Return reporting requirements.

Usually the licence fee period is the same as the reporting period.

Transfer of licence

The licence holder can apply to transfer the licence to another person. An application form for this purpose is available from the EPA.

Public register and access to monitoring data

Part 9.5 of the Act requires the EPA to keep a public register of details and decisions of the EPA in relation to, for example:

- licence applications;
- licence conditions and variations;
- statements of compliance;
- load based licensing information; and
- load reduction agreements.

Under s320 of the Act application can be made to the EPA for access to monitoring data which has been submitted to the EPA by licensees.

This licence is issued to:

BORAL CSR BRICKS PTY LIMITED
LOCKED BAG 1345
NORTH RYDE NSW 1670

subject to the conditions which follow.

Environment Protection Licence

Licence - 1808

1 Administrative Conditions

A1 What the licence authorises and regulates

A1.1 This licence authorises the carrying out of the scheduled activities listed below at the premises specified in A2. The activities are listed according to their scheduled activity classification, fee-based activity classification and the scale of the operation.

Unless otherwise further restricted by a condition of this licence, the scale at which the activity is carried out must not exceed the maximum scale specified in this condition.

Scheduled Activity	Fee Based Activity	Scale
Ceramic Works	Ceramics production	> 50000 - 200000 T produced
Crushing, Grinding or Separating	Crushing, grinding or separating	> 100000 - 500000 T processed
Extractive Activities	Land-based extractive activity	> 100000 - 500000 T extracted, processed or stored
Mining for Minerals	Mining for minerals	> 100000 - 500000 T produced

A2 Premises or plant to which this licence applies

A2.1 The licence applies to the following premises:

Premises Details
BRINGELLY
LOT 2 GREENDALE ROAD
BRINGELLY
NSW 2556
LOT 11 DP 1125892

A3 Information supplied to the EPA

A3.1 Works and activities must be carried out in accordance with the proposal contained in the licence application, except as expressly provided by a condition of this licence.

In this condition the reference to "the licence application" includes a reference to:
a) the applications for any licences (including former pollution control approvals) which this licence replaces under the Protection of the Environment Operations (Savings and Transitional) Regulation 1998; and
b) the licence information form provided by the licensee to the EPA to assist the EPA in connection with the issuing of this licence.

2 Discharges to Air and Water and Applications to Land

P1 Location of monitoring/discharge points and areas

P1.1 The following points referred to in the table below are identified in this licence for the purposes of monitoring and/or the setting of limits for the emission of pollutants to the air from the point.

Air

EPA identification no.	Type of Monitoring Point	Type of Discharge Point	Location Description
2	Discharge to Air; Air Emissions Monitoring	Discharge to Air; Air Emissions Monitoring	Kiln exhaust stack as marked on map showing locations of discharge points submitted to the EPA with Licence Information Form dated 9/05/00.

P1.2 The following utilisation areas referred to in the table below are identified in this licence for the purposes of the monitoring and/or the setting of limits for any application of solids or liquids to the utilisation area.

P1.3 The following points referred to in the table are identified in this licence for the purposes of the monitoring and/or the setting of limits for discharges of pollutants to water from the point.

Water and land

EPA Identification no.	Type of Monitoring Point	Type of Discharge Point	Location Description
1	Discharge and Monitoring; Discharge to waters	Discharge and Monitoring; Discharge to waters	Outlet from Dam 1 on map labelled: Site Layout Plan, Figure 2, Water Management Plan dated 10.11.15 (EPA DOC15/464889-02). Discharge point is located on the NE corner of Dam 1.
5	Discharge and Monitoring; Discharge to waters	Discharge and Monitoring; Discharge to waters	Discharge from Dam 5 on map labelled: Site Layout Plan, Figure 2, Water Management Plan dated 10.11.15 (EPA DOC15/464889-02). Discharge point is located on the NW corner of Dam 5.

3 Limit Conditions

L1 Pollution of waters

L1.1 Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.

Environment Protection Licence

L2 Load limits

L2.1 The actual load of an assessable pollutant discharged from the premises during the reporting period must not exceed the load limit specified for the assessable pollutant in the table below.

L2.2 The actual load of an assessable pollutant must be calculated in accordance with the relevant load calculation protocol.

Assessable Pollutant	Load limit (kg)
Coarse Particulates (Air)	8400.00
Fine Particulates (Air)	33300.00
Fluoride (Air)	11700.00
Nitrogen Oxides - Summer (Air)	
Nitrogen Oxides (Air)	90300.00
Sulfur Oxides (Air)	186500.00

Note: An assessable pollutant is a pollutant which affects the licence fee payable for the licence.

L3 Concentration limits

L3.1 For each monitoring/discharge point or utilisation area specified in the table\s below (by a point number), the concentration of a pollutant discharged at that point, or applied to that area, must not exceed the concentration limits specified for that pollutant in the table.

L3.2 Where a pH quality limit is specified in the table, the specified percentage of samples must be within the specified ranges.

L3.3 To avoid any doubt, this condition does not authorise the pollution of waters by any pollutant other than those specified in the table\s.

L3.4 Air Concentration Limits

POINT 2

Pollutant	Units of measure	100 percentile concentration limit	Reference conditions	Oxygen correction	Averaging period
Total Solid Particles	milligrams per cubic metre	100			
Hydrogen fluoride	milligrams per cubic metre	50			
Nitrogen Oxides	milligrams per cubic metre	2000			

L3.5 Water and/or Land Concentration Limits

POINT 1

Pollutant	Units of Measure	50 percentile concentration limit	90 percentile concentration limit	3DGM concentration limit	100 percentile concentration limit
Oil and Grease	milligrams per litre				10
pH	pH				6.5-8.5
Turbidity	nephelometric turbidity units				150

POINT 5

Pollutant	Units of Measure	50 percentile concentration limit	90 percentile concentration limit	3DGM concentration limit	100 percentile concentration limit
Conductivity	microsiemens per centimetre				1450
Oil and Grease	milligrams per litre				10
pH	pH				6.5-8.5
Turbidity	nephelometric turbidity units				150

L4 Noise limits

L4.1 Noise from the mobile plant must not exceed an LA10 (15 minute) noise emission criterion of 35 dB(A) at all times.

except as expressly provided by this licence.

L4.2 Noise from the premises must not exceed an LA10 (15 minute) noise emission criterion of 35 dB(A) at all times.

except as expressly provided by this licence.

L4.3 Noise from the premises is to be measured or computed at any point within 30 metres of the most affected residence to determine compliance with condition L4.1 and L4.2. 5dB(A) must be added if the noise is tonal or impulsive in character.

Environment Protection Licence

4 Operating Conditions

O1 Activities must be carried out in a competent manner

O1.1 Licensed activities must be carried out in a competent manner.
This includes:
a) the processing, handling, movement and storage of materials and substances used to carry out the activity; and
b) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity.

O2 Maintenance of plant and equipment

O2.1 All plant and equipment installed at the premises or used in connection with the licensed activity:
a) must be maintained in a proper and efficient condition; and
b) must be operated in a proper and efficient manner.

O3 Dust

O3.1 The premises must be maintained in a condition which minimises or prevents the emission of dust from the premises.

5 Monitoring and Recording Conditions

M1 Monitoring records

M1.1 The results of any monitoring required to be conducted by this licence or a load calculation protocol must be recorded and retained as set out in this condition.

M1.2 All records required to be kept by this licence must be:
a) in a legible form, or in a form that can readily be reduced to a legible form;
b) kept for at least 4 years after the monitoring or event to which they relate took place; and
c) produced in a legible form to any authorised officer of the EPA who asks to see them.

M1.3 The following records must be kept in respect of any samples required to be collected for the purposes of this licence:
a) the date(s) on which the sample was taken;
b) the time(s) at which the sample was collected;
c) the point at which the sample was taken; and
d) the name of the person who collected the sample.

M2 Requirement to monitor concentration of pollutants discharged

M2.1 For each monitoring/discharge point or utilisation area specified below (by a point number), the licensee

must monitor (by sampling and obtaining results by analysis) the concentration of each pollutant specified in Column 1. The licensee must use the sampling method, units of measure, and sample at the frequency, specified opposite in the other columns:

M2.2 Air Monitoring Requirements

POINT 2

Pollutant	Units of measure	Frequency	Sampling Method
Hydrogen fluoride	milligrams per cubic metre	Yearly	TM-9
Nitrogen Oxides	milligrams per cubic metre	Yearly	TM-11
Total Solid Particles	milligrams per cubic metre	Yearly	TM-15

M2.3 Water and/ or Land Monitoring Requirements

POINT 1

Pollutant	Units of measure	Frequency	Sampling Method
Oil and Grease	milligrams per litre	Weekly during any discharge	Grab sample
pH	pH	Weekly during any discharge	Grab sample
Turbidity	nephelometric turbidity units	Weekly during any discharge	Grab sample

POINT 5

Pollutant	Units of measure	Frequency	Sampling Method
Conductivity	microsiemens per centimetre	<24hrs prior to discharge	Grab sample
Oil and Grease	milligrams per litre	<24hrs prior to discharge	Grab sample
pH	pH	<24hrs prior to discharge	Grab sample
Turbidity	nephelometric turbidity units	<24hrs prior to discharge	Grab sample

M3 Testing methods - concentration limits

M3.1 Monitoring for the concentration of a pollutant emitted to the air required to be conducted by this licence must be done in accordance with:
a) any methodology which is required by or under the Act to be used for the testing of the concentration of

the pollutant; or
b) if no such requirement is imposed by or under the Act, any methodology which a condition of this licence requires to be used for that testing; or
c) if no such requirement is imposed by or under the Act or by a condition of this licence, any methodology approved in writing by the EPA for the purposes of that testing prior to the testing taking place.

Note: The *Protection of the Environment Operations (Clean Air) Regulation 2010* requires testing for certain purposes to be conducted in accordance with test methods contained in the publication "Approved Methods for the Sampling and Analysis of Air Pollutants in NSW".

M3.2 Subject to any express provision to the contrary in this licence, monitoring for the concentration of a pollutant discharged to waters or applied to a utilisation area must be done in accordance with the Approved Methods Publication unless another method has been approved by the EPA in writing before any tests are conducted.

M4 Testing methods - load limits

Note: Division 3 of the *Protection of the Environment Operations (General) Regulation 2009* requires that monitoring of actual loads of assessable pollutants listed in L2.2 must be carried out in accordance with the relevant load calculation protocol set out for the fee-based activity classification listed in the Administrative Conditions of this licence.

M5 Recording of pollution complaints

M5.1 The licensee must keep a legible record of all complaints made to the licensee or any employee or agent of the licensee in relation to pollution arising from any activity to which this licence applies.

M5.2 The record must include details of the following:
a) the date and time of the complaint;
b) the method by which the complaint was made;
c) any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
d) the nature of the complaint;
e) the action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and
f) if no action was taken by the licensee, the reasons why no action was taken.

M5.3 The record of a complaint must be kept for at least 4 years after the complaint was made.

M5.4 The record must be produced to any authorised officer of the EPA who asks to see them.

M6 Telephone complaints line

M6.1 The licensee must operate during its operating hours a telephone complaints line for the purpose of receiving any complaints from members of the public in relation to activities conducted at the premises or

by the vehicle or mobile plant, unless otherwise specified in the licence.

M6.2 The licensee must notify the public of the complaints line telephone number and the fact that it is a complaints line so that the impacted community knows how to make a complaint.

M6.3 The preceding two conditions do not apply until 3 months after: the date of the issue of this licence.

6 Reporting Conditions

R1 Annual return documents

R1.1 The licensee must complete and supply to the EPA an Annual Return in the approved form comprising:
1. a Statement of Compliance,
2. a Monitoring and Complaints Summary,
3. a Statement of Compliance - Licence Conditions,
4. a Statement of Compliance - Load based Fee,
5. a Statement of Compliance - Requirement to Prepare Pollution Incident Response Management Plan,
6. a Statement of Compliance - Requirement to Publish Pollution Monitoring Data,
7. a Statement of Compliance - Environmental Management Systems and Practices; and
8. a Statement of Compliance - Environmental Improvement Works.

At the end of each reporting period, the EPA will provide to the licensee a copy of the form that must be completed and returned to the EPA.

R1.2 An Annual Return must be prepared in respect of each reporting period, except as provided below.

Note: The term "reporting period" is defined in the dictionary at the end of this licence. Do not complete the Annual Return until after the end of the reporting period.

R1.3 Where this licence is transferred from the licensee to a new licensee:
a) the transferring licensee must prepare an Annual Return for the period commencing on the first day of the reporting period and ending on the date the application for the transfer of the licence to the new licensee is granted; and
b) the new licensee must prepare an Annual Return for the period commencing on the date the application for the transfer of the licence is granted and ending on the last day of the reporting period.

Note: An application to transfer a licence must be made in the approved form for this purpose.

R1.4 Where this licence is surrendered by the licensee or revoked by the EPA or Minister, the licensee must prepare an Annual Return in respect of the period commencing on the first day of the reporting period and ending on:
a) in relation to the surrender of a licence - the date when notice in writing of approval of the surrender is given; or
b) in relation to the revocation of the licence - the date from which notice revoking the licence operates.

R1.5 The Annual Return for the reporting period must be supplied to the EPA by registered post not later than 60 days after the end of each reporting period or in the case of a transferring licence not later than 60 days after the date the transfer was granted (the 'due date').

R1.6 Where the licensee is unable to complete a part of the Annual Return by the due date because the licensee was unable to calculate the actual load of a pollutant due to circumstances beyond the licensee's control, the licensee must notify the EPA in writing as soon as practicable, and in any event not later than the due date. The notification must specify:
a) the assessable pollutants for which the actual load could not be calculated; and
b) the relevant circumstances that were beyond the control of the licensee.

R1.7 The licensee must retain a copy of the Annual Return supplied to the EPA for a period of at least 4 years after the Annual Return was due to be supplied to the EPA.

R1.8 Within the Annual Return, the Statements of Compliance must be certified and the Monitoring and Complaints Summary must be signed by:
a) the licence holder; or
b) by a person approved in writing by the EPA to sign on behalf of the licence holder.

R2 Notification of environmental harm

R2.1 Notifications must be made by telephoning the Environment Line service on 131 555.

R2.2 The licensee must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred.

Note: The licensee or its employees must notify all relevant authorities of incidents causing or threatening material harm to the environment immediately after the person becomes aware of the incident in accordance with the requirements of Part 5.7 of the Act.

R3 Written report

R3.1 Where an authorised officer of the EPA suspects on reasonable grounds that:
a) where this licence applies to premises, an event has occurred at the premises; or
b) where this licence applies to vehicles or mobile plant, an event has occurred in connection with the carrying out of the activities authorised by this licence,
and the event has caused, is causing or is likely to cause material harm to the environment (whether the harm occurs on or off premises to which the licence applies), the authorised officer may request a written report of the event.

R3.2 The licensee must make all reasonable inquiries in relation to the event and supply the report to the EPA within such time as may be specified in the request.

R3.3 The request may require a report which includes any or all of the following information:
a) the cause, time and duration of the event;
b) the type, volume and concentration of every pollutant discharged as a result of the event;
c) the name, address and business hours telephone number of employees or agents of the licensee, or a specified class of them, who witnessed the event;
d) the name, address and business hours telephone number of every other person (of whom the licensee is aware) who witnessed the event, unless the licensee has been unable to obtain that information after making reasonable effort;

e) action taken by the licensee in relation to the event, including any follow-up contact with any complainants;
f) details of any measure taken or proposed to be taken to prevent or mitigate against a recurrence of such an event; and
g) any other relevant matters.

R3.4 The EPA may make a written request for further details in relation to any of the above matters if it is not satisfied with the report provided by the licensee. The licensee must provide such further details to the EPA within the time specified in the request.

7 General Conditions

G1 Copy of licence kept at the premises or plant

G1.1 A copy of this licence must be kept at the premises to which the licence applies.

G1.2 The licence must be produced to any authorised officer of the EPA who asks to see it.

G1.3 The licence must be available for inspection by any employee or agent of the licensee working at the premises.

G2 Other general conditions

G2.1 **Completed Programs**

PRP	Description	Completed Date
PRP 1 - WATER MONITORING PROGRAM	Water monitoring program for conductivity in discharges into Thompsons Creek from Licensed Discharge Point 4.	30-May-2014
PRP 2 - WATER MANAGEMENT PLAN	Protect and reduce the impact on Thompsons Creek by preparing a Water Management Plan (WMP) which outlines options to improve on site water management and reduce pollutant loads discharged from the site to Thompsons Creek.	13-November-2015

8 Special Conditions

E1 Summary Table of Special Conditions Completed

E1.1

Environment Protection Licence

Licence - 1808

No.	Special Condition	Description	Completed Date
1	Water Quality	To submit a report confirming details of all surface water; process water and effluent management systems; all existing sedimentation controls; modifications required; and timetable for implementation.	1 Nov 2002
2	Surface water management options	To submit a report on the best utilisation of water from dams 5 & 6.	1 Mar 2005

Environment Protection Licence

Licence - 1808

Dictionary

General Dictionary

3DGM [in relation to a concentration limit]	Means the three day geometric mean, which is calculated by multiplying the results of the analysis of three samples collected on consecutive days and then taking the cubed root of that amount. Where one or more of the samples is zero or below the detection limit for the analysis, then 1 or the detection limit respectively should be used in place of those samples
Act	Means the Protection of the Environment Operations Act 1997
activity	Means a scheduled or non-scheduled activity within the meaning of the Protection of the Environment Operations Act 1997
actual load	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
AM	Together with a number, means an ambient air monitoring method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.
AMG	Australian Map Grid
anniversary date	The anniversary date is the anniversary each year of the date of issue of the licence. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
annual return	Is defined in R1.1
Approved Methods Publication	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
assessable pollutants	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
BOD	Means biochemical oxygen demand
CEM	Together with a number, means a continuous emission monitoring method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.
COD	Means chemical oxygen demand
composite sample	Unless otherwise specifically approved in writing by the EPA, a sample consisting of 24 individual samples collected at hourly intervals and each having an equivalent volume.
cond.	Means conductivity
environment	Has the same meaning as in the Protection of the Environment Operations Act 1997
environment protection legislation	Has the same meaning as in the Protection of the Environment Administration Act 1991
EPA	Means Environment Protection Authority of New South Wales.
fee-based activity classification	Means the numbered short descriptions in Schedule 1 of the Protection of the Environment Operations (General) Regulation 2009.
general solid waste (non-putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997

Environment Protection Licence

Licence - 1808

flow weighted composite sample	Means a sample whose composites are sized in proportion to the flow at each composites time of collection.
general solid waste (putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environmen t Operations Act 1997
grab sample	Means a single sample taken at a point at a single time
hazardous waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
licensee	Means the licence holder describe d at the front of this licence
load calculation protocol	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
local authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
material harm	Has the same meaning as in section 147 Protection of the Environment Operations Act 1997
MBAS	Means methylene blue active substances
Minister	Means the Minister administering the Protection of the Environment Operations Act 1997
mobile plant	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
motor vehicle	Has the same meaning as in the Protection of the Environment Operations Act 1997
O&G	Means oil and grease
percentile [in relation to a concentration limit of a sample]	Means that percentage [eg.50%] of the number of samples taken that must meet the concentration limit specified in the licence for that pollutant over a specified period of time. In this licence, the specified period of time is the Reporting Period unless otherwise stated in this licence.
plant	Includes all plant within the meaning of the Protection of the Environment Operations Act 1997 as well as motor vehicles.
pollution of waters [or water pollution]	Has the same meaning as in the Protection of the Environment Operations Act 1997
premises	Means the premises described in condition A2.1
public authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
regional office	Means the relevant EPA office referred to in the Contacting the EPA document accompanying this licence
reporting period	For the purposes of this licence, the reporting period means the period of 12 months after the issue of the licence, and each subsequent period of 12 mo nths. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
restricted solid waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
scheduled activity	Means an activity listed in Schedule 1 of the Protection of the Environment Operations Act 1997
special waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
TM	Together with a number, means a test method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.

