

Hanson Construction Materials Pty Ltd



Surface Water Hydrology Assessment and Management

Hansons Somersby Quarry Project

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January 2010

ENVIRONMENTAL



WATER



WASTEWATER



GEOTECHNICAL



CIVIL



PROJECT
MANAGEMENT



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Head Office
6/37 Leighton Place
Hornsby, NSW 2077, Australia
ACN 070 240 890 ABN 85 070 240 890
Phone: +61-2-9476-9999
Fax: +61-2-9476-8767
Email: mail@martens.com.au
Web: www.martens.com.au

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Megan Bowling			Andrew Norris		Andrew Norris			
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All enquiries regarding this project are to be directed to the Project Manager.

Executive Summary

Overview

A preliminary Surface Water Assessment, completed in July, 2008 (Martens and Associates) formed part of a Preliminary Environmental Assessment (PEA) for the NSW Department of Planning (DoP) as part of an application for a boundary readjustment and expansion of the resource extraction operations of the existing Somersby Quarry (Central Coast Sands) into the subject site.

Subsequent Director-General's Requirements (DGEARs) were released on 22 October, 2008. Regarding surface water hydrology and management, the DGEARs require the following:

- *A detailed description of the potential incremental and cumulative impacts of the project on surface water resources in the area during all stages of the project, paying particular attention to potential impacts of the project on Mooney Mooney Creek and the Money Dam catchment; and*
- *A site water balance detailing the availability of a sustainable water supply and measures to minimise water use and manage any water discharges.*

Mooney Mooney Dam Catchment

Two (2) unnamed tributaries of Mooney Mooney Creek were identified as being potentially influenced by flows from the existing and proposed site.

1. Unnamed Tributary 1 is classed as a Category 3 watercourse and was found to be generally in poor condition upstream of the existing quarry, (eutrophication and bank erosion) downstream of the quarry the morphology and condition of the creek is improved. Flow within the watercourse principally comes from overflow from the quarry's 'Make Up' dam (licensed by the NSW EPA as Point 1) and some minor site runoff.
2. Unnamed Tributary 2 is also a Category 3 watercourse, however quarried areas do not drain into the watercourse and water quality/quantity is not effected by quarry activities.

No drainage lines traverse the proposed expansion site or are within close proximity of it. As the site is hydrogeologically upslope of the existing quarry, all runoff from the proposed site currently flows into current pit areas and therefore the surface water flow regime will remain unchanged as a result of the development.

Water Balance Assessment

The water balance assessment indicates that the site currently, and will continue to have, a surplus of water after all site demands/uses are satisfied. Although this surplus is predicted to increase from current volumes by 16.7%, based on the current ultimate approved quarry form, surplus is predicted to decrease by 17.5%. This is almost entirely attributed to changes in groundwater interception between the three scenarios.

The water balance demonstrates that sufficient water will be available to satisfy demands for process waters and future demands associated with irrigation of remediation areas.

Water Cycle Management Measures

Water Quantity

Water balance modelling results suggest that the predicted increase in flows is not considered significant, and the two EPA discharge points are appropriately armoured to dissipate these flows and thus prevent erosion and scour of the identified tributaries of Mooney Mooney Creek. This rip rap shall be maintained as part of the proposal and the ongoing operation of the quarry.

Water Quality

1. To ensure acceptable post-development water quality outcomes, the existing Make Up dam is to be modified to include;
 - A deepened 'deep water zone' in the dam. of 1335 m² deepened to 2.0m (if required) to achieve enhanced sedimentation of fines (to a size of 75 µm) prior to any required site discharge. The 'deep water zone' is to be located such that dam inflow pass through it first.
 - A macrophyte zone at the outlet of the dam to enhance the removal of colloidal clays and other sub 75 µm material. The macrophyte zone is to extend 50m from the outlet pipes as shown on the attached plans. The macrophyte zone is to be regraded to provide a water depth of approximately 500 mm and have an area of approximately 2500 m².
2. The existing site water cycle management process is to be formalised as per Section 6.
3. The remnants of the drainage line shown in Figure 2 require stabilisation and revegetation remediation to reduce sedimentation of downstream receiving environments. We recommend jute matting and revegetation in this area,

Contents

1 OVERVIEW	8
1.1 Background	8
1.2 Scope	8
2 SITE AND PROPOSAL DESCRIPTION	10
2.1 Existing Land Use	10
2.2 Proposed Development	10
3 GEOMORPHIC ASSESSMENT	11
3.1 Unnamed Tributary 1	11
3.1.1 Location	11
3.1.2 Geomorphology	11
3.1.3 Classification and Significance	12
3.1.4 Quarry Discharge	13
3.2 Unnamed Tributary 2	14
3.2.1 Location	14
3.2.2 Geomorphology and Condition	14
3.2.3 Classification	14
3.2.4 Quarry Drainage	14
3.3 Proposed Expansion Site	14
4 EXISTING WATER CYCLE MANAGEMENT	16
4.1 Catchment Flows	16
4.2 Existing Stormwater Management Plan	16
5 WATER BALANCE ASSESSMENT.....	18
5.1 Overview	18
5.2 Methodology	18
5.3 Water Supply	18
5.3.1 Rainfall	18
5.3.2 Upslope Run-on	18
5.3.3 Groundwater Interception	19
5.4 Water Demand/Uses	19
5.4.1 Evaporation	20
5.4.2 Onsite Demands	20
5.5 Results	20
5.6 Implications and Conclusions	21
6 WATER CYCLE MANAGEMENT PLAN.....	23
6.1 Overview	23
6.2 Water Quantity Treatment	23
6.3 Water Quality Treatment	23
6.4 Water Management Plan	24
7 CONCLUSIONS.....	26
8 REFERENCES.....	28
9 ATTACHMENT A – SITE PLAN	29

10 ATTACHMENT B – FIGURES	31
11 ATTACHMENT C – EXISTING AND PROPOSED WATER CYCLE MANAGEMENT PLAN	39

1 Overview

1.1 Background

A preliminary Surface Water Assessment was completed in July, 2008 (Martens and Associates) to detail the surface water environment at the proposed quarry expansion site. This included both a desktop study and site investigations to document conditions of existing drainage lines.