Environment Protection Licence

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TSP	Means total suspended particles
TSS	Means total suspended solids
Type 1 substance	Means the elements antimony, arsenic, cadmium, lead or mercury or any compound containing one or more of those elements
Type 2 substance	Means the elements beryllium, chromium, cobalt, manganese, nickel, selenium, tin or vanadium or any compound containing one or more of those elements
utilisation area	Means any area shown as a utilisation area on a map submitted with the application for this licence
waste	Has the same meaning as in the Protection of the Environment Operations Act 1997
waste type	Means liquid, restricted solid waste, general solid waste (putrescible), general solid waste (non-putrescible), special waste or hazardous waste

Ms Nadia Kanhoush

Environment Protection Authority

(By Delegation)

Date of this edition: 10-August-2000

Environment Protection Licence

Licence - 1808

End Notes

1	Licence varied by Change of contact details, issued on 20-Nov-2001, which came into effect on 20-Nov-2001.
2	Licence varied by notice 1016336, issued on 27-Jun-2002, which came into effect on 22-Jul-2002.
3	Licence varied by notice 1040220, issued on 23-Sep-2004, which came into effect on 18-Oct-2004.
4	Licence varied by notice 1043879, issued on 21-Jan-2005, which came into effect on 15-Feb-2005.
5	Licence varied by notice 1051526, issued on 05-Sep-2005, which came into effect on 30-Sep-2005.
6	Licence varied by notice 1062983, issued on 28-Aug-2006, which came into effect on 28-Aug-2006.
7	Licence varied by change to legislation, issued on 06-Jul-2007, which came into effect on 06-Jul-2007.
8	Licence varied by notice 1076143, issued on 19-Sep-2007, which came into effect on 19-Sep-2007.
9	Licence varied by notice 1079902, issued on 15-Nov-2007, which came into effect on 15-Nov-2007.
10	Condition A1.3 Not applicable varied by notice issued on <issue date> which came into effect on <effective date>
11	Licence varied by change to FBA for summer pollutants, issued on 16-Jan-2009, which came into effect on 16-Jan-2009.
12	Licence varied by notice 1503297 issued on 23-Jan-2012
13	Licence varied by notice 1510257 issued on 06-Feb-2013
14	Licence varied by notice 1520429 issued on 20-May-2014
15	Licence varied by notice 1524516 issued on 28-Aug-2014
16	Licence transferred through application 1530191 approved on 04-May-2015 , which came into effect on 04-May-2015
17	Licence format updated on 04-May-2015
18	Licence format updated on 05-May-2015
19	Licence varied by notice 1536325 issued on 04-Mar-2016

Appendix D: Monthly Stormwater Management System Inspection Checklist

BRINGELLY STORMWATER MANAGEMENT SYSTEM INSPECTION - MONTHLY

DATE: _____ COMPLETED BY: _____ Report non-conformances to Plant Manager

AREA	ITEM	Y or N	COMMENT
Dam 1	Dam wall intact		
	Water level lower than Power Pole		
	Pump tested OK		
Flow from North West Stockpile Area to Dam 1	Drain-ways intact		
	Flow controls intact		
Quarry	Flow diversions around top of South, West and North walls intact		
	Pump tested OK		
	Water truck filling station OK		
	Water level contained within sump		
Dam 4	Dam walls intact		
	South West inlet from Stockpile Area flow controls intact		
	Dam depth > 1 m		
Dam 5	Dam walls intact		
	Emergency overflow at North West corner intact		
	South East inlet from Stockpile Area flow controls intact		
	Dam depth > 1 m		
	Pump tested OK		
	Flocculent dosing pump tested OK		
	Stock of Flocculent > 1 IBC		

Appendix E: Kleinfelder EPL Letter and Monitoring Results

Kleinfelder Australia Pty Ltd
ABN: 23 146 082 500
Level 1, 95 Coventry Street
South Melbourne VIC 3205
T| 03 9907 6000 **F|** 03 9907 6090
www.kleinfelder.com/australia

13 November 2015

20154511.001A/Bringelly/MLB15L30155

NSW EPA C/O
Boral CSR Bricks Pty Ltd,
Lot 2, Greendale Road,
Bringelly, NSW 2556

Attention: Michal Gow

Email: Michael.Gow@boral.com.au

Subject: **Proposed License Amendments**
Boral Bricks Bringelly
Lot 2, Greendale Road
Bringelly, NSW 2556

On behalf of Boral CSR Bricks Pty Ltd (Boral/CSR) Kleinfelder Australia Pty Ltd (Kleinfelder) is pleased to provide the New South Wales Environment Protection Authority (NSW EPA) with a letter to complement the Water Management Plan (WMP) for the Boral Bricks Bringelly site, previously provided to Boral/CSR on 27 August 2015. Refer to **Figure 1** for location and **Figure 2** for the site layout.

The NSW EPA required Boral/CSR to prepare a WMP, the objective of which, was to specifically address the requirements in Section 8 of License 1808 ("*Pollution Studies and Reduction Programs*)" issued by NSW EPA on 28 August 2014.

During the preparation of the WMP and discussions with the EPA, Boral/CSR are seeking to make the following five amendments to their License:

1. **It is proposed to adjust the sampling frequency of Dam 1 – Licensed Discharge Point 5 (LDP5) from daily to weekly.**

Justification: This sampling frequency would be consistent with the frequency for LDP 4. Monitoring of this discharge point does not indicate any exceedances of the discharge licence and discharge from this point is relatively low with regard to volume. This monitoring regime is considered to remain protective of the surrounding environment.

2. **It is proposed to transfer the licenced discharge compliance point from Dam 6 (LDP 4) outlet to Dam 5 outlet.**

Justification: The Dam 5 outlet is within Boral/CSR's property and all inflows are under their control. LDP4 includes flow from a greater catchment including areas not owned by Boral/CSR and therefore out of their control.

3. **It is proposed to amend the nomenclature of:**

    - LDP 5 to LDP 1. (Discharge from dam 1);
    - LDP 4 to LDP 5. (Discharge from dam 5); and
    - Naming of kiln exhaust stack LDP 2.

Justification: Amending the nomenclature of the LDP's to correlate with Dam numbering at the site for simplicity.

4. **Amending the discharge limit for conductivity from 700 uS/cm to 2,200 uS/cm.**

Justification: To reflect background levels within the receiving environment. Appendix A attached provides a more detailed justification.

5. **Removal of Total Suspended Solids from the licensed discharge requirements.**

Justification: The Total Suspended Solids is considered to be a duplication of the Turbidity measure, which will be used as a surrogate measurement during site monitoring. All other pollutants can be measured on site, and this will allow for more efficient monitoring.

Based on the Kleinfelder WMP and the assumption that the proposed amendments listed above are accepted, Boral/CSR have prepared a Water Management Procedure which outlines how future water monitoring and treatment will be undertaken. This procedure is attached as **Appendix B**. It is noted that the document references a monthly inspection form and some sub-procedures 130.1, 130.2 and 130.3. These portions are under development and will be completed by the 11th of December 2015. Desilting of Treatment Dam 4 is scheduled to be completed by the 30th June 2016.

If you require additional information or clarification, please contact the undersigned at (03) 9907 6000.

Sincerely,
Kleinfelder Australia Pty Ltd

Tim Robson
Hydrogeologist

Jeremy Newstead
Associate Engineer

ATTACHMENTS

Figures

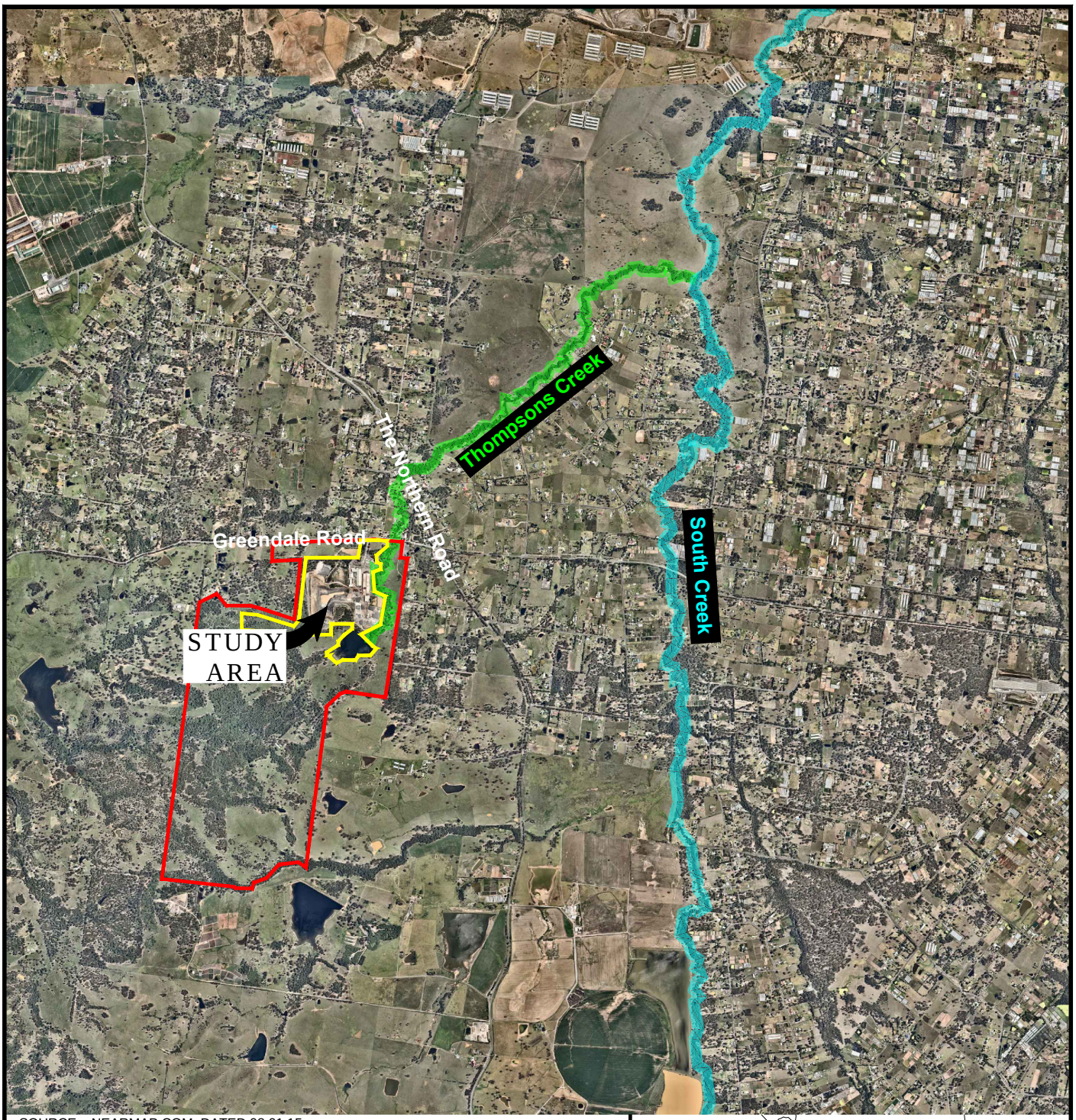
Figure 1 – Site Location Plan

Figure 2 – Site Layout Plan

Appendices

Appendix A: Conductivity Justification
Appendix B: Boral/CSR Water Management Procedure
Appendix C: Limitations

FIGURES



SOURCE: NEARMAP.COM, DATED 08.01.15

LEGEND

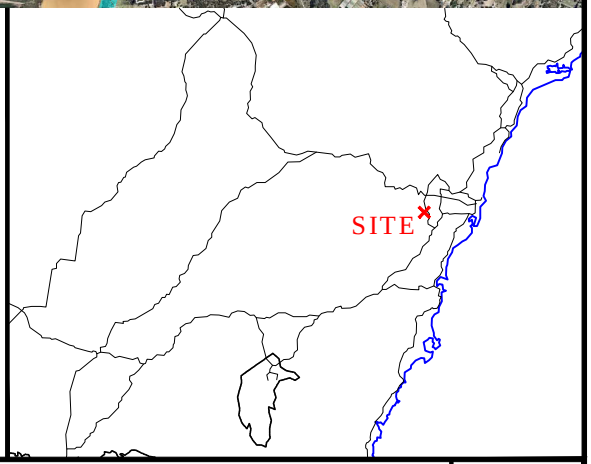
PROPERTY BOUNDARY

STUDY AREA

0 500 1,000 1,500 2,000 2,500

SCALE 1:50000 (A3) METRES

N



KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT:	20154511.001A
DATE DRAWN:	10.11.15
DRAWN BY:	LZ
CHECKED BY:	TR
FILE NAME:	20154511.001A-2.dwg

SITE LOCATION PLAN

WATER MANAGEMENT PLAN

LOT 2 GREENDALE ROAD
BRINGELLY, NSW

FIGURE
1

PLOTTED: 10-Nov-2015, 04:15PM , lziemelis
ATTACHED IMAGES: "region.jpg" "site.jpg" "site 2.jpg"
CAD FILE: O:\09_Projects\DELTEK Projects\Regular\2015\20154511.001A Boral Bringelly\Figures LAYOUT: 1
MELBOURNE, AU

LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- (1) BRICK MAKING FACILITY
- (2) CLAY PREPARATION BUILDING
- (3) BOX FEEDER
- (4) BRICK STORAGE AREA
- (5) CAR PARK
- (6) GATEHOUSE
- (7) BRICK STORAGE AREA
- (8) DAM 1
- (9) DAM 2
- (10) QUARRY PIT SUMP
- (11) DAM 4
- (12) DAM 5
- (13) DAM 6 (THOMPSONS CREEK DAM)
- (14) SOUTHERN STOCKPILES
- (15) NORTHERN STOCKPILE
- (16) WESTERN STOCKPILE 1
- (17) WESTERN STOCKPILE 2

N

NOTE: ALL LOCATIONS ARE APPROXIMATE.
DIMENSIONS IN METRES (m).

0 40 80 120 160 200
SCALE 1:4000 (A3) METRES

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PROJECT:	20154511.001A
DATE DRAWN:	10.11.15
DRAWN BY:	LZ
CHECKED BY:	TR
FILE NAME:	20154511.001A-2.dwg

SITE LAYOUT PLAN

WATER MANAGEMENT PLAN

LOT 2 GREENDALE ROAD
BRINGELLY, NSW

FIGURE
2

PLOTTED: 10-Nov-2015, 04:15PM, lziemelis

ATTACHED IMAGES: "region.jpg" "site.jpg" "site 2.jpg"
CAD FILE: O:\09_Projects\DELTEK Projects\Regular\2015\20154511.001A Boral Bringelly\Figures LAYOUT: 2
MELBOURNE, AU

APPENDIX A: CONDUCTIVITY JUSTIFICATION

During preparation of the WMP, which included a review of recent water data, Kleinfelder considered that the upper conductivity limit (i.e. 700 uS/cm) was unlikely to be representative of regional conditions. Subsequently, in order to propose a variation to the conductivity limit Kleinfelder have prepared this letter. This letter summarises the historical monitoring results and provides the results of a desktop study used to support a proposed revision to the upper limit for conductivity.

Kleinfelder note that Boral Licence 1808 currently identifies two discharge points, specifically:

- Dam 1 outlet (Licensed Discharged Point 5 or LDP5).
- Dam 6 outlet (Licensed Discharged Point 4 or LDP4).

Summary of Monitoring Data

This justification for conductivity limit references Kleinfelder's WMP. It is recommended that the WMP is read in conjunction with this letter.

On Site Conductivity Values

Conductivity values at the Dam 1 outlet (LDP5) range from 480 to 610 uS/cm and are below the licence criteria of 700 uS/cm.

Conductivity values at the Dam 6 outlet (LDP4) range from 850 to 1,120 uS/cm. Since November 2014, the values have consistently exceeded the licence criteria of 700 uS/cm.

Conductivity values measured across the site in the quarry pit, Dam 4 and Dam 5 are consistent with values measured at the Dam 6.

Off Site Conductivity Values

Thompsons Creek (which is the receiving water body of the site) travels approximately 4 km northeast before joining as a tributary to South Creek (which runs parallel to the site approximately 2.5 km to the east). Conductivity values measured in South Creek were between 2,700 uS/cm and 2,900 uS/cm. The South Creek sampling location is considered to be representative of regional creek conditions.

Conductivity values measured upstream of Dam 6 (onsite) were between 800 and 1,200 uS/cm[1]. It is noted that a review of the cation and anion distribution (via piper plot analysis) indicates that the water monitored across the majority of the site (including quarry pit water, the water that passes through Boral/CSR's treatment dams and the Dam 5 discharge point) are indicative of a similar water type. This water also correlates to the water monitored within surrounding waterways (i.e. Thompsons and South Creek) all of which are sodium-chloride types and typical of rainwater.

Background Conditions

Kleinfelder consider that it is reasonable to assume that the water at Dam 6 upstream and South Creek represent regional conductivity conditions for the following reasons:

- The catchment area of Dam 6 is relatively undisturbed (i.e. particularly by onsite activities), the catchment land being used for grazing purposes.

- The source of South Creek is approximately 6 km upstream of the sampling point and flows through pasture lands and regions of urban development. In 2002, the then Department of Infrastructure, Planning and Natural Resources mapped the salinity hazards in Western Sydney. It was reported that *"Bringelly road crosses land that has moderate to high salinity potential or areas where salinity issues are known"* (Source: "*Bringelly Road upgrade, Review of Environmental factors*", Road and Maritime Services, New South Wales Government). Areas of known salinity are located where South Creek crosses below Bringelly Road. High potential for salinity also occurs at Kemps Creek and Bonds Creek as these areas have similar conditions to those areas where salinity is present. The rest of the site is located in areas of moderate salinity potential.

Criteria Discussion

The Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines use salinity or electrical conductivity (EC) guidelines to describe conductivity. The ANZECC guidelines segregate flowing waterways into lowland and upland rivers based on altitude whereby upland rivers are defined as >150m altitude. The site is at an altitude of approximately 100 m and the surrounding receiving rivers are below this level. As such, the site and surrounds are considered to fall within the lowland river ecosystem. The ANZECC default salinity guidelines for protection of ecosystems in south east Australia are between 125 to 2,200 uS/cm for lowland rivers (Table 3.3.3 of ANZECC 2000). The range in these default

[1] One value of 550 uS/cm observed at Dam 6 upstream station is considered an outlier.

guidelines and lack of specificity as to their application makes it difficult to nominate a criterion for a site.

In NSW, the ANZECC guidelines (2000) are widely used for environmental assessment and reporting by a variety of organisations. However, it is considered more accurate to assess local waterway quality with consideration of the default ANZECC guideline range. A review of localised water quality monitoring data assists in demonstrating whether the condition of the waterway is at the lower or higher end of the default ANZECC guideline range.

Furthermore, the regions within the ANZECC guidelines are geographically expansive and geologically complex. The default guideline for south-east Australia applies to the Murray Darling Basin through to the small coastal tributaries of the Sydney Basin. Major differences in water geochemistry occur across this vast area (Hart & McKelvie, 1986). This requires the default water quality values to be sufficiently flexible to incorporate a wide range of biological or geophysical difference which the default ANZECC guideline range have attempted to encompass and likely reflect.

The ANZECC framework encourages the development of region/catchment specific guidelines to better reflect local conditions. The ANZECC guidelines (2000) outline the approach necessary to develop locally derived water quality guidelines and also to incorporate biological assessment of waterways into monitoring programs. This is in line with Section 8 of Boral license 1808 which stipulates: "[…] *provide additional conductivity data that could be used to review the conductivity limits at LDP4 (Dam 6*)".

Due to the local variability in conductivity results (as discussed above), Kleinfelder have proposed to develop a site specific conductivity value (discussed below) that more accurately reflects that site's likely conductivity contribution based on local waterway data and background conditions.

Proposed Conductivity Limit

Based on available data, Kleinfelder considers that the current Boral license discharge limit for conductivity of 700 uS/cm does not reflect the conductivity quality within local waterways. Data from South Creek indicates background concentrations are as high as 2,900 uS/cm. Data upstream of Dam 6 are as high as 1,200 uS/cm.

Kleinfelder propose a revised discharge limit for the upper limit of conductivity of 2,200 uS/cm. This discharge limit is based on the upper end of the ANZECC 2000 range for lowland rivers with consideration also given to the peak concentration recorded in South Creek (which has been used as an indication of background/natural conditions).

APPENDIX B: BORAL/CSR WATER MANAGEMENT PROCEDURE

1. OBJECTIVE

Under the Protection of the Environment Operations Act 1997 ("the Act") and the Regulations made under the Act, PGH Bricks & Pavers Bringelly must control the pollution of waters. The objective of this plan is to define the methods that will improve on site water management and reduce pollutant loads discharged from the site to Thompsons Creek.

2. BACKGROUND AND SCOPE

Refer to the Water Management Plan for a detailed description of the storm water catchment on the site.

Under the site's Environment Protection Licence (#1808) discharge is permitted with limits for discharges of pollutants to water as follows:

EPA Identification Number	Type of monitoring point	Type of discharge point	Location description
1	Discharge to waters and effluent quality monitoring	Discharge to waters and effluent quality monitoring	Outlet from Dam 1
5	Discharge to waters and effluent quality monitoring	Discharge to waters and effluent quality monitoring	Discharge Pump Intake from Dam 5

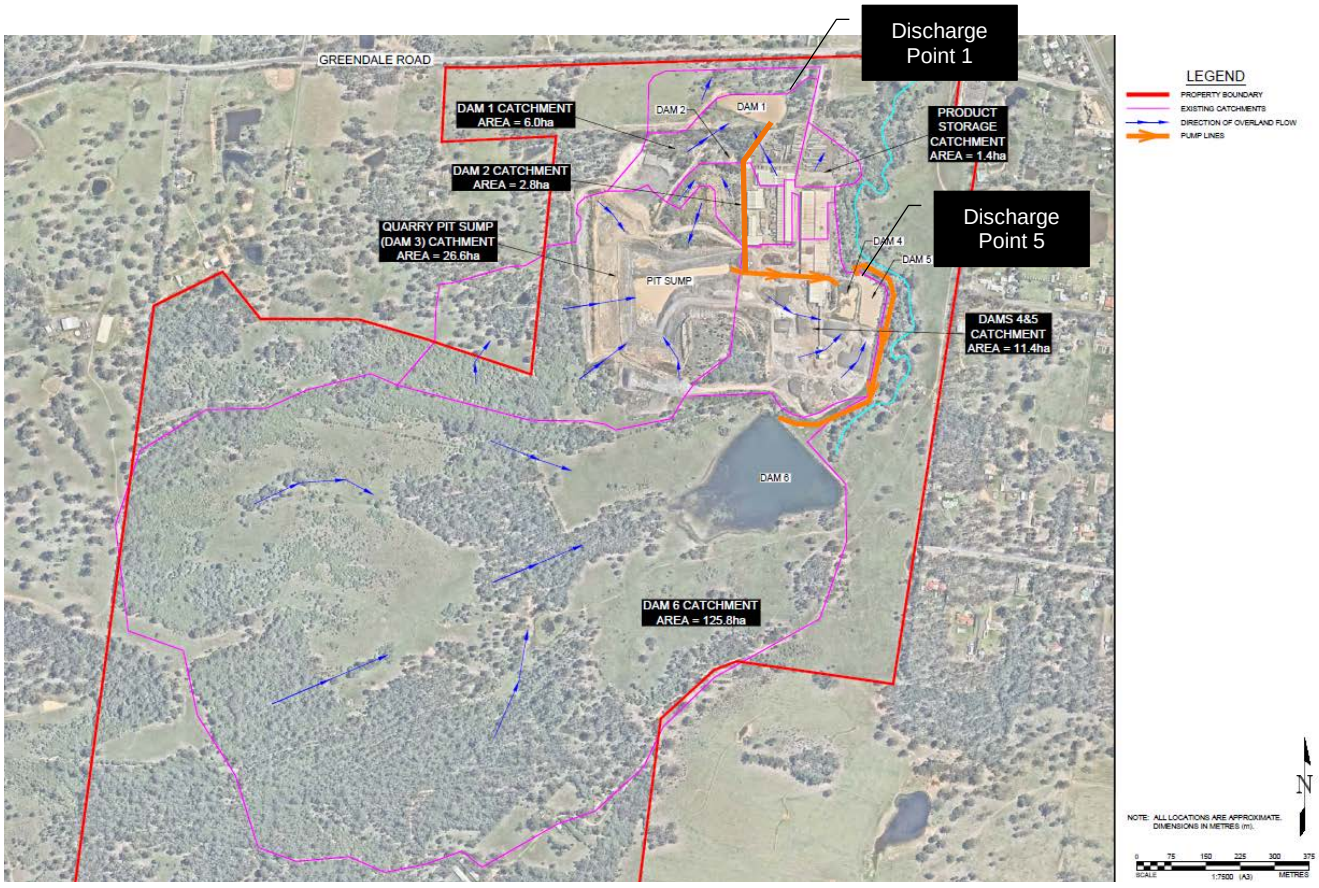

Figure 1 – Licenced Discharge Points

The water pollutant limits are as follows:

Pollutant	Units of measure	100 percentile concentration limit	
		Point 1	Point 5
Conductivity	Microsiemens per centimetre	2,200	2,200
Oil & Grease	milligrams per litre	10	10
pH	pH	6.5 – 8.5	6.5 – 8.5
Turbidity	nephelometric turbidity units	150	150

This Water Management Plan will describe the methods for storm water control and maintenance, water transfer, water treatment, water testing, calibration of testing devices and recording & reporting.

3. STORM WATER CONTROLS & MAINTENANCE

Soil erosion, sediment and drainage control measures shall be used throughout the site to control the migration of sediment downstream as follows:

- Water transfer and treatment is minimised through the use of a water truck for site dust suppression
- Exposed surfaces will be minimised to necessary mining areas only
- Divert flows away from disturbed surfaces where possible. This is particularly critical around the Southern, Western and Northern perimeter of the Quarry, and the flow from the Quarry toward Dam 1
- Stabilise un-used exposed areas with seeding, mulching, geotextiles
- Maintain rip-rap stabilisation (broken brick), or textile wrapped hay bales in flow areas and unvegetated drains
- Dam 5 has an emergency overflow with rip-rap stabilisation at the Northern end to accommodate emergency discharge during very heavy rain events

All storm water controls are to be inspected monthly and repaired when found to be heavily silted or ineffective. Inspections are to be recorded at [P:\003 Operations\Enviromental\Water Testing\Storm Water Inspections].

4. STORM WATER TRANSFER

The Water Trucks can be filled from the Quarry Pump diversion or the Dam 5 Discharge Pump.

Dam 1 and Treatment Dams 4 and 5 shall always be emptied to their lowest level in readiness for future inflows, particularly heavy rain events.

Transfer of water from the Quarry to Dam 4 shall commence at least six (6) weeks prior to a mining campaign. This will ensure sufficient time for emptying, treatment and drying out of the Quarry floor and sump. Efforts shall be made to contain storm water within the Quarry sump to avoid silt depositing on the Quarry benches.

If testing confirms the water quality in Dam 1 at the outlet is within the limits specified in Table 2 overflow is permitted. The testing shall be repeated four (4) times per calendar month whilst discharging. Where sampling indicates limits have been exceeded, water shall be pumped to Treatment Dams 4 and 5 for treatment prior to discharge.

Dam 5 shall only be discharged to Dam 6 when the water quality at the outlet is within the limits specified in Table 2. Testing must be repeated 4 times per calendar month whilst discharging.

5. STORM WATER TREATMENT

The controls implemented in sections 3 and 4 ensure that limits for pH, conductivity and oil & grease can be achieved. Due to loading with sediment during flow into the Quarry, storm water can require treatment for turbidity to ensure compliance prior to discharge. Turbidity is treated using the following method (refer to Figure 2):

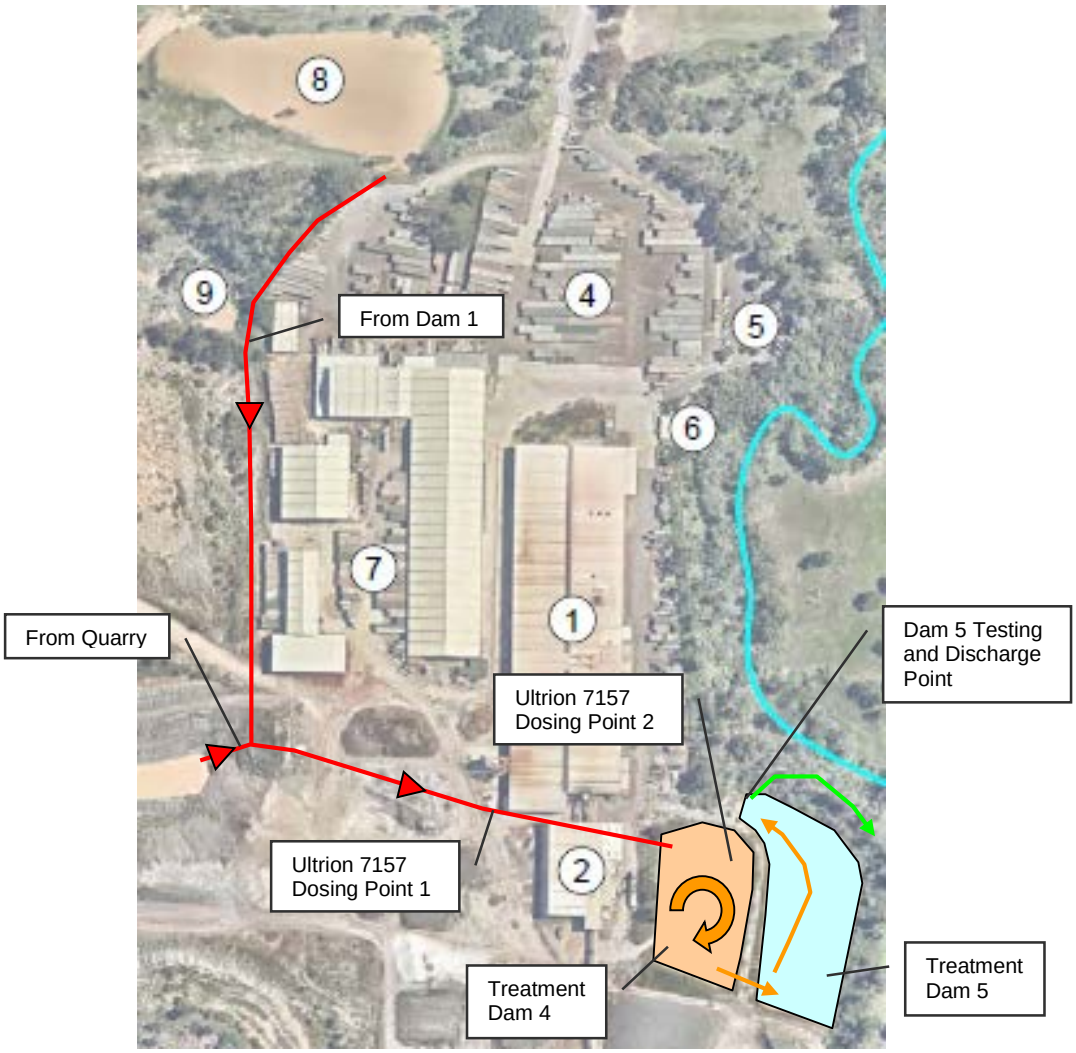

Figure 2 – Turbidity Treatment System

- Storm water is pumped from the Quarry or Dam 1 to Treatment Dam 4
- A flocculent additive, Nalco Ultrion 7157, is dosed at a rate of 200 mL/min into:
  - i. Dosing Point 1 - storm water grate at the South Western corner of the Plant near the Scrubber; or
  - ii. Dosing Point 2 - inlet of the Treatment Dams Pump in Dam 4
- Operation of the Dosing Pump is described in BRI-BRSOP-130.1 Flocculent Dosing Pump
- Depending on the most suitable method for the prevailing conditions, water can then be:
  - i. Allowed to flow naturally from Dam 4 to Dam 5
  - ii. Recycled through Dam 4 before transfer to Dam 5 using the Treatment Dams Pump

iii. Pumped directly from Dam 4 to Dam 5

- Dam 5 has a primary sedimentation trap which overflows rip-rap into a secondary sedimentation trap and then into a discharge sump

Figure 3 – Treatment Dam 5 Sedimentation Stages

- After treatment the water at the inlet to the Treatment Dam Pump in Dam 5 is tested for turbidity and other concentration limits. When results are below the concentration limit, the water can be discharged to Dam 6

This method has proven effective for achieving suitable turbidity levels.

Treatment Dams 4 and 5 shall be maintained with depths greater than 1 m to ensure sufficient residence time for sedimentation. The Dams must be de-silted periodically as depths diminish to less than 1 m, as verified during the monthly inspections.

6. STORM WATER SAMPLING AND ANALYSIS

Storm water must be sampled at Licenced Discharge Points 1 and 5 according to the following condition in line with the Environment Protection Licence 1808:

- the collection of samples shall occur within one hour after the commencement of each discharge and at least four samples per calendar month in the case of frequent discharges.

Samples must be analysed for pH, conductivity, turbidity and oil & grease using the following methods.

6.1 pH and Conductivity

pH and Conductivity are measured using the TPS WP81 pH and Conductivity Meter. The TPS WP81 pH and Conductivity Meter should be calibrated weekly prior to measurement. Refer to BRI-BRSOP-130.2 pH and Conductivity Meter for instructions on calibration and testing. Record results at [P:\003 Operations\Enviromental\Water Testing\EPL Water Testing Results Database.xls].

6.2 Turbidity

Turbidity is measured using the TPS WP88 Turbidity Meter. The TPS WP88 Turbidity Meter should be calibrated when a " * " replaces the decimal point on the digital display of the meter. Refer to BRI-BRSOP-130.3 Turbidity Meter for instructions on calibration and testing. Record results at [P:\003 Operations\Enviromental\Water Testing\EPL Water Testing Results Database.xls].

6.3 Oil & Grease

The routine test for Oil & Grease is a visual check. No evidence of Oil & Grease is considered to be <10 mg/L. If Oil & Grease is detected at the sampling point, water from the point is to be sampled into an amber glass sampling jar

from ALS Enviro, packed with ice into an esky for dispatch to ALS for analysis. Include a Chain of Custody document stored at [P:\003 Operations\Enviromental\Water Testing\Past COC Records]. Call 02 8784 8555 for pick up.

7. REPORTING

1. Results are to be updated monthly on the company's environmental website.

2. Any exceedances of concentration limits are to be reported to the EPA via PGH's National WHSE Manager via email as soon as possible.

3. A summary of results and exceedances is reported annually with the Environment Protection Licence Annual Return.

Skills & Knowledge Assessment			
Practical	*Operator must obtain **100%** on practical assessment & **80%** on theory assessment to be deemed competent*	**Competent**	**Not Comp.**
Correct PPE identified and used			
Demonstrate competence as per Work Instruction Storm Water Inspection, BRI-BRSOP-130.1 Flocculent Dosing Pump, BRI-BRSOP-130.2 pH and Conductivity, Refer BRI-BRSOP-130.3 Turbidity Meter (tick each step on work instruction and attach)			
Theory		**Competent**	**Not Comp.**
1. What are the four pollutants that must be analysed? Response:			
2. When do the pollutants need to be analysed? Response:			
3. How often does the pH & Conductivity Meter need to be calibrated? Response:			
4. When does the Turbidity Meter need to be calibrated? Response:			
5. How often is the Storm Water Management System inspected? Response:			
6. Describe two methods of keeping storm water clean. Response:			
7. What chemical is used for improving turbidity? At what addition rate? Response:			
8. How is 'Oil & Grease' assessed? Response:			
9. Who do we report to in the event of an exceedance? Response:			
Practical Assessment 100% Yes / No		Theory Assessment ≥80% Yes / No	
Overall Assessment: Competent / Not Yet Competent (NYC)			

Both Practical and Theoretical Assessments were undertaken by the named operator for the work instruction so named above; the operator agrees they have had sufficient time to become familiar with the task and have been advised of the result of the assessment. The assessor has been deemed competent to assess under an internal CSR B&R program.

Operator Name:	Operator Signature:
Assessor; Co-assessor Name/s:	Assessor; Co-assessor Signature/s:
Date Assessed:	Date for re-assessment if NYC: 2 weeks after initial assessment
Supervisors Name:	Supervisors Signature:

Questions for Assessors to ask Operator (from previous page)

1. What are the four pollutants that must be analysed?
2. When do the pollutants need to be analysed?
3. How often does the pH & Conductivity Meter need to be calibrated?
4. When does the Turbidity Meter need to be calibrated?
5. How often is the Storm Water Management System inspected?
6. Describe two methods of keeping storm water clean.
7. What chemical is used for improving turbidity? At what addition rate?
8. How is 'Oil & Grease' assessed?
9. Who do we report to in the event of an exceedance?

Suggested Response:

1. pH, conductivity, turbidity and oil & grease
2. Within 1 hour of commencement of discharge, 4 times per calendar month when discharging
3. Weekly
4. When the decimal point is showing as a " * "
5. Monthly
6. Use storm water in the water truck; Minimise exposed areas; Divert flows away from exposed areas; stabilise unused areas; stabilise over-flows and drains
7. Nalco Ultrion 7157 at 200 mL/min
8. Visual. Send for analysis if present.
9. PGH National WHSE Manager who will report to the EPA

APPENDIX C: LIMITATIONS

LIMITATIONS

The findings and conclusions contained within this report are made following a review of information, reports, correspondence and data previously reported by third parties. Kleinfelder does not provide guarantees or assurances regarding the accuracy and validity of information and data obtained by third parties in previously commissioned investigations. The conclusions presented in this report are relevant to the conditions of the site and the state of legislation currently enacted as at the date of this report.

Kleinfelder has used a degree of skill and care ordinarily exercised by reputable members of our profession practicing in the same or similar locality.

Kleinfelder does not make any representation or warranty that the conclusions in this report will be applicable in the future as there may be changes in the condition of the site, applicable legislation or other factors that would affect the conclusions contained in this report.