The Surface Water Assessment formed part of a Preliminary Environmental Assessment (PEA) for the NSW Department of Planning (DoP) as part of an application for a boundary readjustment and expansion of the resource extraction operations of the existing Somersby Quarry (Central Coast Sands) into the subject site.

Subsequent Director-General's Requirements (DGEARs) were released on 22 October, 2008. Regarding surface water hydrology and management, the DGEARs require the following:

- A detailed description of the potential incremental and cumulative impacts of the project on surface water resources in the area during all stages of the project, paying particular attention to potential impacts of the project on Mooney Mooney Creek and the Money Dam catchment; and
- A site water balance detailing the availability of a sustainable water supply and measures to minimise water use and manage any water discharges.

1.2 Scope

This Surface Water Assessment aims to assess the potential impacts of the proposal on the existing surface water regime at the site and demonstrate that the proposed development is sustainable. The current site stormwater management scheme will be reviewed and necessary measures for management and treatment will be outlined to protect the environment of downstream receiving waters. Specifically, this document shall:

1. Assess the geomorphic condition of existing drainage lines and their significance;
2. Assess likely flows into quarried areas and outline the existing Stormwater Management Scheme including water supply resources, water storages and treatment;

3. Undertake a water balance assessment;
4. Assess the implications of surface water hydrology changes, including surface water treatment and discharge alterations; and
5. Investigate water balance management requirements and the likely treatment and discharge strategies for disposal of water during operation and at final finished form.

2 Site and Proposal Description

2.1 Existing Land Use

The proposed extension site (Figure 1) is identified as part of Lot 10 DP 1090880, Keighley Road, Somersby within the Gosford City Council local government area (LGA) and is zoned as 1 (a) Non-Urban. The site has a total area of approximately 8 ha and is currently used for intensive agriculture including:

- Cultivation of avocados,
- Cultivation of oranges, and
- Poultry farming.

Structures found on site include;

- Existing weatherboard/fibro clad dwelling fronting Keighley Road,
- Four poultry sheds of varying size (averaging 1573 m²),
- A fuel pump, and
- Various farm equipment and storage sheds.

Figure 1 (Attachment B) provides the location of these onsite activities and structures.

2.2 Proposed Development

The site is to the north east of and adjacent to Hanson's existing Somersby Quarry. The proposed development involves 2 primary components:

1. A boundary readjustment between the existing quarry and the adjoining subject site for the purposes of adding the additional area to the existing quarry; and
2. Expansion of the resource extraction operations of the existing quarry into the subject site to extend the life of operations by a projected 35 years (note annual quarry output will remain unchanged).

3 Geomorphic Assessment

3.1 Unnamed Tributary 1

3.1.1 Location

Review of the 1:25 000 topographic map (Figure 2), reveals an existing drainage line ('Unnamed Tributary 1') traversing the active quarry site from east to west. As shown in Figure 3, Unnamed Tributary 1 commences at the overflow of a dam on the eastern neighbouring property and enters the quarry site through a constructed bund. It then flows into the existing extraction area.

Evidence of the original watercourse exiting the site at the western boundary (Figure 4) was observed. However, there is reduced flow in this depression due to interception of flow by the existing pit. Rip rap has been placed at the outlet to protect the downstream channel.

3.1.2 Geomorphology

Unnamed Tributary 1 flows through neighbouring Brisbane Waters National Park as a minor tributary of Mooney Mooney Creek. This portion of Mooney Mooney Creek is dammed downstream of where the tributary join the main creek.

Due to varying conditions of the watercourse, it has been split into 2 reaches for the purposes of this assessment; that reach upstream of the quarry and that downstream of the quarry.

Upstream of Quarry

Site inspection has shown that the watercourse is heavily disturbed upstream of the existing quarry site. Bed and bank vegetation is limited and consists mainly of exotic trees and vines. The right bank appears unstable and there is evidence of active erosion and undercutting (Figure 3). Dam discharge into the watercourse appears to be highly eutrophied and affected by algal blooms, most likely due to excess nutrients from current agricultural land use practices on the property.

Further downstream, but before it enters the quarry site, the condition of the watercourse improves with denser vegetation lining the banks. Although consisting primarily of weed species, remnant vegetation also occurs in this area (Figure 3).

Unnamed tributary 1 enters the quarry site through a constructed bund. From here, only remnants of the channel exist. All vegetation, excluding some scattered grasses, has been recently cleared for quarrying

activities. Bed widths range from approximately 0.1m up to 0.5m and bank heights range from 0m to approximately 1.0m and are highly eroded. The watercourse then flows into an active quarry pit and terminates (Figure 3).

Downstream of Quarry

There is some evidence of a downstream channel near the quarries western boundary which receives site runoff during high flow events. As shown in Figure 4, this area is highly silted has no bed or bank vegetation. Flow is constricted within a 'channel' that has formed between 2 banks constructed either side for quarry dams.

Runoff passes through 2 rows of staked hay bales (for sediment and erosion control) before flowing in a 600mm pipe under the site's western boundary road. Rip rap has been placed at the outlet to prevent scour of the downstream receiving environments.

The morphology of the downstream portion of the watercourse is similar to the upstream portion however; the condition of the watercourse is improved. The channel is experiencing some minor silting from quarry runoff however there is no evidence to suggest erosion of banks or undercutting. This can be attributed to the outlet rip rap and denser mainly native vegetation that line both banks (Figure 4).

Flow within the watercourse downstream of the site comes principally from the quarry 'make up' dam (Figure 4 and Figure 6) as the original channel has been totally intercepted by the existing operation. Section 3.1.4 further details the quarry discharge point.

3.1.3 Classification and Significance

Unnamed Tributary 1 is classed, under the Stahler system, as a first order stream. Given it is not considered an environmental corridor and is of minimal quality for terrestrial and aquatic habitat, the tributary is considered a 'Category 3' watercourse, according to Landcom, 2004. Category 3 watercourses typically carry out the function of protecting bank stability, native vegetation and water quality for the greater catchment area. This is particularly important for unnamed tributary 1 which flows directly into Mooney Mooney Creek, which forms part of the Gosford-Wyong Water Supply Scheme and is covered by the Water Sharing Plan for the Kulnurra Mangrove Mountain Groundwater Sources (as 'Zone 8'). Water from this portion of Mooney Mooney Creek is dammed by Mooney Mooney Dam (Figure 5) which is pumped to the Somersby Treatment Plan and then to Gosford residents.

It is therefore necessary that discharge from the site is of an appropriate water quality and water quantity so as to not degrade this part of the catchment.

3.1.4 Quarry Discharge

Unnamed Tributary 1 receives waters directly from the overflow from the quarries 'make up dam' (Figure 5) via a single 450mm HDPE corrugated pipe. This discharge point is one of two points on site licensed by NSW EPA (identified as "Point 2" on the Environmental Protection Licence). As shown in Figure 6, rip rap has also been placed at the outlet of this discharge point to prevent erosion and scour from occurring. At the time of inspection there was a steady flow from this discharge point.

South of Point 2 is the other licensed discharge point identified as 'Point 1' on the Environmental Protection License (EPL) (Figure 5). Overflow from the 'process dam' flows into twin 600mm cast iron pipes, under an internal road and out into a concrete lined channel approximately 400mm deep and 3100mm wide (top width) (Figure 6). This channel continues into the adjoining National Park. Review of the site aerial and contours suggests that flow from this point reaches Unnamed Tributary 1 at a point downstream. It is noted, however, that overflow from this discharge point does not occur as frequently as from Point 2.

The NSW EPA EPL requires discharge flows from the site to be of a certain water quality standard and is monitored annually. Review of the client's most recent EPL has indicated the following water quality parameter concentration limits are required.

Table 1: Water Quality Parameter Limits for Somersby Quarry; NSW EPA

Discharge Point ID	Pollutant	Units	100 percentile Concentration Limit
1	Oil and Grease	mg/L	10
	pH	pH	6.5 - 8.5
	Total Suspended Solids (TSS)	mg/L	50
2	Oil and Grease	mg/L	10
	pH	pH	6.5 - 8.5
	Total Suspended Solids (TSS)	mg/L	50

Review of the last 8 years of annual return information indicates that non-compliance with water quality parameter limits has occurred 6 times. In recent years this has been caused by TSS levels exceeding concentration limits after periods of heavy rainfall.

3.2 Unnamed Tributary 2

3.2.1 Location

The 1:25 000 topographic map (Figure 2) shows another watercourse (Unnamed Tributary 2) flowing from the site's north western corner into the neighbouring Brisbane Waters National Park.

3.2.2 Geomorphology and Condition

Unnamed tributary 2 is a tributary of Money Mooney Creek.

During recent site inspection this watercourse was unable to be located due to dense vegetation along the quarries northern and western boundary and limited access into the National Park area. Examination of recent aerials of the site show the watercourse is densely vegetated along almost the entire length until it reaches Mooney Mooney Creek. Given this and its limited access to the general public, it can be assumed that this tributary is in good condition.

3.2.3 Classification

Like Tributary 1, Tributary 2 is also a first order stream and can be classified as a 'Category 3' creek, important for water quality and bank stability purposes. As this tributary flows directly into Mooney Mooney Creek, it also forms part of the Gosford-Wyong Water Supply Scheme and is covered by the Water Sharing Plan for the Kulnorra Mangrove Mountain Groundwater Sources (as 'Zone 8').

3.2.4 Quarry Drainage

During site inspection there was no evidence to suggest that quarried areas are draining into this watercourse. Site contours suggests that the vegetated areas on the northern and western boundaries drain into this watercourse. As these areas are undisturbed runoff is expected to be commensurate with natural water quality and quantity, thus having no detrimental impact on the downstream catchment/channel.

3.3 Proposed Expansion Site

Review of the 1:25 000 topographic map (Figure 2) shows no drainage lines traversing the proposed expansion site or within close proximity to the site. As the site is hydrogeologically upslope of the existing quarry, all runoff from the proposed site currently flows into current pit areas.

This surface water regime will remain unchanged as a result of the development. Runoff will continue to flow to the quarry and be circulated within the site's existing stormwater management system.

Site excess water shall continue to overflow via Point 2 into Mooney Mooney Creek.

4 Existing Water Cycle Management

4.1 Catchment Flows

The existing quarry site has a surface area of 48.6 ha. All runoff from the site (excluding the vegetated northern and western boundary) is collected within existing extraction pits and is processed as part of the current stormwater management plan. During heavy or prolonged periods of rainfall some runoff discharges via a 600mm pipe into Unnamed Tributary 1.

The natural quarry's upslope catchment is approximately 49.5 ha (Figure 2) and includes the proposed expansion site. Flow rates, based on design rainfall estimates according to AR&R data, were calculated to determine the likely flow of water into quarry areas. Modelling indicates that during a 1 in 100 year event, the flow rate for surface water entering the quarry is approximately 12 m³/s.

4.2 Existing Stormwater Management Plan

According to information provided by the client, the following stormwater management plan is in place at the quarry site:

- Water that is collected within the Eastern Pit (from: intercepted rainfall; groundwater ingress; and the upslope catchment) is pumped into the 'make up' dam where entrained sediment is allowed to settle out. In the event that the site collects excess water, overflow is discharged to Unnamed Tributary 1. This discharge is licensed by NSW EPA and known as "Point 2".
- Water collected within the Western Pit (consisting of 3 tailings dams/cells) is allowed to settle and flows to the 'pump dam'.
- Water stored within the 'pump dam' is distributed to either the 'Wash out dam', to the processing plant area or is passes to the make-up dam. This water is used on-site for product washing and dust suppression. During periods of peak flow, water may be discharged into the National Park from the 'pump dam'. This discharge point is also licensed by the NSW EPA and is known as "Point 1".
- Wastewater from the process plant area is discharged to the western pit to remove fine sediment and then to the pump dam for recycling as above.