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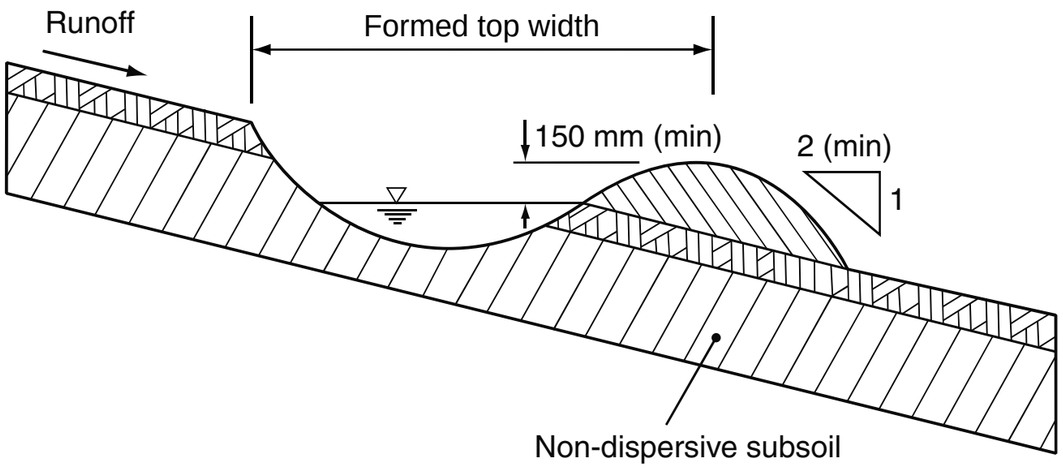
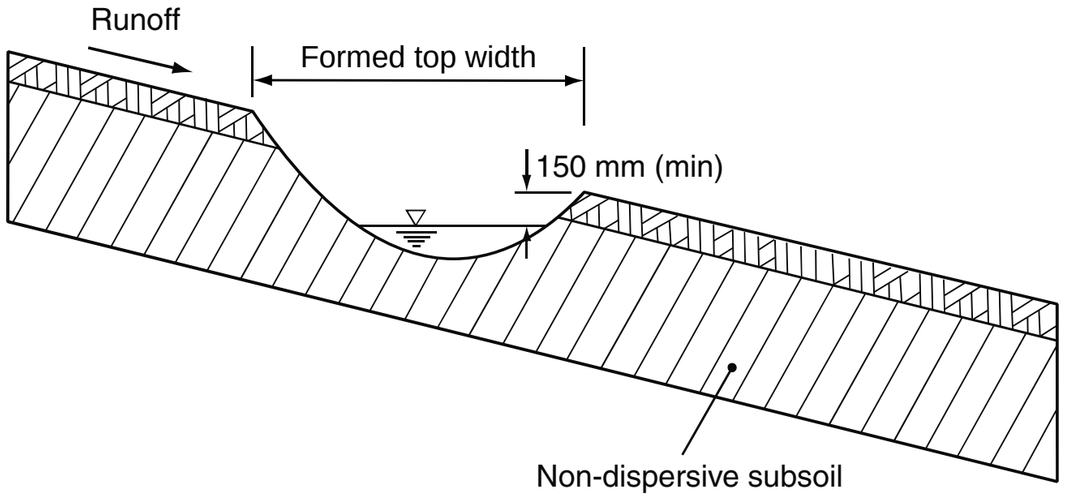
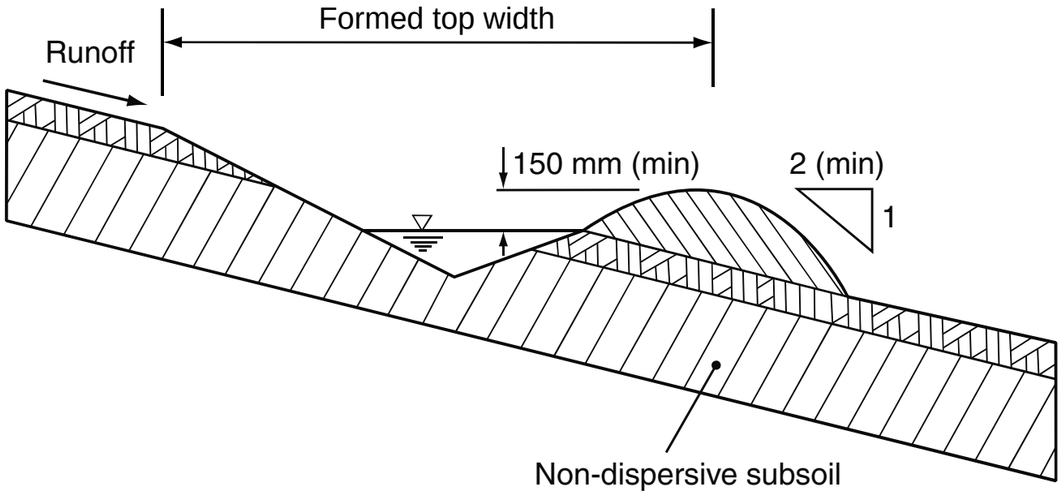
Appendix F: Blue Book Standard Drawings



(a) Parabolic catch drain with down-slope bank



(c) Parabolic catch drain without bank



(b) Triangular V-drain with down-slope bank

Constructed dimensions of parabolic catch drains		
Drain type	Formed top width with or without bank	Formed depth with or without bank
Type-A	1.6 m	0.30 m
Type-B	2.4 m	0.45 m
Type-C	3.6 m	0.65 m

Constructed dimensions of triangular V-drains		
Drain type	Formed top width with or without bank	Formed depth with or without bank
Type-AV	2.0 m	0.30 m
Type-BV	2.7 m	0.45 m
Type-CV	3.9 m	0.65 m

NOT TO SCALE

Drawn:	Date:		
GMW	Dec-09	Catch Drains	CD-01

INSTALLATION (EARTH-LINED)

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10cm EVERY 10m FOR EACH 1% OF REQUIRED CHANNEL GRADIENT.

5. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

6. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT TO THE TOP OF THE EMBANKMENT.

7. ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

8. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. SPECIFICALLY, ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE CATCH DRAIN IS FINISHED AND THE AREA IS STABILISED, THE TEMPORARY DRAIN AND ANY ASSOCIATED BANKS SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED WITHIN THE APPROVED SITE REHABILITATION PLAN.

Drawn:	Date:		
GMW	Dec-09	Catch Drains - Earth Lined	CD-02

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. ENSURE ALL NECESSARY SOIL TESTING (e.g. SOIL pH, NUTRIENT LEVELS) AND ANALYSIS HAS BEEN COMPLETED, AND REQUIRED SOIL ADJUSTMENTS PERFORMED PRIOR TO PLANTING.

3. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

4. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

5. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10cm EVERY 10m FOR EACH 1% OF CHANNEL GRADIENT.

6. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

7. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT TO THE TOP OF THE EMBANKMENT. WHERE NECESSARY, CUT THE DRAIN SLIGHTLY DEEPER THAN THAT SPECIFIED ON THE PLANS SUCH THAT THE CORRECT CHANNEL DIMENSIONS ARE ACHIEVED FOLLOWING PLACEMENT OF THE TURF.

8. ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

9. TURF SHOULD BE USED WITHIN 12-HOURS OF DELIVERY, OTHERWISE ENSURE THE TURF IS STORED IN CONDITIONS APPROPRIATE FOR THE WEATHER CONDITIONS (e.g. A SHADED AREA).

10. MOISTENING THE TURF AFTER IT IS UNROLLED WILL HELP MAINTAIN ITS VIABILITY.

11. TURF SHOULD BE LAID ON A MINIMUM 75mm BED OF ADEQUATELY FERTILISED TOPSOIL. RAKE THE SOIL SURFACE TO BREAK THE CRUST JUST BEFORE LAYING THE TURF.

12. DURING THE WARMER MONTHS, LIGHTLY IRRIGATE THE SOIL IMMEDIATELY BEFORE LAYING THE TURF.

13. ENSURE THE TURF IS NOT LAID ON GRAVEL, HEAVILY COMPACTED SOILS, OR SOILS THAT HAVE BEEN RECENTLY TREATED WITH HERBICIDES.

14. FOR WIDE DRAINS AND HIGH VELOCITY CHUTES, LAY THE FIRST ROW OF TURF IN A STRAIGHT LINE DIAGONAL TO THE DIRECTION OF FLOW. STAGGER SUBSEQUENT ROWS IN A BRICK-LIKE (STRETCHER BOND) PATTERN. THE TURF SHOULD NOT BE STRETCHED OR OVERLAPPED. USE A KNIFE OR SHARP SPADE TO TRIM AND FIT IRREGULARLY SHAPED AREAS.

15. FOR NARROW DRAINS, LAY THE TURF ALONG THE DIRECTION OF THE DRAIN, ENSURING, WHEREVER PRACTICABLE, THAT A LONGITUDINAL JOINT BETWEEN TWO STRIPS OF TURF IS NOT POSITIONED ALONG THE INVERT OF THE DRAIN.

16. ENSURE THE TURF EXTENDS UP THE SIDES OF THE DRAIN AT LEAST 100mm ABOVE THE ELEVATION OF THE CHANNEL INVERT, OR AT LEAST TO A SUFFICIENT ELEVATION TO FULLY CONTAIN EXPECTED CHANNEL FLOW.

17. ON CHANNEL GRADIENTS OF 3:1(H:V) OR STEEPER, OR IN SITUATIONS WHERE HIGH FLOW VELOCITIES (i.e. VELOCITY >1.5m/s) ARE LIKELY WITHIN THE FIRST 2-WEEKS FOLLOWING PLACEMENT, SECURE THE INDIVIDUAL TURF STRIPS WITH WOODEN OR PLASTIC PEGS.

18. ENSURE THAT INTIMATE CONTACT IS ACHIEVED AND MAINTAINED BETWEEN THE TURF AND THE SOIL SUCH THAT SEEPAGE FLOW BENEATH THE TURF IS AVOIDED.

19. WATER UNTIL THE SOIL IS WET 100mm BELOW THE TURF. THEREAFTER, WATERING SHOULD BE SUFFICIENT TO MAINTAIN AND PROMOTE HEALTHY GROWTH.

20. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT DOWN-SLOPE SOIL EROSION WILL BE PREVENTED FROM OCCURRING. ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE CATCH DRAIN IS FINISHED AND THE AREA IS STABILISED, THE DRAIN AND ANY ASSOCIATED BANKS SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED WITHIN THE APPROVED PLAN.

Drawn:	Date:		
GMW	Dec-09	Catch Drains - Grass Lined	CD-03

INSTALLATION (DRAIN FORMATION)

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10cm EVERY 10m FOR EACH 1% OF CHANNEL GRADIENT.

5. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

6. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT TO THE TOP OF THE EMBANKMENT.

7. ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

8. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

INSTALLATION (MAT PLACEMENT)

THE METHOD OF MAT INSTALLATION VARIES WITH THE TYPE OF MAT. INSTALLATION PROCEDURES SHOULD BE PROVIDED BY THE MANUFACTURER OR DISTRIBUTOR OF THE PRODUCT. A TYPICAL INSTALLATION PROCEDURE IS DESCRIBED BELOW, BUT SHOULD BE CONFIRMED WITH THE PRODUCT MANUFACTURER OR DISTRIBUTOR.

1. EROSION CONTROL MATS MUST BE STORED AWAY FROM DIRECT SUNLIGHT OR COVERED WITH ULTRAVIOLET LIGHT PROTECTIVE SHEETING UNTIL THE SITE IS READY FOR THEIR INSTALLATION.

2. VEHICLES AND CONSTRUCTION EQUIPMENT MUST NOT BE PERMITTED TO MANOEUVRE OVER THE GEOTEXTILE UNLESS IT HAS BEEN COVERED WITH A LAYER OF SOIL OR GRAVEL AT LEAST 150mm THICK. FILL MATERIAL SHALL NOT BE MIXED OVER THE GEOTEXTILE.

3. IF THE CHANNEL IS TO BE GRASSED, PREPARE A SMOOTH SEED BED OF APPROXIMATELY 75mm OF TOPSOIL, SEED, FERTILISE, WATER AND RAKE TO REMOVE ANY REMAINING SURFACE IRREGULARITIES.

4. EXCAVATE A 300mm DEEP BY 150mm WIDE ANCHOR TRENCH ALONG THE FULL WIDTH OF THE UPSTREAM END OF THE AREA TO BE TREATED.

5. AT LEAST 300mm OF THE MAT MUST BE ANCHORED INTO THE TRENCH WITH THE ROLL OF MATTING RESTING ON THE GROUND UP-SLOPE OF THE TRENCH.

6. STAPLE THE FABRIC WITHIN THE TRENCH AT 200 TO 250mm SPACING USING 100mm WIDE BY 150mm PENETRATION LENGTH U-SHAPED, 8 TO 11 GAUGE WIRE STAPLES. NARROWER U-SECTIONS MAY EASILY TEAR THE MATTING WHEN PLACED UNDER STRESS.

7. WHEN ALL MATS HAVE BEEN ANCHORED WITHIN THE TRENCH ACROSS THE FULL WIDTH OF THE TREATED AREA, THEN THE TRENCH IS BACKFILLED AND COMPACTED. THE MATS ARE THEN UNROLLED DOWN THE SLOPE SUCH THAT EACH MAT COVERS AND PROTECTS THE BACKFILLED TRENCH.

8. WHEN SPREADING THE MATS, AVOID STRETCHING THE FABRIC. THE MATS SHOULD REMAIN IN GOOD CONTACT WITH THE SOIL.

9. IF THE CHANNEL CURVES, THEN SUITABLY FOLD (IN A DOWNSTREAM DIRECTION) AND STAPLE THE FABRIC TO MAINTAIN THE FABRIC PARALLEL TO THE DIRECTION OF CHANNEL FLOW.

10. STAPLE THE SURFACE OF THE MATTING AT 1m CENTRES. ON IRREGULAR GROUND, ADDITIONAL STAPLES WILL BE REQUIRED WHEREVER THE MAT DOES NOT INITIALLY CONTACT THE GROUND SURFACE.

11. AT THE END OF EACH LENGTH OF MAT, A NEW TRENCH IS FORMED AT LEAST 300mm UP-SLOPE OF THE END OF THE MAT SUCH THAT THE END OF THE MAT WILL BE ABLE TO FULLY COVER THE TRENCH. A NEW ROLL OF MATTING IS THEN ANCHORED WITHIN THIS TRENCH AS PER THE FIRST MAT. AFTER THIS NEW MAT HAS BEEN UNROLLED DOWN THE SLOPE, THE UP-SLOPE MAT CAN BE PINNED IN PLACE FULLY COVERING THE NEW TRENCH AND AT LEAST 300mm OF THE DOWN-SLOPE MAT. THE PROCESS IS CONTINUED DOWN THE SLOPE UNTIL THE DESIRED AREA IS FULLY COVERED.

12. IN HIGH-VELOCITY CHANNELS, INTERMEDIATE ANCHOR SLOTS ARE USUALLY REQUIRED AT 10M INTERVALS DOWN THE CHANNEL.

13. ANCHOR THE OUTER MOST EDGES (TOP AND UPPER MOST SIDES) OF THE TREATED AREA IN A 300mm DEEP TRENCH AND STAPLE AT 200 TO 250mm CENTRES.

14. IF THE CHANNEL WAS GRASS SEEDED PRIOR TO PLACEMENT OF THE MATS, THEN THE MATS SHOULD BE ROLLED WITH A SUITABLE ROLLER WEIGHING 60 TO 90kg/m, THEN WATERED.

15. THE INSTALLATION PROCEDURE MUST ENSURE THAT THE MAT ACHIEVES AND RETAINS GOOD CONTACT WITH THE SOIL.

16. DAMAGED MATTING MUST BE REPAIRED OR REPLACED.

ADDITIONAL INSTRUCTIONS FOR THE INSTALLATION OF JUTE MESH (NOT JUTE BLANKETS):

1. ENSURE THE JUTE MESH IS LAID ON A FIRM EARTH SURFACE THAT HAS BEEN TRIMMED, TOPSOILED, WATERED, SOWN WITH SEED AND FERTILISER.

2. THE JUTE MESH IS THEN EITHER TAMPED OR ROLLED FIRMLY ONTO THE PREPARED SURFACE, AVOIDING STRETCHING, WATERED TO ENCOURAGE THE PENETRATION OF THE BITUMEN EMULSION, AND FINALLY SPRAYED WITH A TOP LAYER OF BITUMEN AT 1 TO 3 LITRES PER SQUARE METRE.

3. THE RATE OF EMULSION APPLICATION SHOULD BE ADJUSTED SUCH THAT THE EMULSION JUST STARTS TO POND IN THE MESH SQUARES.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE CATCH DRAIN IS FINISHED AND THE AREA IS STABILISED, THE DRAIN AND ANY ASSOCIATED BANKS SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED WITHIN THE APPROVED PLAN.

Drawn:	Date:		
GMW	May-10	Catch Drains - Geotextile Lined	CD-04

MATERIALS

ROCK:
(i) ALL ROCK MUST BE HARD, WEATHER RESISTANT, AND DURABLE AGAINST DISINTEGRATION UNDER CONDITIONS TO BE MET IN HANDLING, PLACEMENT AND OPERATION.

(ii) ALL ROCK MUST HAVE ITS GREATEST DIMENSION NOT GREATER THAN 3 TIMES ITS LEAST DIMENSIONS.

(iii) THE ROCK USED IN FORMATION OF THE DRAIN MUST BE EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND HAVE SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. DIRT, FINES, AND SMALLER ROCK MUST NOT EXCEED 5% BY WEIGHT.

(iv) THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. SPECIFIC GRAVITY TO BE AT LEAST 2.5.

(v) THE COLOUR OF THE RIPRAP SHALL BE [INSERT] AND MUST BE APPROVED BY THE ENGINEER. ONCE APPROVED, THE COLOUR SHALL BE KEPT CONSISTENT THROUGH THE PROJECT.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDIM A24 OR EQUIVALENT.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. PRIOR TO PLACEMENT, ALL ROCKS MUST BE VISUALLY CHECKED FOR SIZE, ELONGATION, CRACKS, DETERIORATION AND OTHER VISIBLE. THE DEGREE AND THOROUGHNESS OF SUCH CHECKING MUST BE APPROPRIATE FOR THE POTENTIAL CONSEQUENCES ASSOCIATED WITH FAILURE OF THE STRUCTURE OR PURPOSE FOR WHICH THE MATERIAL WILL BE USED.

3. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

4. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

5. REMOVE ALL SOFT, YIELDING MATERIAL; REPLACE WITH SUITABLE ON-SITE MATERIAL; COMPACT TO SMOOTH FIRM SURFACE.

6. EXCAVATE THE DRAIN TO THE LINES AND GRADES SHOWN ON THE APPROVED PLANS. OVER-CUT THE DRAIN TO A DEPTH EQUAL TO THE SPECIFIED DEPTH OF ROCK PLACEMENT SUCH THAT THE FINISHED TOP SURFACE WILL BE AT THE ELEVATION OF THE SURROUNDING LAND. PLACEMENT OF THE ROCK LINING MUST NOT REDUCE THE DRAIN'S TOP WIDTH AND DEPTH AS SPECIFIED WITHIN THE APPROVED PLANS.

7. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10CM EVERY 10m FOR EACH 1% OF CHANNEL GRADIENT.

8. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

9. IF THE DRAIN IS CUT INTO A DISPERSIVE (SODIC) SOIL, THEN PRIOR TO PLACING FILTER CLOTH, THE EXPOSED DISPERSIVE SOIL MUST BE COVERED WITH A MINIMUM 200mm THICK LAYER OF NON-DISPERSIVE SOIL PRIOR TO PLACEMENT OF FILTER CLOTH OR ROCKS.

10. IF A FILTER CLOTH UNDERLAY IS SPECIFIED, PLACE THE FILTER FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN ONE SHEET OF FILTER CLOTH IS REQUIRED TO OVER THE AREA, OVERLAP THE EDGE OF EACH SHEET AT LEAST 300mm, AND SECURE ANCHOR PINS AT MINIMUM 1M SPACING ALONG THE OVERLAP.

11. ENSURE THE FILTER CLOTH IS PROTECTED FROM PUNCHING OR TEARING DURING INSTALLATION OF THE FABRIC AND THE ROCK. REPAIR ANY DAMAGE BY REMOVING THE ROCK AND PLACING WITH ANOTHER PIECE OF FILTER CLOTH OVER THE DAMAGED AREA OVERLAPPING THE EXISTING FABRIC A MINIMUM OF 300mm.

12. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER LAYER. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS.

13. PLACE ROCK LINING TO THE EXTENT AND DEPTH INDICATED WITHIN THE APPROVED PLANS.

14. ENSURE THE ROCK IS PLACED IN AN APPROPRIATE MANNER TO AVOID DISPLACING UNDERLYING MATERIALS OR PLACING UNDUE IMPACT FORCE ON THE BEDDING MATERIALS.

15. ENSURE THE ROCK IS PLACED WITH A MINIMUM THICKNESS OF 1.5 TIMES THE NOMINAL ROCK SIZE (D50).

16. ENSURE MATERIALS THAT ARE D50 AND LARGER ARE POSITIONED FLUSH WITH THE TOP SURFACE WITH FACES AND SHAPES MATCHED TO MINIMISE VOIDS.

17. ENSURE PROJECTIONS ABOVE OR DEPRESSIONS UNDER THE SPECIFIED TOP SURFACE ARE LESS THAN 20% OF THE ROCK LAYER THICKNESS. THE AVERAGE SURFACE PLANE OF THE FINISHED ROCK IS DEFINED AS THE PLANE WHERE 50% OF THE TOPS OF ROCKS WOULD CONTACT.

18. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT (AVERAGE SURFACE PLANE ALONG CHANNEL INVERT) TO THE TOP OF THE EMBANKMENT. THE AVERAGE SURFACE PLANE OF THE FINISHED ROCK IS DEFINED AS THE PLANE WHERE 50% OF THE TOPS OF ROCKS WOULD CONTACT.

19. TO THE MAXIMUM DEGREE PRACTICABLE, THE MATERIAL BETWEEN LARGER ROCK MUST NOT BE LOOSE OR EASILY DISPLACED BY THE EXPECTED FLOW.

20. AFTER PLACEMENT OF THE ROCK LINING, ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

21. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. CLOSELY INSPECT THE OUTER EDGES OF THE ROCK PROTECTION. ENSURE WATER ENTRY INTO THE ROCK-LINED AREA IS NOT CAUSING EROSION ALONG THE EDGE OF THE ROCK PROTECTION.

3. CAREFULLY CHECK THE STABILITY OF THE ROCK LOOKING FOR INDICATIONS OF PIPING, SCOUR HOLES, OR BANK FAILURES.

4. REPLACE OR REPOSITION THE SURFACE ROCK SUCH THAT THE DRAIN FUNCTIONS AS REQUIRED AND THE DRAIN'S REQUIRED HYDRAULIC CAPACITY IS NOT REDUCED.