Results from the site's annual return information indicate the water quality of discharge is generally satisfactory and compliant with license conditions. However, suspended solids have exceeded levels during periods of extended or prolonged rainfall. This suggests that, while the current water cycle management system generally treats water satisfactorily, any increase in flows as a result of the proposal would require improved treatment to reduce the concentration of solids in discharge waters.

A site plan showing the existing stormwater management plan is provided in Attachment C.

5 Water Balance Assessment

5.1 Overview

In order to demonstrate the proposal will have no impact on the existing water balance and sufficient water supply is available for the proposed development a water balance assessment was undertaken.

5.2 Methodology

The method for this investigation can be separated into three stages;

1. Site Water Supply: Identify the water supply sources and calculate the average annual supply volume for the existing and proposed quarry area.
2. Site Water Demand: Identify the existing average annual water demands/uses and estimate the demand for the proposed quarry.
3. Water Balance Model: Create a water balance model to determine water yields, storage and demands/uses to establish the sites sustainability and long-term self-sufficiency.

5.3 Water Supply

The following water supply sources have been identified for the quarry site;

- Direct rainfall,
- Upslope run-on, and
- Groundwater interception.

5.3.1 Rainfall

According to the Bureau of Meteorology (BOM), the Somersby/Peats Ridge area receives an average annual rainfall of 1262.1 mm/yr. Given the quarry area is self draining; water supply via rainfall is 613.4 ML. This figure is assumed to increase as a result of the proposed development.

5.3.2 Upslope Run-on

To calculate upslope run-on, 6-minute pluviograph data was obtained from BOM (Station 61351 – Peats Ridge) and used as an input into a MUSIC model. The Model for Urban Stormwater Improvement

Conceptualisation (*MUSIC*, Version 3.0.1) was utilised to evaluate annual upslope catchment flows for the existing and proposed quarry. For both the existing and proposed scenario, a one node model was created to represent the upslope catchment. Areas for each scenario are provided in Table 2.

Table 2: Existing and Proposed MUSIC areas

Scenario	ARQ Category	Upslope Catchment Area (ha)	% Impervious	% Pervious
Existing	"Agricultural"	49.5	10	90
Proposed	"Agricultural"	41.5	12	88

MUSIC modelling indicates that currently approximately 206 ML of run-on flows onto the site annually from the upslope catchment. This is predicted to reduce to 178 ML annually as a result of the quarry expansion.

5.3.3 Groundwater Interception

The finite difference groundwater flow model 'Modflow' was utilised within Visual Modflow to develop a numerical groundwater model to assess groundwater related impacts associated with the project. One aspect of this modelling involved quantifying groundwater inflows (see Martens report P0701949JR05) for the existing (average pit level of 190 mAHD); the already approved and the proposed quarry (existing scenario plus the proposed extraction pit on the proposed expansion site) form. Table 3 summarises the results of this modelling relevant to calculating the sites water balance.

Table 3: Modelling Results; Groundwater Inflow

Scenario	Groundwater Inflow (m ³ /d) ¹	Groundwater Inflow (ML/y)
Current	277	101.1
Ultimate Approved	806	294.2
Proposed	404	147.5

Notes: ¹ Groundwater inflows assume no evaporative losses.

5.4 Water Demand/Uses

The following water uses/demands have been identified for the quarry site:

- Loss through evaporative loss from open water bodies,

- Process water demands (dust suppression, product washing, processing etc), and
- Irrigation of landscape/rehabilitation areas.

5.4.1 Evaporation

According to the Bureau of Meteorology (BOM), Peats Ridge has a mean annual Class A Evaporation Pan of 1202.4 mm. This figure was used to calculate evaporative loss off on-site quarry dams (by applying a coefficient of 0.7 to the Pan A Evaporation rate).

5.4.2 Onsite Demands

Regarding onsite usage, the following information provided by the client was relied upon in this assessment;

- Captured stormwater is used to satisfy the on-site process demands, calculated to be an average of 75 ML annually.
- Quarry areas evolve following the general process of; extraction pit → tailings dams → rehabilitation area.
- Quarry areas are progressively rehabilitated via revegetation at a rate of approximately 1ha/yr (equating to approximately 590 plants). Plants receive a maximum of 15L per week via spot irrigation. This equates to 0.46 ML/yr water use for irrigation.
- In terms of water storage, the site has the capacity to store 600 ML within the existing dams. This figure will remain constant as the quarry evolves (and expands).

5.5 Results

A water balance model was developed for the existing and proposed development scenarios to assess the impact of the proposal on the volume of stormwater entering and leaving the site. The results of this model are provided in Table 4.

Table 4: Water Balance Assessment Results

	Element	Current Volume (ML/y)	Ultimate Approved Volume (ML/yr)	Proposed Volume (ML/y)
Water Sources	Direct Rainfall	613.4	613.4	714.3
	Upslope Run-on	206.0	206.0	178.0
	Groundwater Interception	101.1	294.2	147.5
Water Demands/Uses	Evaporative Loss	44.6	44.6	44.6
	Process Water	75.0	75.0	75.0
	Irrigation	0.46	0.46	0.46
Balance		800.4 ML/y	993.5 ML/y	919.7 ML/y

Results of the water balance assessment indicate that the site currently, and will continue to have, a surplus of water after all site demands/uses are satisfied. Although this surplus is predicted to increase from current volumes by 15%, based on the ultimate approved quarry form, surplus is predicted to decrease by 7.4%. This is almost entirely attributed to changes in groundwater interception between the three scenarios.

It should be noted, however, that groundwater interception predictions for the developed site assume the entire site area (existing and proposed) is at 200 and 190 mAHD respectively, rather than portions of the site having been rehabilitated and revegetated. In this sense, the groundwater interception figures represent a maximum interception rate for the site.

5.6 Implications and Conclusions

The predicted changes in water supply are not considered significant given the scale of the development. The water balance demonstrates that sufficient water will be available to satisfy demands for process waters and future demands associated with irrigation of remediation areas.

The predicted volume of post-development surface flows to be discharged is equivalent to a discharge rate of 0.029 m³/s. Using Figure 5.10 of *Managing Urban Stormwater* (Landcom, 2000), for a discharge rate of 0.04 m³/s and a pipe size of 450mm (as is currently the case) an average rip rap size of 0.1 m is required to adequately dissipate flows to protect downstream environments. Given the outlet of discharge 'Point 2' is protected by rip rap with an average diameter of approximately 0.3 m, the outlet is considered to be adequately armoured to withstand

these increase discharge rates and will therefore continue protecting the creek from erosion and scour.

It should also be noted that given the site's current EPL places no restriction on discharge flow rates from either discharge point, this predicted increase is compliant.

Section 6 proposes water quality treatment structures to ensure increased flow to receiving environments, as a result of the proposal, is also of a suitable quality to prevent degradation of the Mooney Mooney Creek catchment.

6 Water Cycle Management Plan

6.1 Overview

As part of the proposed expansion it is recommended the current water cycle management be formalised to provide a well-structured and effective means of treating process water prior to its discharge to downstream receiving environments.

The sections below provide recommendations for water quantity (based on water balance modelling) and water quality treatment.

6.2 Water Quantity Treatment

Results from water balance modelling suggest that the predicted increase in flows as a result of the proposal is not considered significant, and the two EPA discharge points are appropriately armoured to dissipate these flows and thus prevent erosion and scour of the identified tributaries of Mooney Mooney Creek.

It is therefore recommended that this rip rap be maintained as part of the proposal and the ongoing operation of the quarry.

6.3 Water Quality Treatment

Given the total amount of water surplus onsite is predicted to increase, and the recent excessive total suspended solids concentration and discharge Point 2, it is recommended a sedimentation basin be incorporated into the water management plan to allow fines (to a size of 75 µm) to settle out prior to discharge.

In accordance with volume 2 of the *Constructed Wetlands Manual* (DLWC, 1998), the proposed sedimentation basin has been designed as a 'deep water zone' whose function is to allow separation of suspended impurities from stormwater.

According to the Manual, the surface area required for sedimentation within such a basin can be calculated by dividing the design flow (m³/s) by the product of the desired sedimentation efficiency (in this case 75µm is equivalent to an efficiency of 47%) and its associated settling velocity.

Water balance annual excess of 919.7 ML/yr is equivalent to a flow rate of 0.029 m³/s. Based on this, and using Table 16-6 of the *Constructed Wetlands Manual*, a sedimentation basin with a surface area of 1364 m² (approximately 21.3m wide x 64m long) and depth of 2.0 m is required

to capture fines to a size of 75µm. This can be accommodated on the site. This can be accommodated within the existing make up dam.

To enhance the removal of colloidal clays and other sub 75 µm material, the construction of a macrophyte zone at the outlet of the dam is proposed. The macrophyte zone is to extend 50m from the outlet pipes as shown on the attached plans. The macrophyte zone is to be regraded to provide a water depth of approximately 500 mm and have an area of approximately 2500 m².

6.4 Water Management Plan

We recommend the following water management plan be implemented at the site and be maintained as part of the proposal to ensure the site uses water sustainably and discharges water into receiving environments of an appropriate quality. This plan builds on existing successful components of site water management and provides measures to address failings and predicted water balance surplus.

1. The remnants of the drainage line shown in Figure 2 require remediation to reduce sedimentation of downstream receiving environments. We recommend jute matting and revegetation in this area, as shown on the plans provided in Attachment C.
2. Water captured within the extraction pits shall be pumped to a holding dam serving the same purpose as the existing 'pump dam'. Discharge from this point is to only occur in the event that water captured onsite exceeds the capacity of the sites dams to store and treat water. As is currently the case, 'Point 2' is to remain the preferential discharge point.
3. Water from this dam shall be pumped to the processing plant or to other process dams which are utilised to satisfy the 75 ML/yr demand for dust suppression etc.
4. Process water from the plant is circulated through a series of tailings dams to remove entrained sediments. Remediation has recently commenced in the existing tailings dams area (in the site's south west) and newly constructed dams in the 'Western Pit' are now being used as a tailings dam (Figure 7). The size/number of tailings dams to be provided shall be sufficient to remove coarse sediments to a minimum size of 0.02mm (fine sand).
5. Treated water from the tailings dam shall then be pumped to the holding dam, to satisfy onsite demands or to the 'Make Up' dam.
6. The existing Make Up dam is to be modified to include:

- A sedimentation zone (1364 m²), on the same side as the overflow spillway, deepened to form a 'deep water zone' in the dam to achieve enhanced sedimentation prior to any required site discharge; and
- A macrophyte zone (2500 m²) to enhance the removal of colloidal clays and other sub 75 µm material.

We note that as the quarried areas evolve from pit to tailings dam to rehabilitation area, a storage area of 600ML must be maintained to ensure the site water balance remains consistent, enough water is stored to satisfy onsite demands and adequate treatment is provided.

A site plan showing the proposed stormwater management plan is provided in Attachment C.