5. REPLACE ANY DISPLACED ROCK WITH ROCK OF A SIGNIFICANTLY (MINIMUM 110%) LARGER SIZE THAN THE DISPLACED ROCK.

6. ENSURE SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

7. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

Drawn:	Date:		
GMW	Dec-09	Catch Drains - Rock Lined	CD-05

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. ENSURE ALL NECESSARY SOIL TESTING (e.g. SOIL pH, NUTRIENT LEVELS) AND ANALYSIS HAS BEEN COMPLETED, AND REQUIRED SOIL ADJUSTMENTS PERFORMED PRIOR TO PLANTING.

3. CLEAR THE LOCATION FOR THE CHANNEL, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND CONSTRUCTION EQUIPMENT.

4. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD ANY ASSOCIATED EMBANKMENTS.

5. EXCAVATE THE DIVERSION CHANNEL TO THE SPECIFIED SHAPE, ELEVATION AND GRADIENT. THE SIDES OF THE CHANNEL SHOULD BE NO STEEPER THAN A 2:1 (H:V) IF CONSTRUCTED IN EARTH, UNLESS SPECIFICALLY DIRECTED WITHIN THE APPROVED PLANS.

6. STABILISE THE CHANNEL AND BANKS IMMEDIATELY UNLESS IT WILL OPERATE FOR LESS THAN 30 DAYS. IN EITHER CASE, TEMPORARY EROSION PROTECTION (MATTING, ROCK, ETC.) WILL BE REQUIRED AS SPECIFIED WITHIN THE APPROVED PLANS OR AS DIRECTED.

7. ENSURE THE CHANNEL DISCHARGES TO A STABLE AREA.

ADDITIONAL REQUIREMENTS FOR TURF PLACEMENT:

1. TURF SHOULD BE USED WITHIN 12 HOURS OF DELIVERY, OTHERWISE ENSURE THE TURF IS STORED IN CONDITIONS APPROPRIATE FOR THE WEATHER CONDITIONS (e.g. A SHADED AREA).

2. MOISTENING THE TURF AFTER IT IS UNROLLED WILL HELP MAINTAIN ITS VIABILITY.

3. TURF SHOULD BE LAID ON A MINIMUM 75mm BED OF ADEQUATELY FERTILISED TOPSOIL. RAKE THE SOIL SURFACE TO BREAK THE CRUST JUST BEFORE LAYING THE TURF.

4. DURING THE WARMER MONTHS, LIGHTLY IRRIGATE THE SOIL IMMEDIATELY BEFORE LAYING THE TURF.

5. ENSURE THE TURF IS NOT LAID ON GRAVEL, HEAVILY COMPACTED SOILS, OR SOILS THAT HAVE BEEN RECENTLY TREATED WITH HERBICIDES.

6. ENSURE THE TURF EXTENDS UP THE SIDES OF THE DRAIN AT LEAST 100mm ABOVE THE ELEVATION OF THE CHANNEL INVERT, OR AT LEAST TO A SUFFICIENT ELEVATION TO FULLY CONTAIN EXPECTED CHANNEL FLOW.

7. ON CHANNEL GRADIENTS OF 3:1(H:V) OR STEEPER, OR IN SITUATIONS WHERE HIGH FLOW VELOCITIES (i.e. VELOCITY >1.5m/s) ARE LIKELY WITHIN THE FIRST TWO WEEK FOLLOWING PLACEMENT, SECURE THE INDIVIDUAL TURF STRIPS WITH WOODEN OR PLASTIC PEGS.

8. ENSURE THAT INTIMATE CONTACT IS ACHIEVED AND MAINTAINED BETWEEN THE TURF AND THE SOIL SUCH THAT SEEPAGE FLOW BENEATH THE TURF IS AVOIDED.

9. WATER UNTIL THE SOIL IS WET 100mm BELOW THE TURF. THEREAFTER, WATERING SHOULD BE SUFFICIENT TO MAINTAIN AND PROMOTE HEALTHY GROWTH

MAINTENANCE

1. DURING THE SITE'S CONSTRUCTION PERIOD, INSPECT THE DIVERSION CHANNEL WEEKLY AND AFTER ANY INCREASE IN FLOWS WITHIN THE CHANNEL. REPAIR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE CHANNEL. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE CONSTRUCTION WORK ABOVE A TEMPORARY DIVERSION CHANNEL IS FINISHED AND THE AREA IS STABILISED, THE AREA SHOULD BE APPROPRIATELY REHABILITATED.

2. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA AS SPECIFIED IN THE APPROVED PLAN.

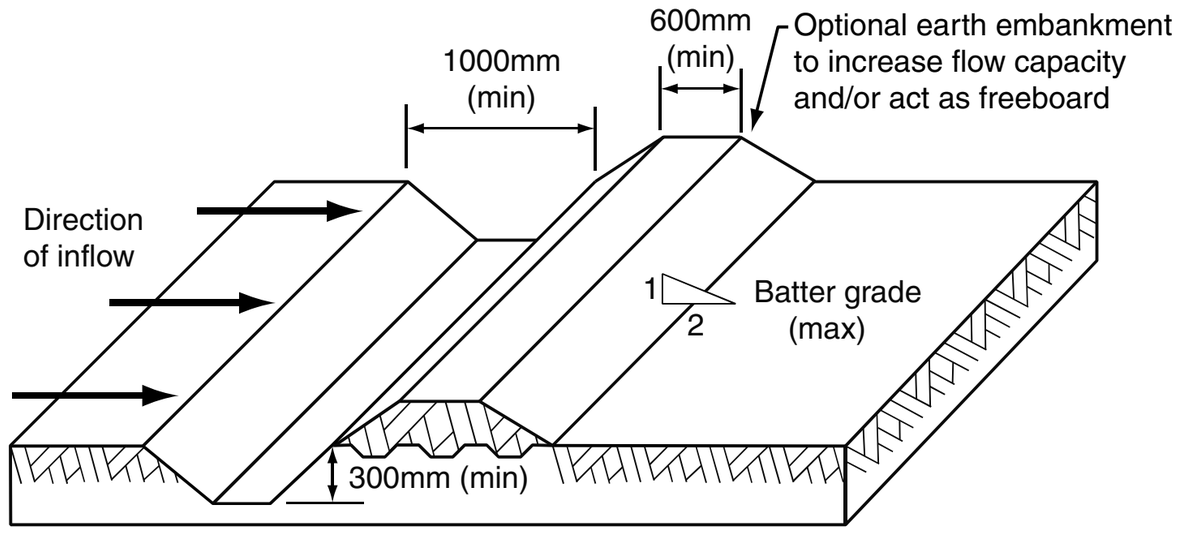


Figure 1 - Typical profile of diversion channel with bank

Drawn:	Date:		
GMW	Dec-09	Diversion Channels	DC-01

CONSTRUCTION

1. THE SPILLWAY MUST BE EXCAVATED AS SHOWN ON THE PLANS, AND THE EXCAVATED MATERIAL IF CLASSIFIED AS SUITABLE, MUST BE USED IN THE EMBANKMENT, AND IF NOT SUITABLE IT MUST BE DISPOSED OF INTO SPOIL HEAPS.

2. ENSURE EXCAVATED DIMENSIONS ALLOW ADEQUATE BOXING-OUT SUCH THAT THE SPECIFIED ELEVATIONS, GRADES, CHUTE WIDTH, AND ENTRANCE AND EXIT SLOPES FOR THE EMERGENCY SPILLWAY WILL BE ACHIEVED AFTER PLACEMENT OF THE ROCK OR OTHER SCOUR PROTECTION MEASURES AS SPECIFIED IN THE PLANS.

3. PLACE SPECIFIED SCOUR PROTECTION MEASURES ON THE EMERGENCY SPILLWAY. ENSURE THE FINISHED GRADE BLENDS WITH THE SURROUNDING AREA TO ALLOW A SMOOTH FLOW TRANSITION FROM SPILLWAY TO DOWNSTREAM CHANNEL.

4. IF A SYNTHETIC FILTER FABRIC UNDERLAY IS SPECIFIED, PLACE THE FILTER FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN 1 SHEET OF FILTER FABRIC IS REQUIRED, OVERLAP THE EDGES BY AT LEAST 300mm AND PLACE ANCHOR PINS AT MINIMUM 1m SPACING ALONG THE OVERLAP. BURY THE UPSTREAM END OF THE FABRIC A MINIMUM 300mm BELOW GROUND AND WHERE NECESSARY, BURY THE LOWER END OF THE FABRIC OR OVERLAP A MINIMUM 300mm OVER THE NEXT DOWNSTREAM SECTION AS REQUIRED. ENSURE THE FILTER FABRIC EXTENDS AT LEAST 1000mm UPSTREAM OF THE SPILLWAY CREST.

5. TAKE CARE NOT TO DAMAGE THE FABRIC DURING OR AFTER PLACEMENT. IF DAMAGE OCCURS, REMOVE THE ROCK AND REPAIR THE SHEET BY ADDING ANOTHER LAYER OF FABRIC WITH A MINIMUM OVERLAP OF 300mm AROUND THE DAMAGED AREA. IF EXTENSIVE DAMAGE IS SUSPECTED, REMOVE AND REPLACE THE ENTIRE SHEET.

6. WHERE LARGE ROCK IS USED, OR MACHINE PLACEMENT IS DIFFICULT, A MINIMUM 100mm LAYER OF FINE GRAVEL, AGGREGATE, OR SAND MAY BE NEEDED TO PROTECT THE FABRIC.

7. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER FABRIC. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS. THE DESIRED DISTRIBUTION OF ROCK THROUGHOUT THE MASS MAY BE OBTAINED BY SELECTIVE LOADING AT THE QUARRY AND CONTROLLED DUMPING DURING FINAL PLACEMENT.

8. THE FINISHED SLOPE SHOULD BE FREE OF POCKETS OF SMALL ROCK OR CLUSTERS OF LARGE ROCKS. HAND PLACING MAY BE NECESSARY TO ACHIEVE THE PROPER DISTRIBUTION OF ROCK SIZES TO PRODUCE A RELATIVELY SMOOTH, UNIFORM SURFACE. THE FINISHED GRADE OF THE ROCK SHOULD BLEND WITH THE SURROUNDING AREA. NO OVERFALL OR PROTRUSION OF ROCK SHOULD BE APPARENT.

9. ENSURE THAT THE FINAL ARRANGEMENT OF THE SPILLWAY CREST WILL NOT PROMOTE EXCESSIVE FLOW THROUGH THE ROCK SUCH THAT THE WATER CAN BE RETAINED WITHIN THE SETTLING BASIN AN ELEVATION NO LESS THAN 50mm ABOVE OR BELOW THE NOMINATED SPILLWAY CREST ELEVATION.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT THE SPILLWAY PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING STORM EVENTS, OR OTHERWISE ON A WEEKLY BASIS. MAKE REPAIRS AS NECESSARY.

2. CHECK FOR MOVEMENT OF, OR DAMAGE TO, THE SPILLWAY'S LINING, INCLUDING SURFACE CRACKING.

3. CHECK FOR SOIL SCOUR ADJACENT THE SPILLWAY. INVESTIGATE THE CAUSE OF ANY SCOUR, AND REPAIR AS NECESSARY.

4. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SPILLWAY TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED.

REMOVAL

1. TEMPORARY SPILLWAYS SHOULD BE REMOVED WHEN AN ALTERNATIVE, STABLE, DRAINAGE SYSTEM IS AVAILABLE.

2. REMOVE ALL MATERIALS AND DEPOSITED SEDIMENT, AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA IN PREPARATION FOR STABILISATION, THEN STABILISE THE AREA AS SPECIFIED IN THE APPROVED PLAN.

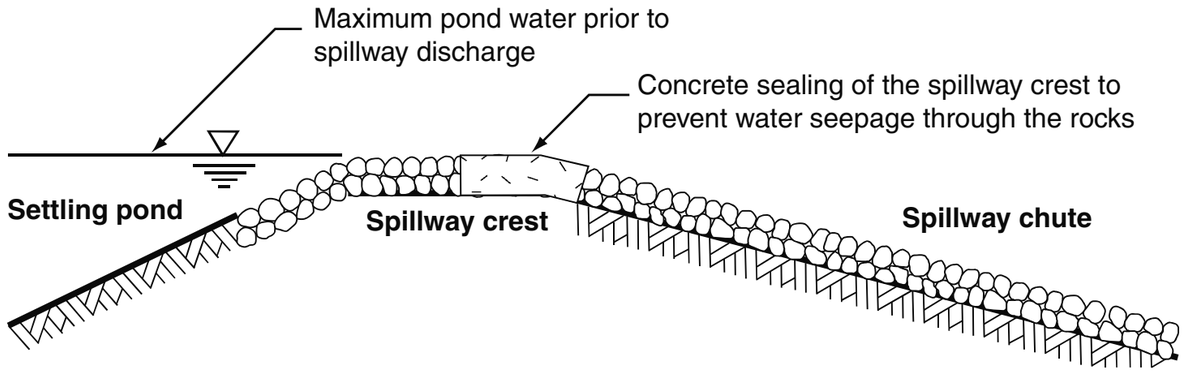


Figure 1 - Example of seepage control on the spillway crest

Drawn:	Date:		
GMW	Dec-09	Emergency Spillways	ES-1

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, DIMENSIONS AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEREVER PRACTICAL, LOCATE THE LEVEL SPREADER ON UNDISTURBED, STABLE SOIL.

3. ENSURE FLOW DISCHARGING FROM THE LEVEL SPREADER WILL DISPERSE ACROSS A PROPERLY STABILISED SLOPE NOT EXCEEDING 10:1 (H:V) AND SUFFICIENTLY EVEN IN GRADE ACROSS THE SLOPE TO AVOID CONCENTRATING THE OUTFLOW.

4. THE OUTLET SILL OF THE SPREADER SHOULD BE PROTECTED WITH EROSION CONTROL MATTING TO PREVENT EROSION DURING THE ESTABLISHMENT OF VEGETATION. THE MATTING SHOULD BE A MINIMUM OF 1200mm WIDE EXTENDING AT LEAST 300mm UPSTREAM OF THE EDGE OF THE OUTLET CREST AND BURIED AT LEAST 150mm IN A VERTICAL TRENCH. THE DOWNSTREAM EDGE SHOULD BE SECURELY HELD IN PLACE WITH CLOSELY SPACED HEAVY-DUTY WIRE STAPLES AT LEAST 150mm LONG.

5. ENSURE THAT THE OUTLET SILL (CREST) IS LEVEL FOR THE SPECIFIED LENGTH.

6. IMMEDIATELY AFTER CONSTRUCTION, TURF, OR SEED AND MULCH WHERE APPROPRIATE, THE LEVEL SPREADER.

MAINTENANCE

1. INSPECT THE LEVEL SPREADER AFTER EVERY RAINFALL EVENT UNTIL VEGETATION IS ESTABLISHED.

2. AFTER ESTABLISHMENT OF VEGETATION OVER THE LEVEL SPREADER, INSPECTIONS SHOULD BE MADE ON A REGULAR BASIS AND AFTER RUNOFF-PRODUCING RAINFALL.

3. ENSURE THAT THERE IS NO SOIL EROSION AND THAT SEDIMENT DEPOSITION IS NOT CAUSING THE CONCENTRATION OF FLOW.

4. ENSURE THAT THERE IS NO SOIL EROSION OR CHANNEL DAMAGE UPSTREAM OF THE LEVEL SPREADER, OR SOIL EROSION OR VEGETATION DAMAGE DOWNSTREAM OF THE LEVEL SPREADER.

5. INVESTIGATE THE SOURCE OF ANY EXCESSIVE SEDIMENTATION.

6. MAINTAIN GRASS IN A HEALTH CONDITION WITH NO LESS THAN 90% COVER UNLESS CURRENT WEATHER CONDITIONS REQUIRE OTHERWISE.

7. GRASS HEIGHT SHOULD BE MAINTAINED AT A MINIMUM 50mm BLADE LENGTH WITHIN THE LEVEL SPREADER AND DOWNSTREAM DISCHARGE AREA, AND A MAXIMUM BLADE LENGTH NO GREATER THAN ADJACENT GRASSES.

REMOVAL

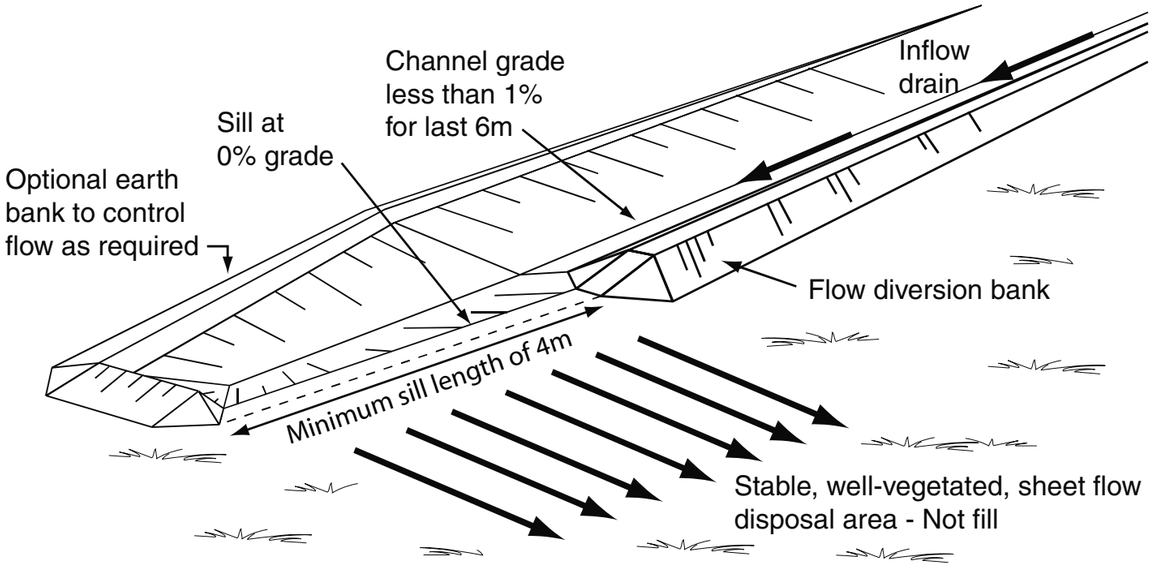
1. TEMPORARY LEVEL SPREADERS SHOULD BE DECOMMISSIONED ONLY AFTER AN ALTERNATIVE STABLE OUTLET IS OPERATIONAL, OR WHEN THE INFLOW CHANNEL IS DECOMMISSIONED.

2. REMOVE COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

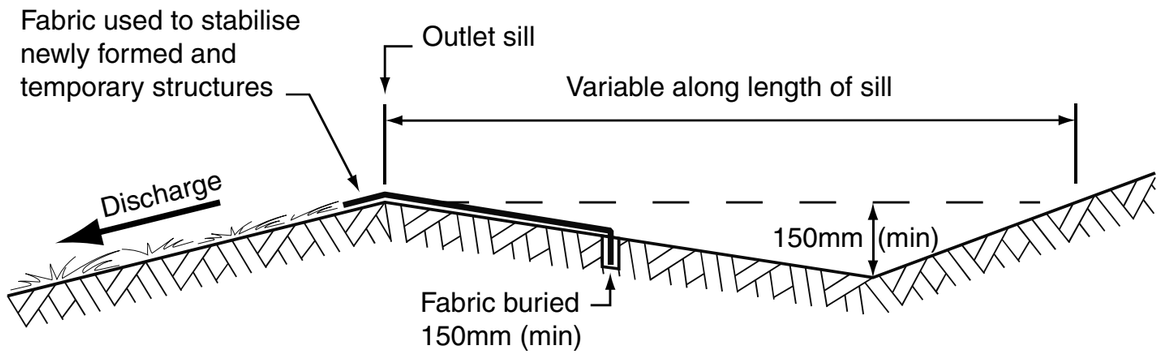
3. REMOVE AND APPROPRIATELY DISPOSE OF ANY EXPOSED GEOTEXTILE.

4. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

5. STABILISE THE AREA AS SPECIFIED ON THE APPROVED PLAN.

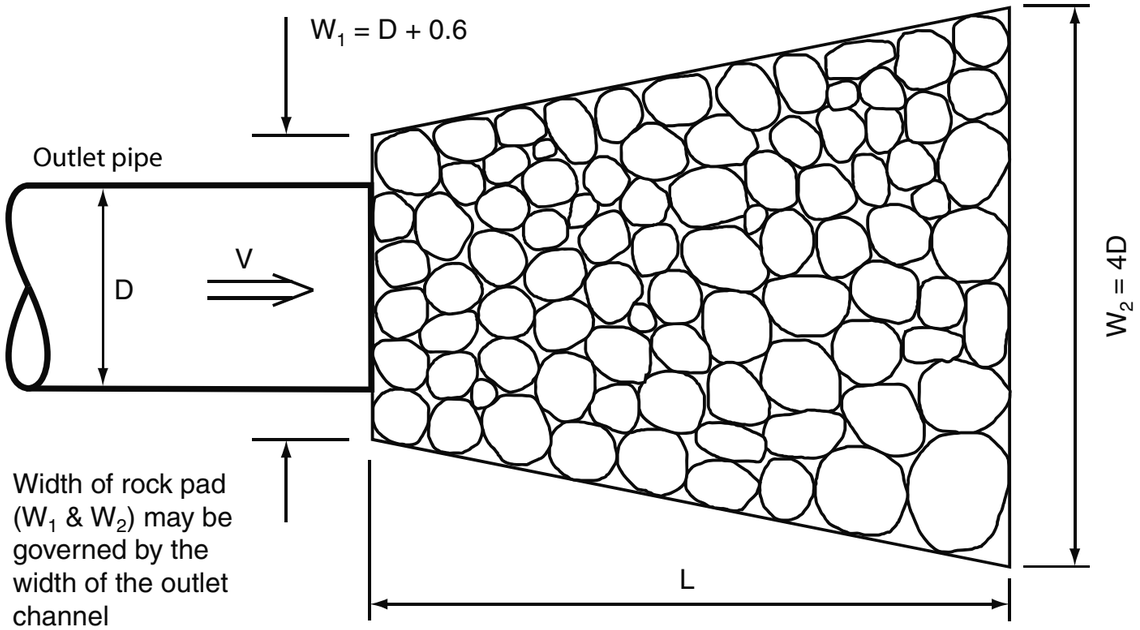


(a) Typical layout of level spreader

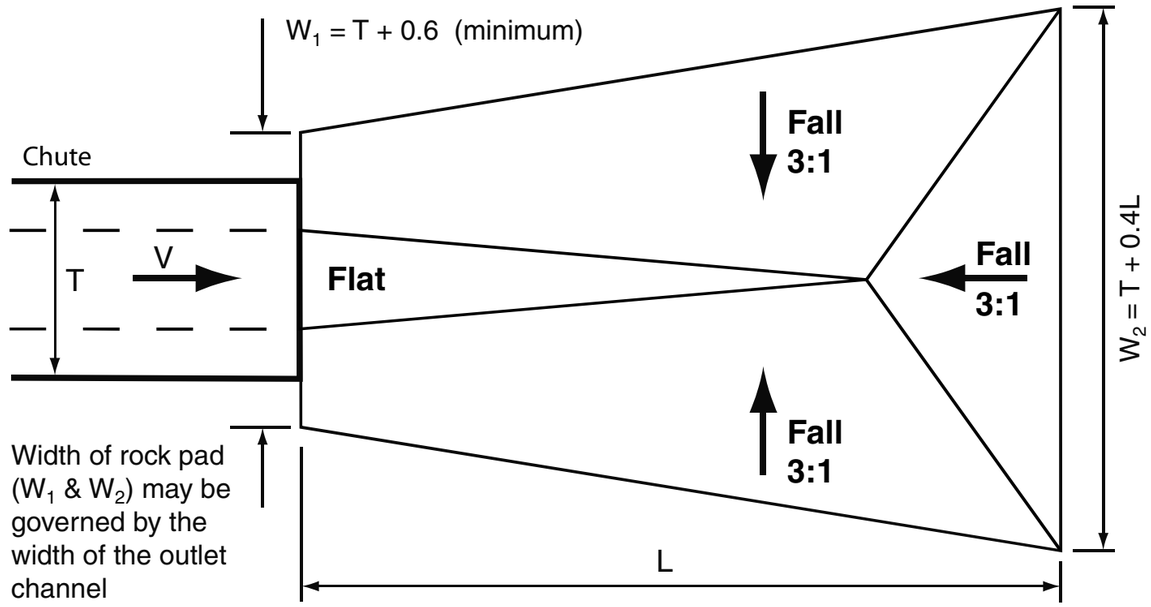


(b) Typical profile of the the outlet weir

Drawn:	Date:		
GMW	Dec-09	Level Spreaders	LS-01

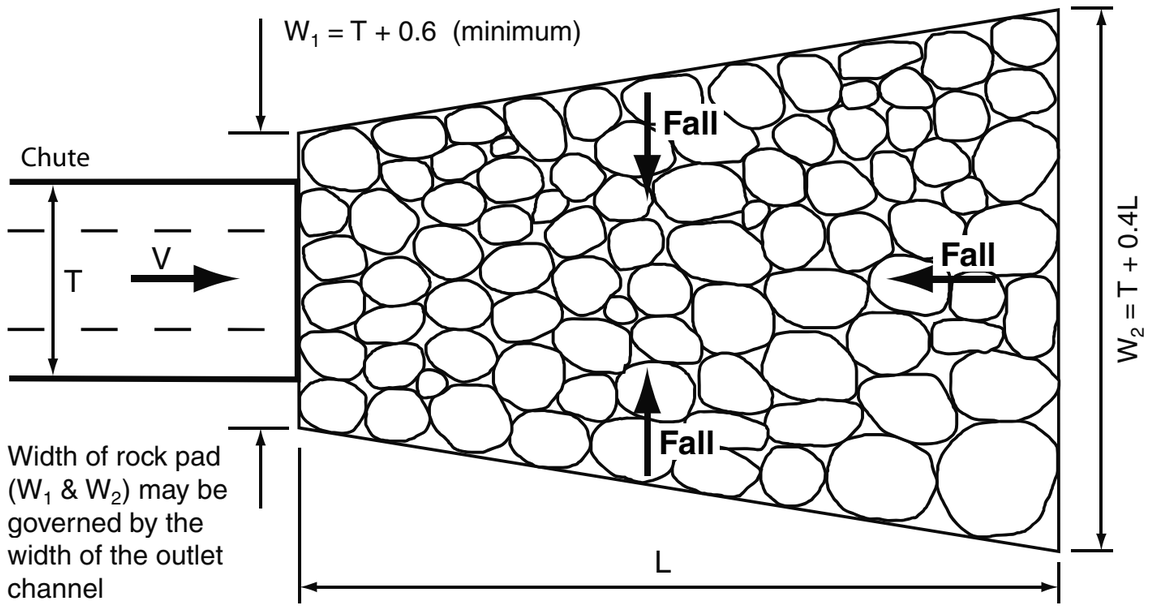


(a) Typical layout of a rock pad outlet structure for a pipe outlet

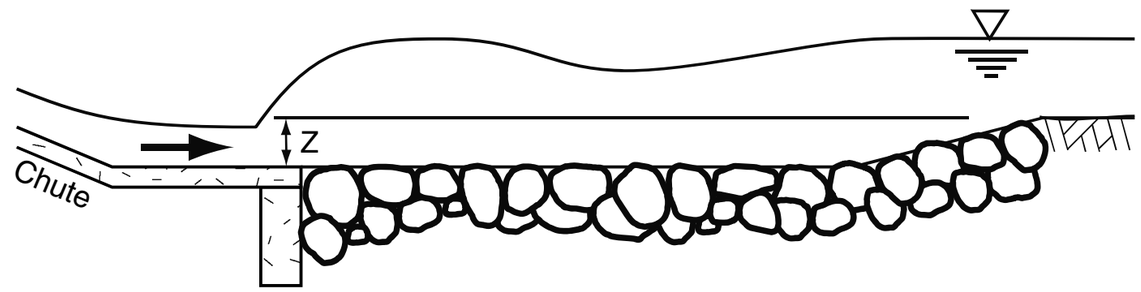


T = Maximum top width of flow at base of chute

(b) Typical form of a rock pad outlet structure for a drainage chute



(c) Typical layout of a rock pad outlet structure for a drainage chute



(d) Typical profile of a rock pad outlet structure for a drainage chute

Notes:

1. Drawings applicable to temporary drainage chutes and slope drains.
2. Rock pad outlet structures for slope drains usually are not required to be recessed below natural ground level as is the case for chute outlets (see Figure B).

Drawn:	Date:		
GMW	Dec-09	Outlet Structures	OS-01

MATERIALS (ROCK PADS)

ROCK: HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. SPECIFIC GRAVITY TO BE AT LEAST 2.5.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDIM A24 OR EQUIVALENT.

INSTALLATION (ROCK PADS)

1. REFER TO APPROVED PLANS FOR LOCATION AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. THE DIMENSIONS OF THE OUTLET STRUCTURE MUST ALIGN WITH THE DOMINANT FLOW DIRECTION.

3. EXCAVATE THE OUTLET PAD FOOTPRINT TO THE SPECIFIED DIMENSION SUCH THE WHEN THE ROCK IS PLACED IN THE EXCAVATED PIT THE TOP OF THE ROCKS WILL BE LEVEL WITH THE SURROUNDING GROUND, UNLESS OTHERWISE DIRECTED.

4. IF THE EXCAVATED SOILS ARE DISPERSIVE, OVER-EXCAVATED THE ROCK PAD BY AT LEAST 300mm AND BACKFILL WITH STABLE, NON-DISPERSIVE MATERIAL.

5. LINE THE EXCAVATED PIT WITH GEOTEXTILE FILTER CLOTH, PREFERABLY USING A SINGLE SHEET. IF JOINTS ARE REQUIRED, OVERLAP THE FABRIC AT LEAST 300mm.

6. ENSURE THE FILTER CLOTH IS PROTECTED FROM PUNCHING OR TEARING DURING INSTALLATION OF THE FABRIC AND THE ROCK. REPAIR ANY DAMAGE BY REMOVING THE ROCK AND PLACING WITH ANOTHER PIECE OF FILTER CLOTH OVER THE DAMAGED AREA OVERLAPPING THE EXISTING FABRIC A MINIMUM OF 300mm.

7. ENSURE THERE ARE AT LEAST TWO LAYERS OF ROCKS. WHERE NECESSARY, REPOSITION THE LARGER ROCKS TO ENSURE TWO LAYERS OF ROCKS ARE ACHIEVED WITHOUT ELEVATING THE UPPER SURFACE ABOVE THE PIPE INVERT.

8. ENSURE THE ROCK IS PLACED IN A MANNER THAT WILL ALLOW WATER TO DISCHARGE FREELY FROM THE PIPE.

9. ENSURE THE UPPER SURFACE OF THE ROCK PAD DOES NOT CAUSE WATER TO BE DEFLECTED AROUND THE EDGE OF THE ROCK PAD.

10. IMMEDIATELY AFTER CONSTRUCTION, APPROPRIATELY STABILISE ALL DISTURBED AREAS.

MAINTENANCE

1. WHILE CONSTRUCTION WORKS CONTINUE ON THE SITE, INSPECT THE OUTLET STRUCTURE PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING RAINFALL, AND ON AT LEAST A WEEKLY BASIS.

2. REPLACE ANY DISPLACED ROCK WITH ROCK OF A SIGNIFICANTLY (MINIMUM 110%) LARGER SIZE THAN THE DISPLACED ROCK.

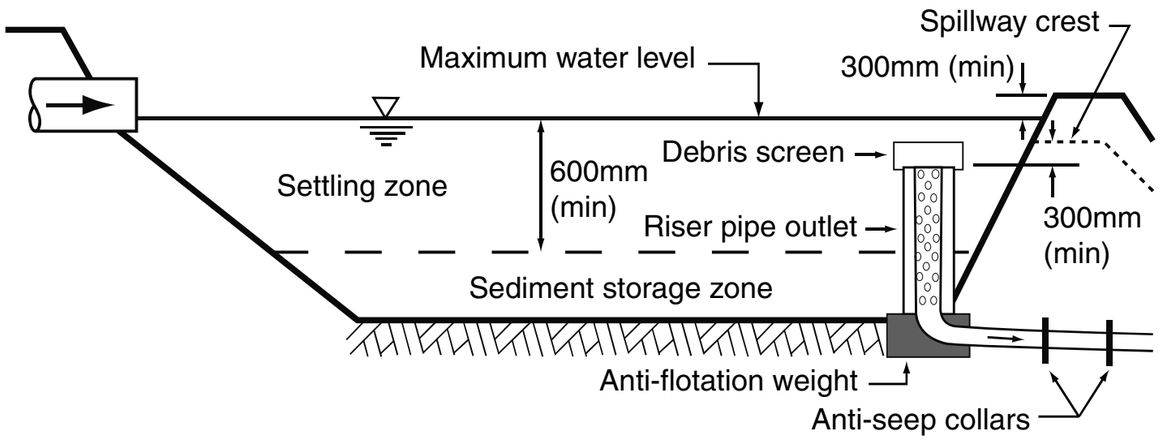
REMOVAL

1. TEMPORARY OUTLET STRUCTURES SHOULD BE COMPLETELY REMOVED, OR WHERE APPROPRIATE, REHABILITATED SO AS NOT TO CAUSE ONGOING ENVIRONMENTAL NUISANCE OR HARM.

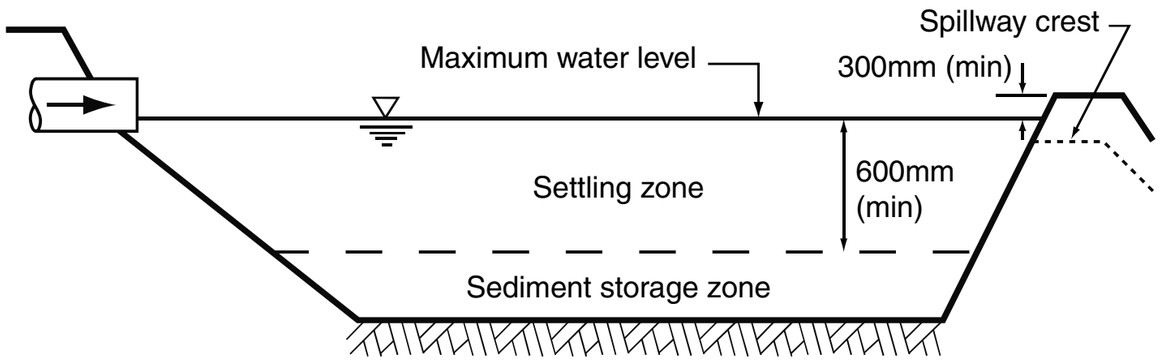
2. FOLLOWING REMOVAL OF THE DEVICE, THE DISTURBED AREA MUST BE APPROPRIATELY REHABILITATED SO AS NOT TO CAUSE ONGOING ENVIRONMENTAL NUISANCE OR HARM.

3. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

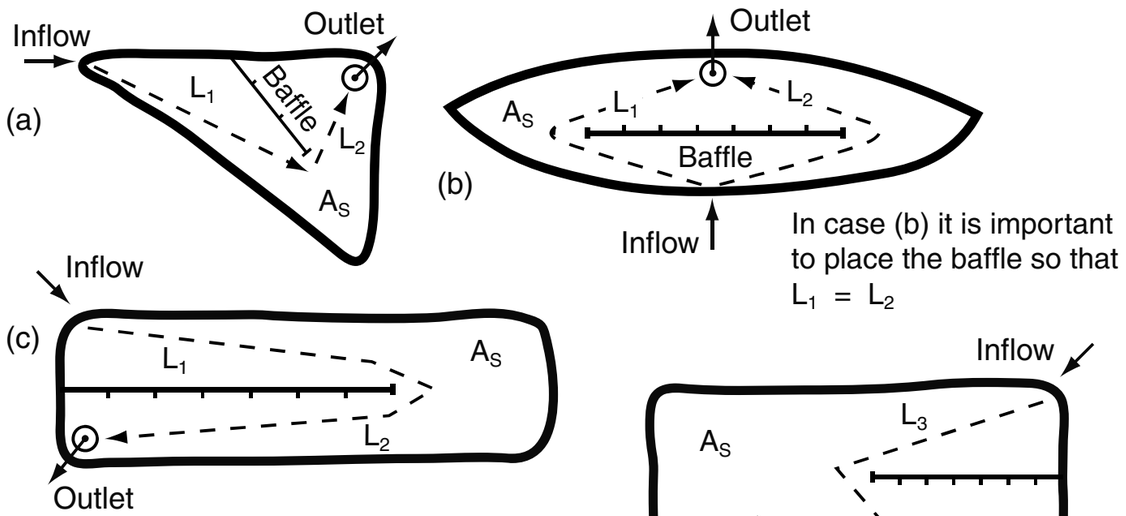
Drawn:	Date:		
GMW	Dec-09	Outlet Structure - Rock Pad	OS-02



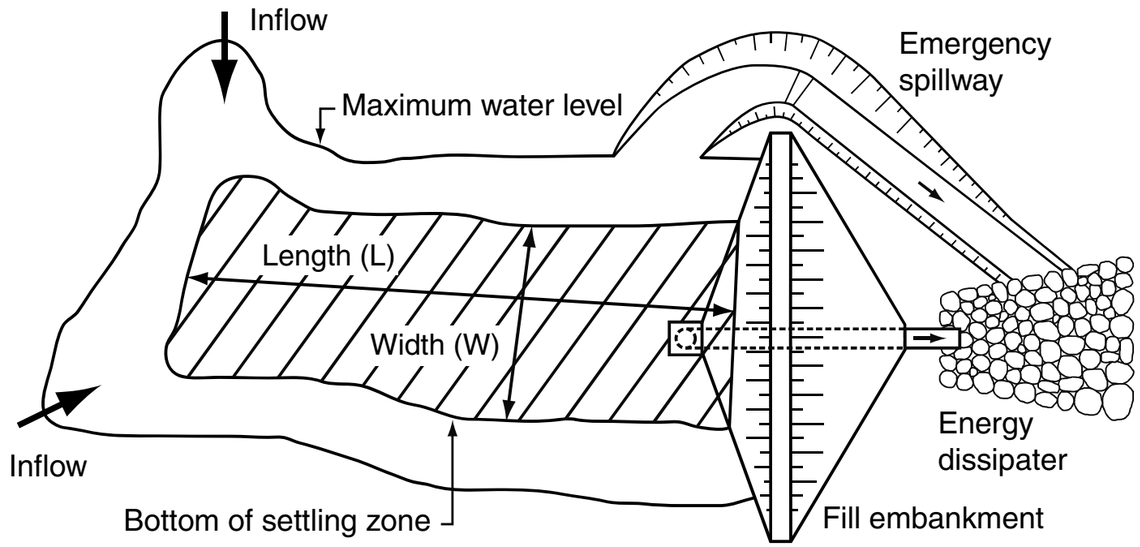
(a) Type C (dry) basin with riser pipe outlet system



(b) Typical profile of Type F/D (wet) basin

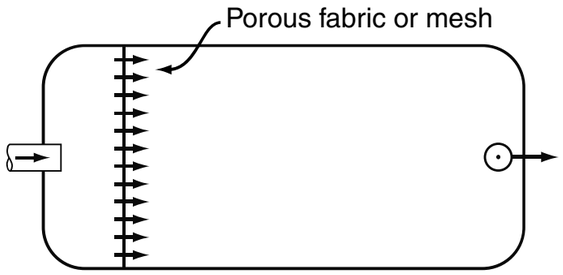


(c) Typical arrangement of internal flow control baffles

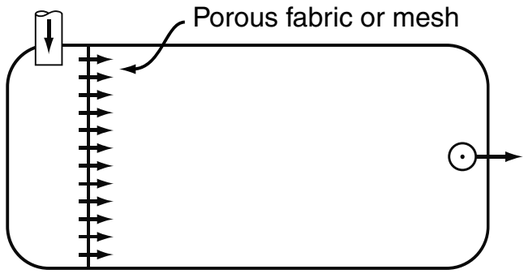


(d) Type C (dry) basin with riser pipe outlet system (plan view)