The results of this surface water assessment is summarised as follows;

1. Two (2) unnamed tributaries of Mooney Mooney Creek were identified as being potentially influenced by flows from the existing and proposed site.
2. Unnamed Tributary 1 was found to be generally in poor condition upstream of the existing quarry due to agriculture induced eutrophication and bank erosion. From where this creek enters the existing site, there is only remnants of the existing channel and flow is intercepted within the extraction pit. Downstream of the quarry the morphology and condition of the creek is improved. Flow within the watercourse principally comes from overflow from the quarry's 'Make Up' dam (licensed by the NSW EPA as Point 1) and some minor site runoff.
3. Unnamed Tributary 1 is classed as a Category 3 watercourse and is therefore important for maintaining the water quality and quantity of downstream Mooney Mooney Creek and Mooney Mooney Dam.
4. Unnamed Tributary 2 is also a Category 3 watercourse and a tributary of Mooney Mooney Creek. No evidence suggests that quarried areas drain into the watercourse and water quality/quantity is expected to be comparable with natural levels.
5. The proposed expansion site is hydrogeologically upslope of the existing quarry. As such the surface water regime will remain unchanged as a result of the proposed development.
6. Identified water supplies to the quarry site are; direct rainfall, upslope run-on and groundwater interception. Existing (and proposed) water storages are estimated to be 600 ML.
7. Identified water demands (or losses) for the quarry site are; evaporation; process water demands for sand washing; and irrigation of landscaped/rehabilitated areas.
8. Results of a water balance assessment for the current and proposed development scenarios indicate the site's water surplus will increase by 14.9% as a result of the proposal.

Comparison of the current ultimate approved site form and the proposed site form indicate a reduction of 7.4%.

9. Existing outlet pipe size and armouring of discharge points is considered adequate to withstand the subsequent discharge rates and will continue to protect downstream environments from erosion and scour.
10. No water quantity treatment is required as EPA discharge points are appropriately armouring to withstand the predicted increase in flows.
11. The site 'make up' dam is to be reconfigured to improve removal of fine sediments. An area of the dam adjacent to the pump outlet point is to be deepened to approximately 2.0 m to promote entrained sediment storage. This area is to be approximately 1364 m². The area within 50m of the outlet (approximately 2000 m²) is to be regraded to a water depth of approximately 0.5m and planted with macrophytes to improve fine sediment removal.
12. The water balance assessment within this report assumes that the existing 600 ML of water storage onsite remains the site evolves.

8 **References**

NSW Department of Lands and Water Conservation (DLWC) (1998) *The Constructed Wetlands Manual: Volume 2*

Landcom (2004) *Soils and Construction: Managing Urban Stormwater*.

9 Attachment A – Site Plan

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martens
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999
Fax: (02) 9476 8767
Email: mail@martens.com.au
Internet: <http://www.martens.com.au>

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SOMERSBY QUARRY**
PROJECT MANAGER:
ANDREW NORRIS

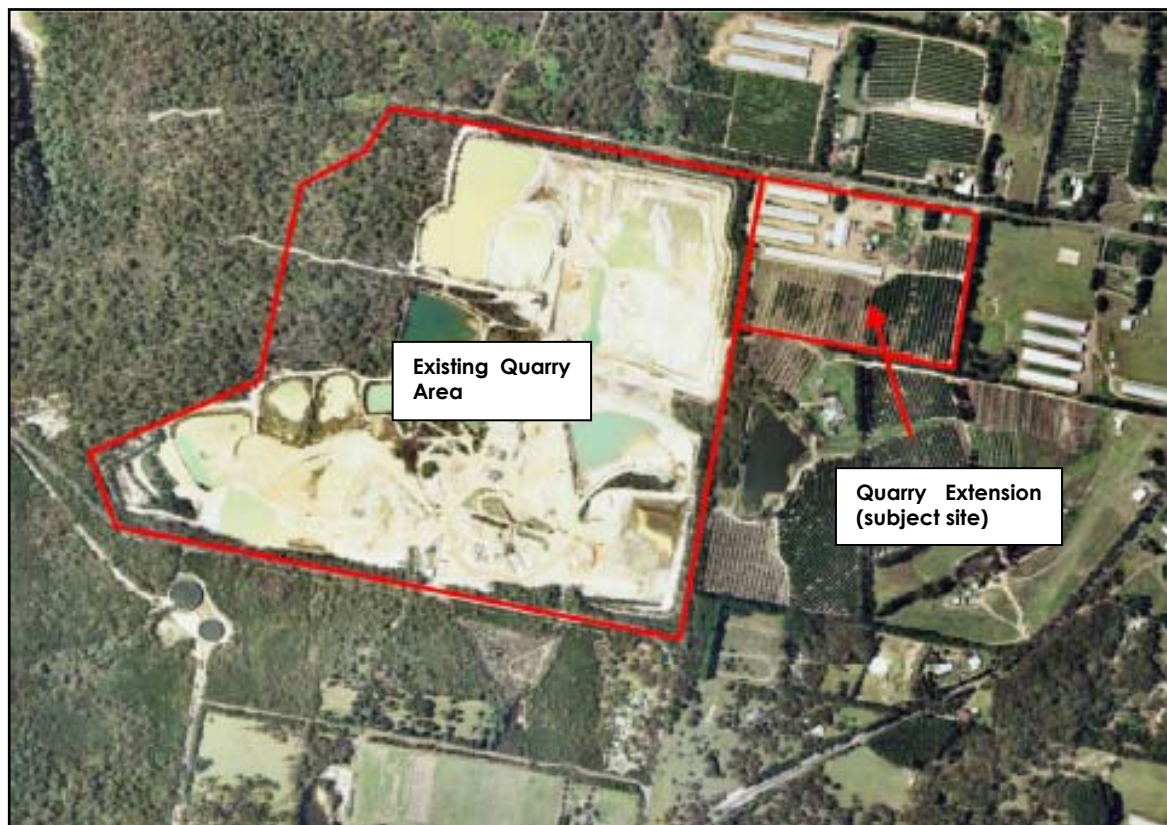
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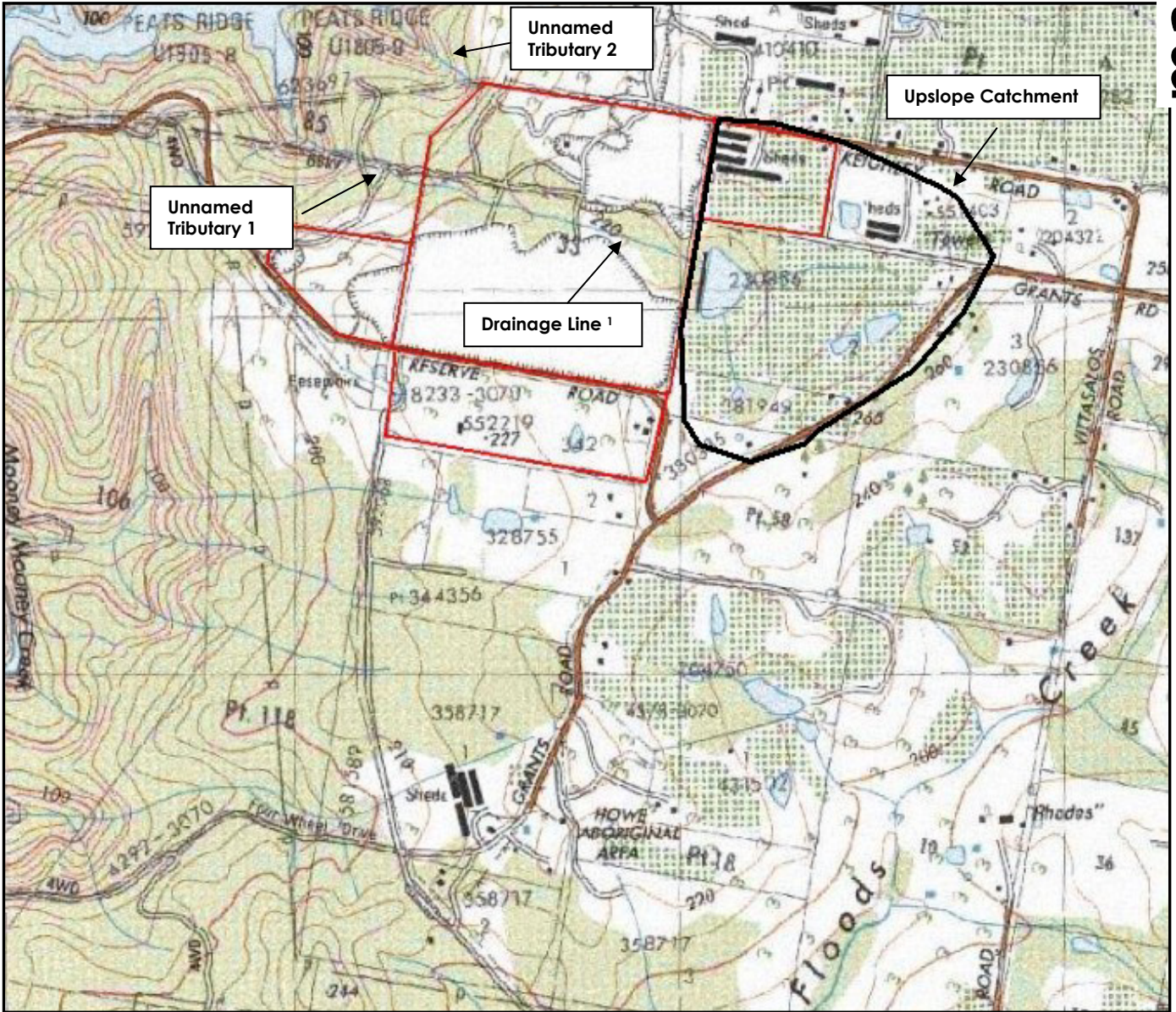
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REV.	DESCRIPTION	DATE	ISSUED
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10 **Attachment B – Figures**



Martens & Associates Pty Ltd ABN 85 070 240 890		Environment Water Wastewater Geotechnical Civil Management	
Drawn:	MLB	Location of Proposed Quarry Extension Site and its Existing Landuse Source: Google Earth, 2009	Drawing No:
Approved:	AN		FIGURE 1
Date:	28.09.09		
Scale:	NA		Job No: P0701949



¹ Note works have progressed to the extent that the marked drainage line no longer exists.

Martens & Associates Pty Ltd ABN 85 070 240 890		Environment Water Wastewater Geotechnical Civil Management	
Drawn:	MLB	Topographic Map: Site Drainage	Drawing No:
Approved:	AN		FIGURE 2
Date:	29.09.09		
Scale:	NA		Job No: P0701949



Martens & Associates Pty Ltd ABN 85 070 240 890		Environment Water Wastewater Geotechnical Civil Management	
Drawn:	MLB	Quarry Site - Drainage Line	Drawing No:
Approved:	AN		FIGURE 3
Date:	29.09.09		
Scale:	NA		Job No: P0701949



Martens & Associates Pty Ltd		Environment Water Wastewater Geotechnical Civil Management	
Drawn:	MLB	Quarry Site – Drainage Line	Drawing No:
Approved:	AN		FIGURE 4
Date:	29.09.09		Job No: P0701949
Scale:	NA		



Martens & Associates Pty Ltd ABN 85 070 240 890		Environment Water Wastewater Geotechnical Civil Management	
Drawn:	MLB	Catchment View and Location of Mooney Mooney Dam Source: Google Earth, 2009	Drawing No:
Approved:	AN		FIGURE 5
Date:	29.09.09		
Scale:	NA		Job No: P0701949