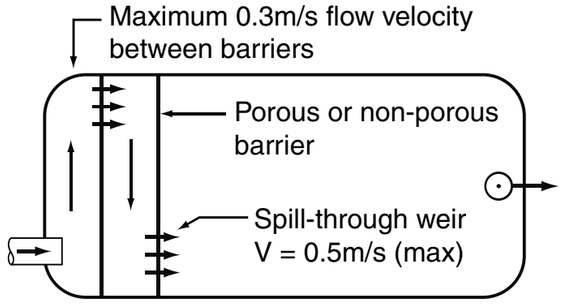
Drawn:	Date:		
GMW	Feb-10	Sediment Basins	SB-01



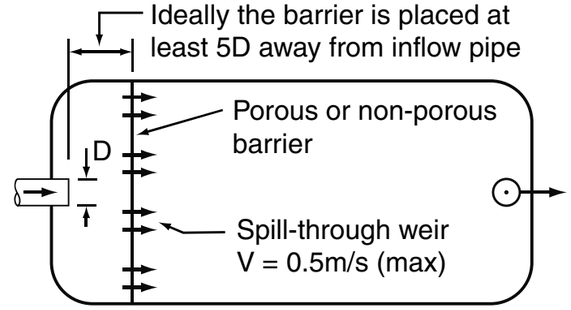
(a1) Porous barrier inlet chamber (plan view)



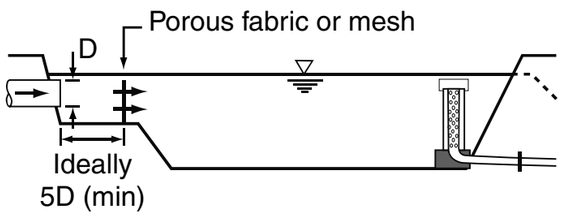
(b1) Porous barrier inlet chamber (plan view)



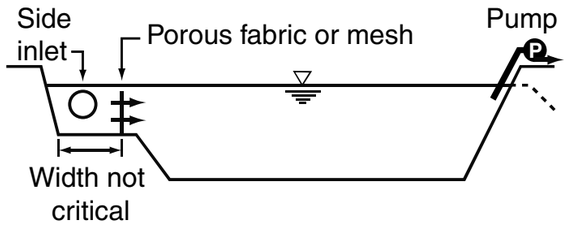
(c1) Alternative inlet chamber (plan view)



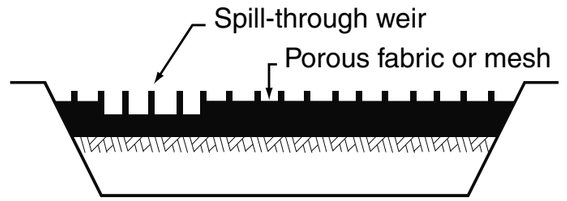
(d1) Alternative inlet chamber (plan view)



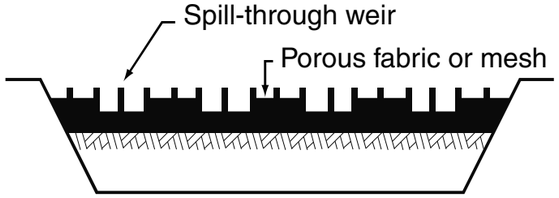
(a2) Typical layout of inlet chamber (long-section)



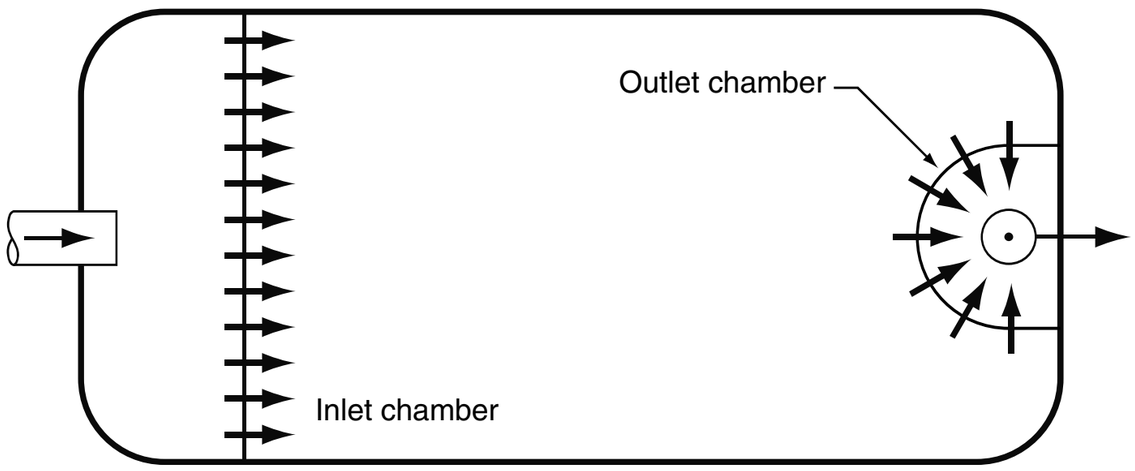
(b2) Typical layout of inlet chamber (long-section)



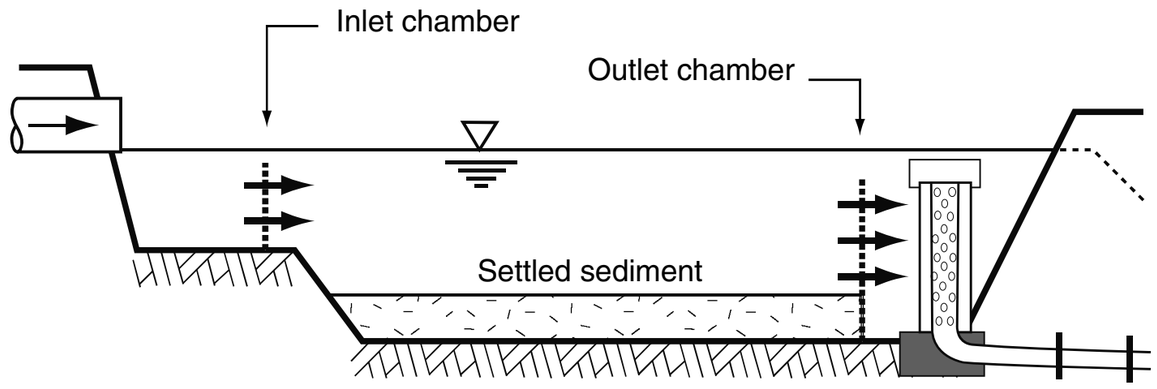
(c2) Single spill-through weir per barrier



(d2) Multiple spill-through weirs per barrier

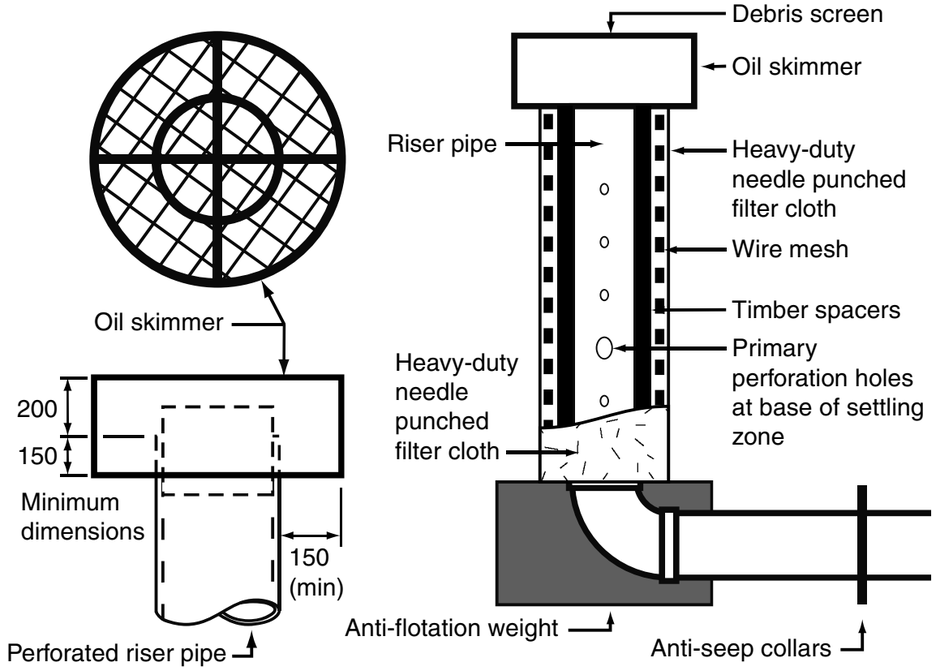


(e) Typical arrangement of inlet and outlet chambers (plan view)

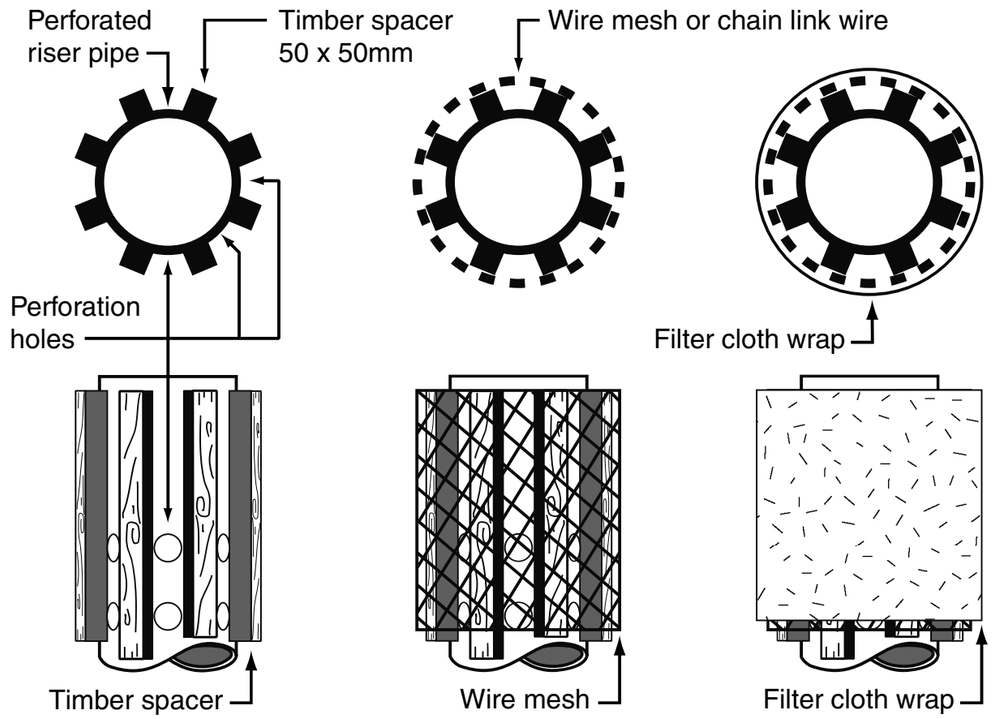


(f) Typical arrangement of inlet and outlet chambers (long-section)

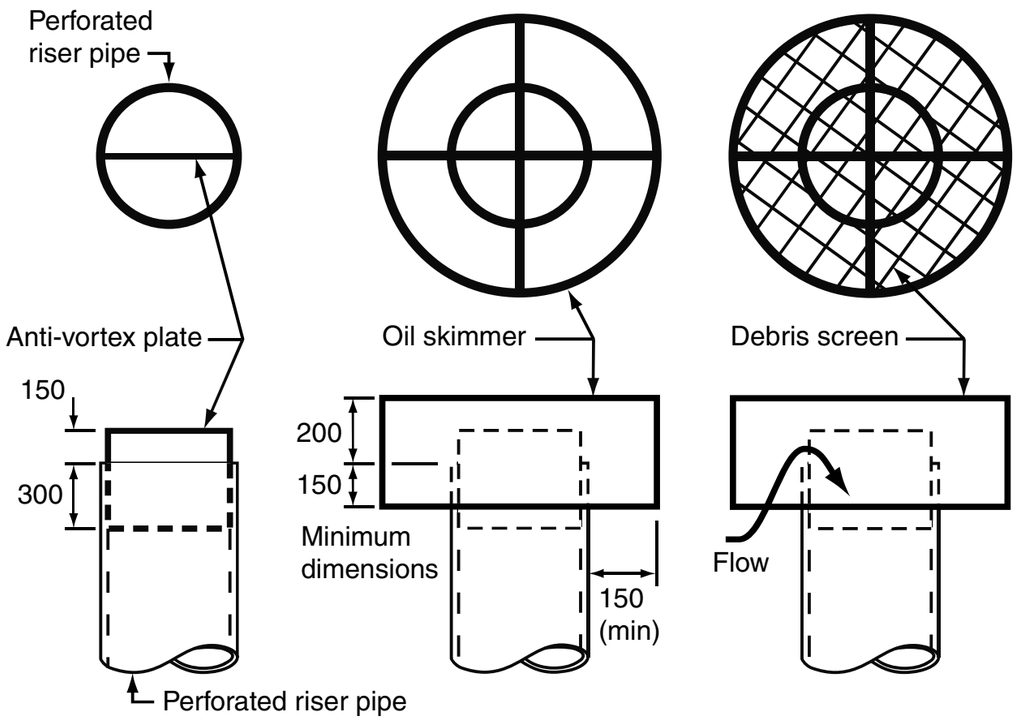
Drawn:	Date:		
GMW	Feb-10	Sediment Basins - Inlet Chambers and Outlet Chambers	SB-02



(a) Riser pipe outlet with geofabric filtration system



(b) Typical assembly of riser pipe with geotextile filter



(c) Anti-vortex plate, oil skimmer and debris screen

Drawn:	Date:		
GMW	Feb-10	Sediment Basins - Riser Pipe Primary Outlet System	SB-03

INSTALLATION OF RISER PIPE

1. DRILL DE-WATERING HOLES IN THE RISER AS SPECIFIED ON THE PLAN.

2. EXCAVATE ANTI-FLOTATION PIT.

3. SECURELY ATTACH THE RISER TO THE CONDUIT OR CONDUIT STUB TO MAKE A WATERTIGHT STRUCTURAL CONNECTION. SECURE ALL CONNECTIONS BETWEEN CONDUIT SECTIONS BY APPROVED WATERTIGHT ASSEMBLIES.

4. ATTACH THE ANTI-SEEP COLLARS TO THE CONDUIT AS SHOWN ON THE APPROVED PLAN, OR OTHERWISE AS SPECIFIED.

5. PLACE THE CONDUIT AND RISER ON A FIRM, SMOOTH FOUNDATION OF IMPERVIOUS SOIL. DO NOT USE PERVIOUS MATERIAL SUCH AS SAND, GRAVEL, OR CRUSHED ROCK AS BACKFILL AROUND THE CONDUIT OR ANTI-SEEP COLLARS.

6. PLACE FILL MATERIAL AROUND THE CONDUIT IN 100mm LAYERS AND COMPACT AROUND THE PIPE TO AT LEAST THE SAME DENSITY AS THE ADJACENT EMBANKMENT. ENSURE APPROPRIATE CARE IS TAKEN NOT TO RAISE THE PIPE FROM FIRM CONTACT WITH ITS FOUNDATION WHEN COMPACTING UNDER THE PIPE HAUNCHES.

7. PLACE A MINIMUM DEPTH OF 600mm OF LIGHTLY COMPACTED BACKFILL OVER THE CONDUIT BEFORE CROSSING IT WITH CONSTRUCTION EQUIPMENT.

8. ANCHOR THE RISER IN PLACE BY CONCRETE OR OTHER SATISFACTORY MEANS TO PREVENT FLOTATION. ENSURE THE ANTI-FLOTATION MASS IS AT LEAST 110% OF WATER MASS DISPLACED BY THE RISER PIPE OUTLET SYSTEM, INCLUDING THE VOLUME DISPLACED BY THE ANTI-FLOTATION WEIGHT.

9. IN NO CASE SHOULD THE CONDUIT BE INSTALLED BY CUTTING A TRENCH THROUGH THE DAM AFTER THE EMBANKMENT IS COMPLETED.

10. ATTACH ANTI-VORTEX DEVICE AND TRASH GUARD TO RISER AND AS REQUIRED (REFER TO SPECIFICATIONS SHOWN ON THE APPROVED PLANS).

MAINTENANCE

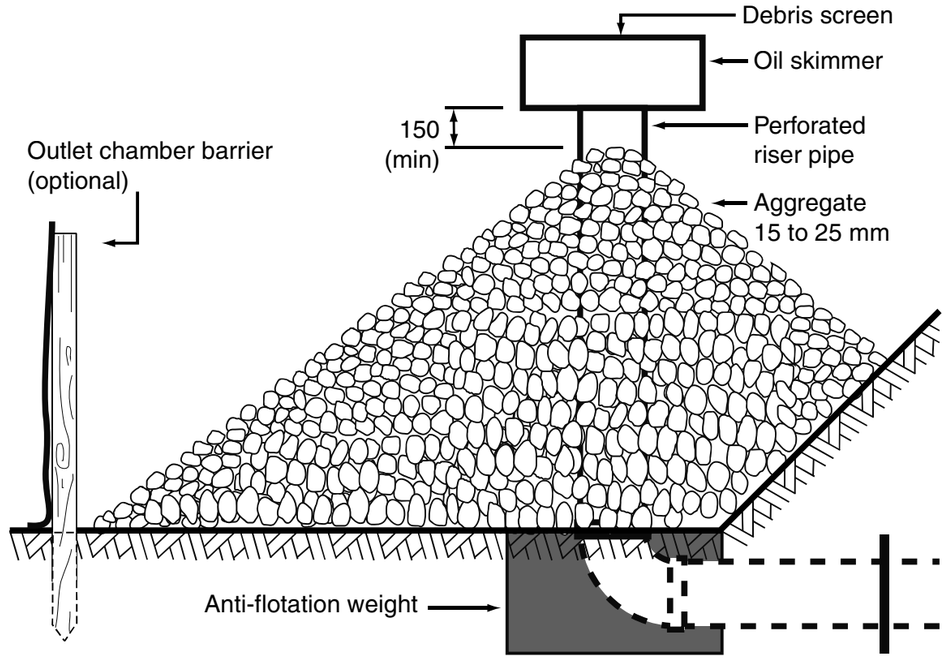
1. CHECK ALL VISIBLE PIPE CONNECTIONS FOR LEAKS, AND REPAIR AS NECESSARY.

2. REMOVE ALL TRASH AND OTHER DEBRIS FROM THE BASIN AND RISER.

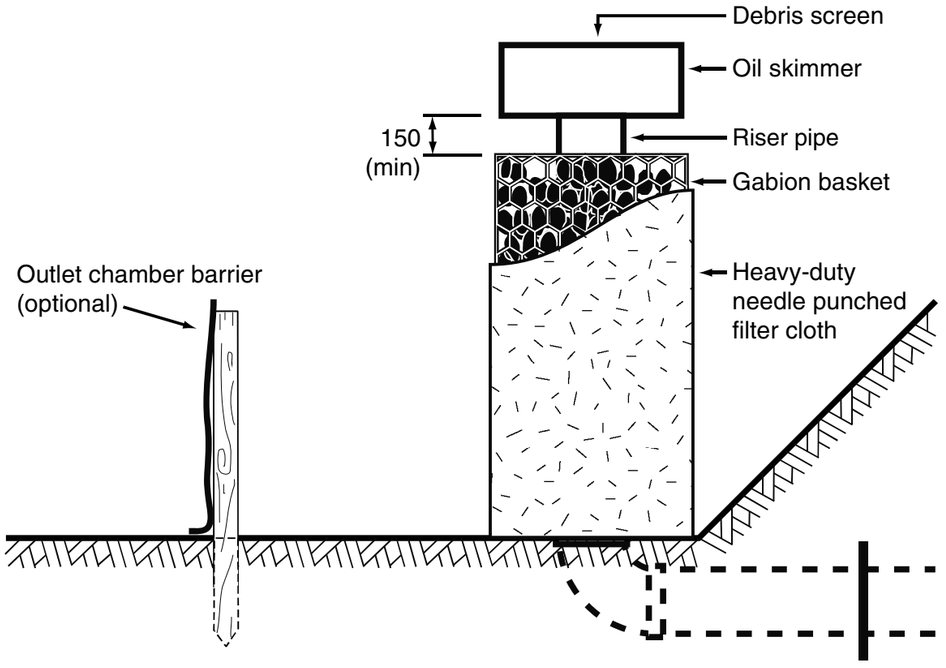
3. SUBMERGED INFLOW PIPES MUST BE INSPECTED AND DE-SILTED (AS REQUIRED) AFTER EACH INFLOW EVENT.

REMOVAL

1. DISPOSE OF ALL MATERIALS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.



(a) Riser pipe outlet with aggregate filtration system



(b) Riser pipe outlet with rock-filled gabion basket filter system

Drawn:	Date:		
GMW	Feb-10	Sediment Basins - Riser Pipe Primary Outlet System	SB-04

MATERIALS

EARTH FILL: CLEAN SOIL WITH EMERSON CLASS 2(1), 3, 4, OR 5, AND FREE OF ROOTS, WOODY VEGETATION, ROCKS AND OTHER UNSUITABLE MATERIAL. SOIL WITH EMERSON CLASS 4 AND 5 MAY NOT BE SUITABLE DEPENDING ON PARTICLE SIZE DISTRIBUTION AND DEGREE OF DISPERSION. CLASS 2(1) SHOULD ONLY BE USED UPON RECOMMENDATION FROM GEOTECHNICAL SPECIALIST. THIS SPECIFICATION MAYBE REPLACED BY AN EQUIVALENT STANDARD BASED ON THE EXCHANGEABLE SODIUM PERCENTAGE.

RISER PIPE: MINIMUM 250mm DIAMETER.

SPILLWAY ROCK: HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED ROCK WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL (d50) ROCK SIZE. LARGE ROCK SHOULD DOMINATE, WITH SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. THE SPECIFIC GRAVITY SHOULD BE AT LEAST 2.5.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM 'BIDIM' A24 OR EQUIVALENT.

CONSTRUCTION

1. NOTWITHSTANDING ANY DESCRIPTION CONTAINED WITHIN THE APPROVED PLANS OR SPECIFICATIONS, THE CONTRACTOR SHALL BE RESPONSIBLE FOR SATISFYING THEMSELVES AS TO THE NATURE AND EXTENT OF THE SPECIFIED WORKS AND THE PHYSICAL AND LEGAL CONDITIONS UNDER WHICH THE WORKS WILL BE CARRIED OUT. THIS SHALL INCLUDE MEANS OF ACCESS, EXTENT OF CLEARING, NATURE OF MATERIAL TO BE EXCAVATED, TYPE AND SIZE OF MECHANICAL PLANT REQUIRED, LOCATION AND SUITABILITY OF WATER SUPPLY FOR CONSTRUCTION AND TESTING PURPOSES, AND ANY OTHER LIKE MATTERS AFFECTING THE CONSTRUCTION OF THE WORKS.

2. REFER TO APPROVED PLANS FOR LOCATION, DIMENSIONS, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

3. BEFORE STARTING ANY CLEARING OR CONSTRUCTION, ENSURE ALL THE NECESSARY MATERIALS AND COMPONENTS ARE ON THE SITE TO AVOID DELAYS IN COMPLETING THE POND ONCE WORKS BEGIN.

4. INSTALL REQUIRED SHORT-TERM SEDIMENT CONTROL MEASURES DOWNSTREAM OF THE PROPOSED EARTHWORKS TO CONTROL SEDIMENT RUNOFF DURING CONSTRUCTION OF THE BASIN.

5. THE AREA TO BE COVERED BY THE EMBANKMENT, BORROW PITS AND INCIDENTAL WORKS, TOGETHER WITH AN AREA EXTENDING BEYOND THE LIMITS OF EACH FOR A DISTANCE NOT EXCEEDING FIVE (5) METRES ALL AROUND MUST BE CLEARED OF ALL TREES, SCRUB, STUMPS, ROOTS, DEAD TIMBER AND RUBBISH AND DISPOSED OF IN A SUITABLE MANNER. DELAY CLEARING THE MAIN POND AREA UNTIL THE EMBANKMENT IS COMPLETE.

6. ENSURE ALL HOLES MADE BY GRUBBING WITHIN THE EMBANKMENT FOOTPRINT ARE FILLED WITH SOUND MATERIAL, ADEQUATELY COMPACTED, AND FINISHED FLUSH WITH THE NATURAL SURFACE.
CUT-OFF TRENCH:

7. BEFORE CONSTRUCTION OF THE CUT-OFF TRENCH OR ANY ANCILLARY WORKS WITHIN THE EMBANKMENT FOOTPRINT, ALL GRASS GROWTH AND TOPSOIL MUST BE REMOVED FROM THE AREA TO BE OCCUPIED BY THE EMBANKMENT AND MUST BE DEPOSITED CLEAR OF THIS AREA AND RESERVED FOR TOPDRESSING THE COMPLETING THE EMBANKMENT.

8. EXCAVATE A CUT-OFF TRENCH ALONG THE CENTRE LINE OF THE EARTH FILL EMBANKMENT. CUT THE TRENCH TO STABLE SOIL MATERIAL, BUT IN NO CASE MAKE IT LESS THAN 600mm DEEP. THE CUT-OFF TRENCH MUST EXTEND INTO BOTH ABUTMENTS TO AT LEAST THE ELEVATION OF THE RISER PIPE CREST. MAKE THE MINIMUM BOTTOM WIDTH WIDE ENOUGH TO PERMIT OPERATION OF EXCAVATION AND COMPACTION EQUIPMENT, BUT IN NO CASE LESS THAN 600mm. MAKE THE SIDE SLOPES OF THE TRENCH NO STEEPER THAN 1:1 (H:V).

9. ENSURE ALL WATER, LOOSE SOIL, AND ROCK ARE REMOVED FROM THE TRENCH BEFORE BACKFILLING COMMENCES. THE CUT-OFF TRENCH MUST BE BACKFILLED WITH SELECTED EARTH-FILL OF THE TYPE SPECIFIED FOR THE EMBANKMENT, AND THIS SOIL MUST HAVE A MOISTURE CONTENT AND DEGREE OF COMPACTION THE SAME AS THAT SPECIFIED FOR THE SELECTED CORE ZONE.

10. MATERIAL EXCAVATED FROM THE CUT-OFF TRENCH MAY BE USED IN CONSTRUCTION OF THE EMBANKMENT PROVIDED IT IS SUITABLE AND IT IS PLACED IN THE CORRECT ZONE ACCORDING TO ITS CLASSIFICATION.

EMBANKMENT:

11. SCARIFY AREAS ON WHICH FILL IS TO BE PLACED BEFORE PLACING THE FILL.

12. ENSURE ALL FILL MATERIAL USED TO FORM THE EMBANKMENT MEETS THE SPECIFICATIONS CERTIFIED BY A SOIL SCIENTIST OR GEOTECHNICAL SPECIALIST.

13. THE FILL MATERIAL MUST CONTAIN SUFFICIENT MOISTURE SO IT CAN BE FORMED BY HAND INTO A BALL WITHOUT CRUMBLING. IF WATER CAN BE SQUEEZED OUT OF THE BALL, IT IS TOO WET FOR PROPER COMPACTION. PLACE FILL MATERIAL IN 150 TO 250mm CONTINUOUS LAYERS OVER THE ENTIRE LENGTH OF THE FILL AREA AND THEN COMPACT BEFORE PLACEMENT OF FURTHER FILL.

14. PLACE RISER PIPE OUTLET SYSTEM, IF SPECIFIED, IN APPROPRIATE SEQUENCE WITH THE EMBANKMENT FILLING. REFER TO SEPARATE INSTALLATION SPECIFICATIONS.

15. UNLESS OTHERWISE SPECIFIED ON THE APPROVED PLANS, COMPACT THE SOIL AT ABOUT 1% TO 2% WET OF OPTIMUM AND TO 95% MODIFIED OR 100% STANDARD COMPACTION.

16. WHERE BOTH DISPERSIVE AND NON-DISPERSIVE CLASSIFIED EARTH-FILL MATERIALS ARE AVAILABLE, NON-DISPERSIVE EARTH-FILL MUST BE USED IN THE CORE ZONE. THE REMAINING CLASSIFIED EARTH-FILL MATERIALS MUST ONLY BE USED AS DIRECTED BY [INSERT TITLE].

17. WHERE SPECIFIED, CONSTRUCT THE EMBANKMENT TO AN ELEVATION 10% HIGHER THAN THE DESIGN HEIGHT TO ALLOW FOR SETTLING; OTHERWISE FINISHED DIMENSIONS OF THE EMBANKMENT AFTER SPREADING OF TOPSOIL MUST CONFORM TO THE DRAWING WITH A TOLERANCE OF 75mm FROM THE SPECIFIED DIMENSIONS.

18. ENSURE DEBRIS AND OTHER UNSUITABLE BUILDING WASTE IS NOT PLACED WITHIN THE EARTH EMBANKMENT.

19. AFTER COMPLETION OF THE EMBANKMENT ALL LOOSE UNCOMPACTED EARTH-FILL MATERIAL ON THE UPSTREAM AND DOWNSTREAM BATTER MUST BE REMOVED PRIOR TO SPREADING OF TOPSOIL.

20. TOPSOIL AND REVEGETATE/STABILISED ALL EXPOSED EARTH AS DIRECTED WITHIN THE APPROVED PLANS.

(continued on SB-06)

Drawn:	Date:		
GMW	Feb-10	Sediment Basins	SB-05

SPILLWAY CONSTRUCTION:

21. THE SPILLWAY MUST BE EXCAVATED AS SHOWN ON THE PLANS, AND THE EXCAVATED MATERIAL IF CLASSIFIED AS SUITABLE, MUST BE USED IN THE EMBANKMENT, AND IF NOT SUITABLE IT MUST BE DISPOSED OF INTO SPOIL HEAPS.

22. ENSURE EXCAVATED DIMENSIONS ALLOW ADEQUATE BOXING-OUT SUCH THAT THE SPECIFIED ELEVATIONS, GRADES, CHUTE WIDTH, AND ENTRANCE AND EXIT SLOPES FOR THE EMERGENCY SPILLWAY WILL BE ACHIEVED AFTER PLACEMENT OF THE ROCK OR OTHER SCOUR PROTECTION MEASURES AS SPECIFIED IN THE PLANS.

23. PLACE SPECIFIED SCOUR PROTECTION MEASURES ON THE EMERGENCY SPILLWAY. ENSURE THE FINISHED GRADE BLENDS WITH THE SURROUNDING AREA TO ALLOW A SMOOTH FLOW TRANSITION FROM SPILLWAY TO DOWNSTREAM CHANNEL.

24. IF A SYNTHETIC FILTER FABRIC UNDERLAY IS SPECIFIED, PLACE THE FILTER FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN ONE SHEET OF FILTER FABRIC IS REQUIRED, OVERLAP THE EDGES BY AT LEAST 300mm AND PLACE ANCHOR PINS AT MINIMUM 1m SPACING ALONG THE OVERLAP. BURY THE UPSTREAM END OF THE FABRIC A MINIMUM 300mm BELOW GROUND AND WHERE NECESSARY, BURY THE LOWER END OF THE FABRIC OR OVERLAP A MINIMUM 300mm OVER THE NEXT DOWNSTREAM SECTION AS REQUIRED. ENSURE THE FILTER FABRIC EXTENDS AT LEAST 1000mm UPSTREAM OF THE SPILLWAY CREST.

25. TAKE CARE NOT TO DAMAGE THE FABRIC DURING OR AFTER PLACEMENT. IF DAMAGE OCCURS, REMOVE THE ROCK AND REPAIR THE SHEET BY ADDING ANOTHER LAYER OF FABRIC WITH A MINIMUM OVERLAP OF 300mm AROUND THE DAMAGED AREA. IF EXTENSIVE DAMAGE IS SUSPECTED, REMOVE AND REPLACE THE ENTIRE SHEET.

26. WHERE LARGE ROCK IS USED, OR MACHINE PLACEMENT IS DIFFICULT, A MINIMUM 100mm LAYER OF FINE GRAVEL, AGGREGATE, OR SAND MAY BE NEEDED TO PROTECT THE FABRIC.

27. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER FABRIC. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS. THE DESIRED DISTRIBUTION OF ROCK THROUGHOUT THE MASS MAY BE OBTAINED BY SELECTIVE LOADING AT THE QUARRY AND CONTROLLED DUMPING DURING FINAL PLACEMENT.

28. THE FINISHED SLOPE SHOULD BE FREE OF POCKETS OF SMALL ROCK OR CLUSTERS OF LARGE ROCKS. HAND PLACING MAY BE NECESSARY TO ACHIEVE THE PROPER DISTRIBUTION OF ROCK SIZES TO PRODUCE A RELATIVELY SMOOTH, UNIFORM SURFACE. THE FINISHED GRADE OF THE ROCK SHOULD BLEND WITH THE SURROUNDING AREA. NO OVERFALL OR PROTRUSION OF ROCK SHOULD BE APPARENT.

29. ENSURE THAT THE FINAL ARRANGEMENT OF THE SPILLWAY CREST WILL NOT PROMOTE EXCESSIVE FLOW THROUGH THE ROCK SUCH THAT THE WATER CAN BE RETAINED WITHIN THE SETTLING BASIN AN ELEVATION NO LESS THAN 50mm ABOVE OR BELOW THE NOMINATED SPILLWAY CREST ELEVATION. ESTABLISHMENT OF SETTLING POND:

30. THE AREA TO BE COVERED BY THE STORED WATER OUTSIDE THE LIMITS OF THE BORROW PITS MUST BE CLEARED OF ALL SCRUB AND RUBBISH. TREES MUST BE CUT DOWN STUMP HIGH AND REMOVED FROM THE IMMEDIATE VICINITY OF THE WORK.

31. ESTABLISH ALL REQUIRED INFLOW CHUTES AND INLET BAFFLES, IF SPECIFIED, TO ENABLE WATER TO DISCHARGE INTO THE BASIN IN A MANNER THAT WILL NOT CAUSE SOIL EROSION OR THE RE-SUSPENSION OF SETTLED SEDIMENT.

32. INSTALL A SEDIMENT STORAGE LEVEL MARKER POST WITH A CROSS MEMBER SET JUST BELOW THE TOP OF THE SEDIMENT STORAGE ZONE (AS SPECIFIED ON THE APPROVED PLANS). USE AT LEAST A 75mm WIDE POST FIRMLY SET INTO THE BASIN FLOOR.

33. IF SPECIFIED, INSTALL INTERNAL SETTLING POND BAFFLES. ENSURE THE CREST OF THESE BAFFLES IS SET LEVEL WITH, OR JUST BELOW, THE ELEVATION OF THE EMERGENCY SPILLWAY CREST.

34. INSTALL ALL APPROPRIATE MEASURES TO MINIMISE SAFETY RISK TO ON-SITE PERSONNEL AND THE PUBLIC CAUSED BY THE PRESENCE OF THE SETTLING POND. AVOID STEEP, SMOOTH INTERNAL SLOPES. APPROPRIATELY FENCE THE SETTLING POND AND POST WARNING SIGNS IF UNSUPERVISED PUBLIC ACCESS IS LIKELY OR THERE IS CONSIDERED TO BE AN UNACCEPTABLE RISK TO THE PUBLIC.

MAINTENANCE OF SEDIMENT BASIN

1. INSPECT THE SEDIMENT BASIN DURING THE FOLLOWING PERIODS:

(i) DURING CONSTRUCTION TO DETERMINE WHETHER MACHINERY, FALLING TREES, OR CONSTRUCTION ACTIVITY HAS DAMAGED ANY COMPONENTS OF THE SEDIMENT BASIN. IF DAMAGE HAS OCCURRED, REPAIR IT.

(ii) AFTER EACH RUNOFF EVENT. INSPECT THE EROSION DAMAGE AT FLOW ENTRY AND EXIT POINTS. IF DAMAGE HAS OCCURRED, MAKE THE NECESSARY REPAIRS.

(iii) AT LEAST WEEKLY DURING THE NOMINATED WET SEASON (IF ANY) OTHERWISE AT LEAST FORTNIGHTLY.

(iv) PRIOR TO, AND IMMEDIATELY AFTER, PERIODS OF 'STOP WORK' OR SITE SHUTDOWN.

2. CLEAN OUT ACCUMULATED SEDIMENT WHEN IT REACHES THE MARKER BOARD/POST, AND RESTORE THE ORIGINAL STORAGE VOLUME. PLACE SEDIMENT IN A DISPOSAL AREA OR, IF APPROPRIATE, MIX WITH DRY SOIL ON THE SITE.

3. DO NOT DISPOSE OF SEDIMENT IN A MANNER THAT WILL CREATE AN EROSION OR POLLUTION HAZARD.

4. CHECK ALL VISIBLE PIPE CONNECTIONS FOR LEAKS, AND REPAIR AS NECESSARY.

5. CHECK ALL EMBANKMENTS FOR EXCESSIVE SETTLEMENT, SLUMPING OF THE SLOPES OR PIPING BETWEEN THE CONDUIT AND THE EMBANKMENT; MAKE ALL NECESSARY REPAIRS.

6. REMOVE ALL TRASH AND OTHER DEBRIS FROM THE BASIN AND RISER.

7. SUBMERGED INFLOW PIPES MUST BE INSPECTED AND DE-SILTED (AS REQUIRED) AFTER EACH INFLOW EVENT.

REMOVAL OF SEDIMENT BASIN

1. WHEN GRADING AND CONSTRUCTION IN THE DRAINAGE AREA ABOVE A TEMPORARY SEDIMENT BASIN IS COMPLETED AND THE DISTURBED AREAS ARE ADEQUATELY STABILISED, THE BASIN MUST BE REMOVED OR OTHERWISE INCORPORATED INTO THE PERMANENT STORMWATER DRAINAGE SYSTEM. IN EITHER CASE, SEDIMENT SHOULD BE CLEARED AND PROPERLY DISPOSED OF AND THE BASIN AREA STABILISED.

2. BEFORE STARTING ANY MAINTENANCE WORK ON THE BASIN OR SPILLWAY, INSTALL ALL NECESSARY SHORT-TERM SEDIMENT CONTROL MEASURES DOWNSTREAM OF THE SEDIMENT BASIN.

3. ALL WATER AND SEDIMENT MUST BE REMOVED FROM THE BASIN PRIOR TO THE DAM'S REMOVAL. DISPOSE OF SEDIMENT AND WATER IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

4. BRING THE DISTURBED AREA TO A PROPER GRADE, THEN SMOOTH, COMPACT, AND STABILISE AND/OR REVEGETATE AS REQUIRED TO ESTABLISH A STABLE LAND SURFACE.

Drawn:	Date:		
GMW	Feb-10	Sediment Basins	SB-06

Appendix G: Blue Book Calculations

1. Erosion Hazard and Sediment Basins

Site Name: **Bringelly**

Site Location: **Pit**

Precinct/Stage: **Developed with diversion**

Other Details: **average slopes and lengths used from nearmaps**

Site area	Sub-catchment or Name of Structure						Notes
	dam 1	2	3	4	5	7	
Total catchment area (ha)	3.1		31.2	8.8	3	7.4	
Disturbed catchment area (ha)	3.1		31.2	8.8	3		

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	D	D	D	D	D	D	From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)							Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	D	D	D	D	D	D	Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5		5	5	5	5	See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	90		90	90	90	90	
x-day, y-percentile rainfall event (mm)	42.6		42.6	42.6	42.6	42.6	
Rainfall R-factor (if known)							Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)	9.74	9.74	9.74	9.74	9.74	9.74	

RUSLE Factors

Rainfall erosivity (*R* -factor)	2110	2110	2110	2110	2110	2110	Auto-filled from above
Soil erodibility (*K* -factor)	0.05		0.05	0.05	0.05	0.05	RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	100		300	220	220	280	
Slope gradient (%)	3		10	3	3	7	
Length/gradient (*LS* -factor)	0.72		6.92	1.05	1.05	3.87	
Erosion control practice (*P* -factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C* -factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	2	2	2	2	2	2	Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.69	0.69	0.69	0.69	0.69	0.69	See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	99		949	144	144	531	
Soil Loss Class	1		6	1	1	5	See Table 4.2, page 4-13
Soil loss (m^3/ha/yr)	76		730	111	111	408	Conversion to cubic metres
Sediment basin storage (soil) volume (m^3)	39		3795	163	55		See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m^3)	911		9171	2587	882	2175	See Sections 6.3.4(i) for calculations
Sediment basin total volume (m^3)	950		12966	2750	937		

NB for sizing of Type C (coarse) sediment basins, see Worksheet 3 (if required).