'Point 1' inlet



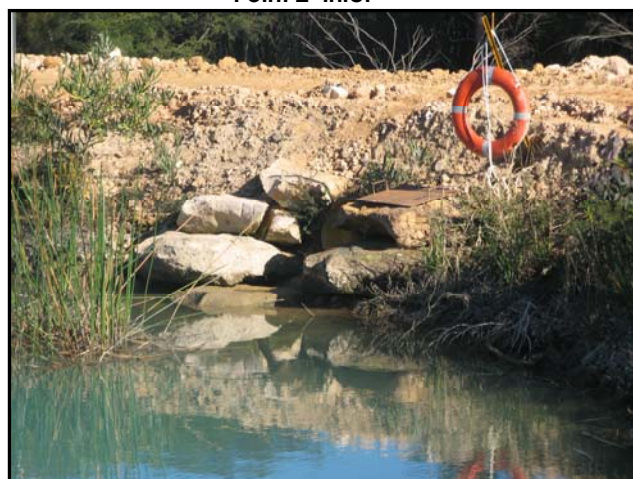
'Point 1' inlet and pump dam



'Point 1' outlet – concrete lined channel



'Point 2' inlet



'Point 2' inlet



'Point 2' outlet – rip rap

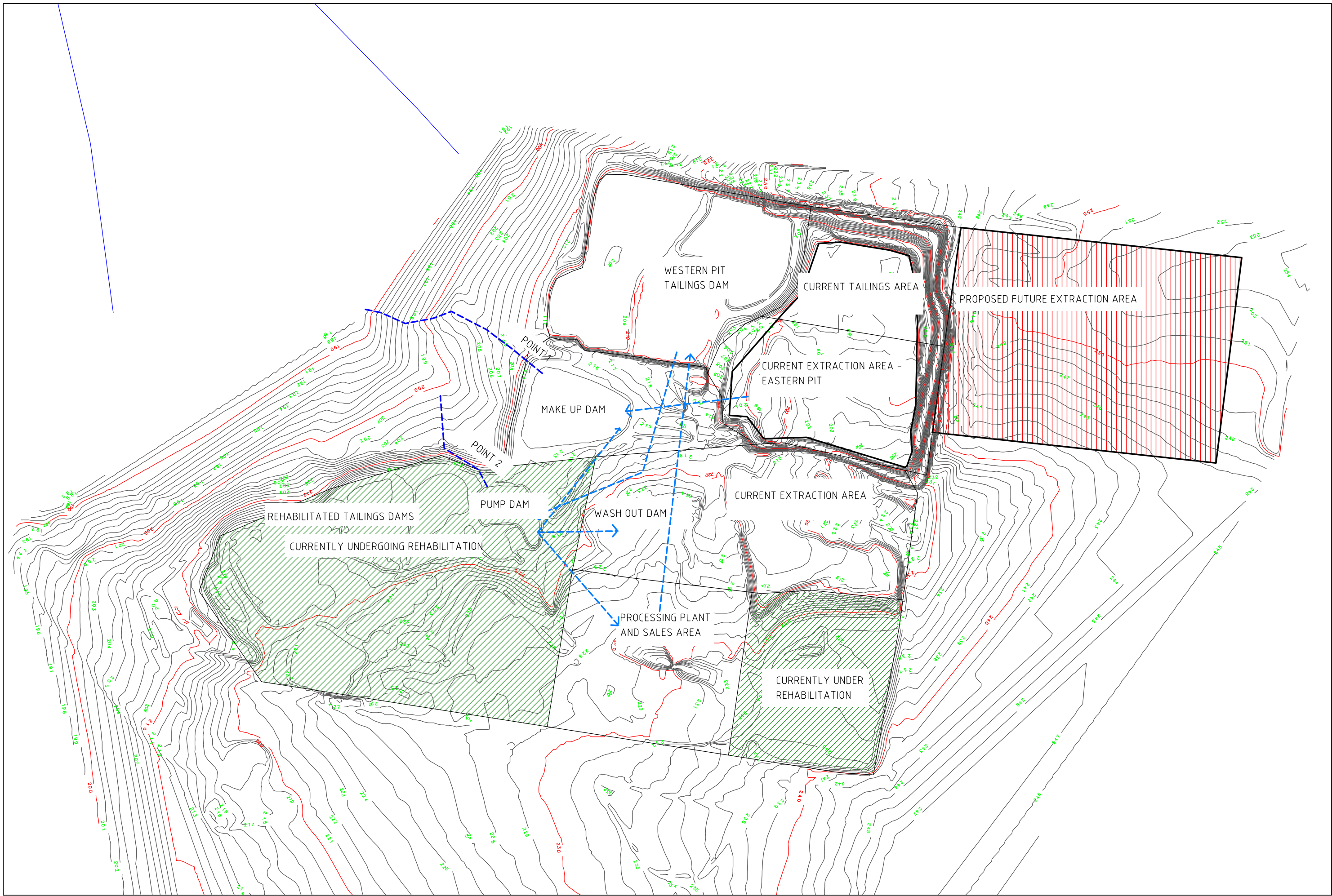
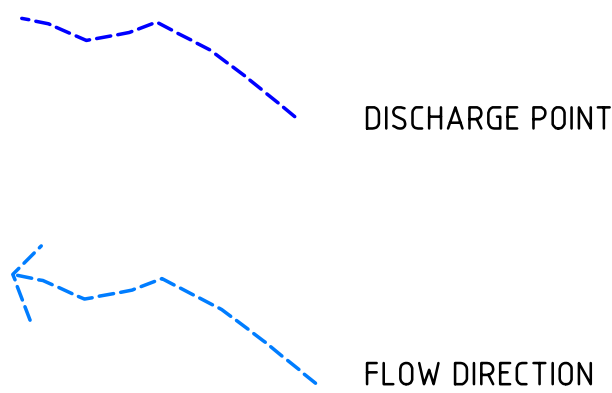
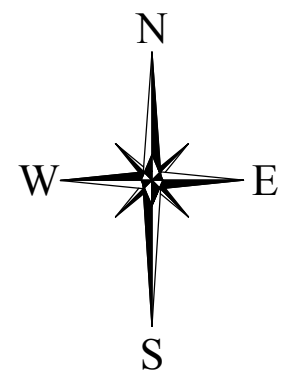


Martens & Associates Pty Ltd ABN 85 070 240 890		Environment Water Wastewater Geotechnical Civil Management	
Drawn:	MLB	Discharge Point 1 and 2 Inlet and Outlet Points	Drawing No:
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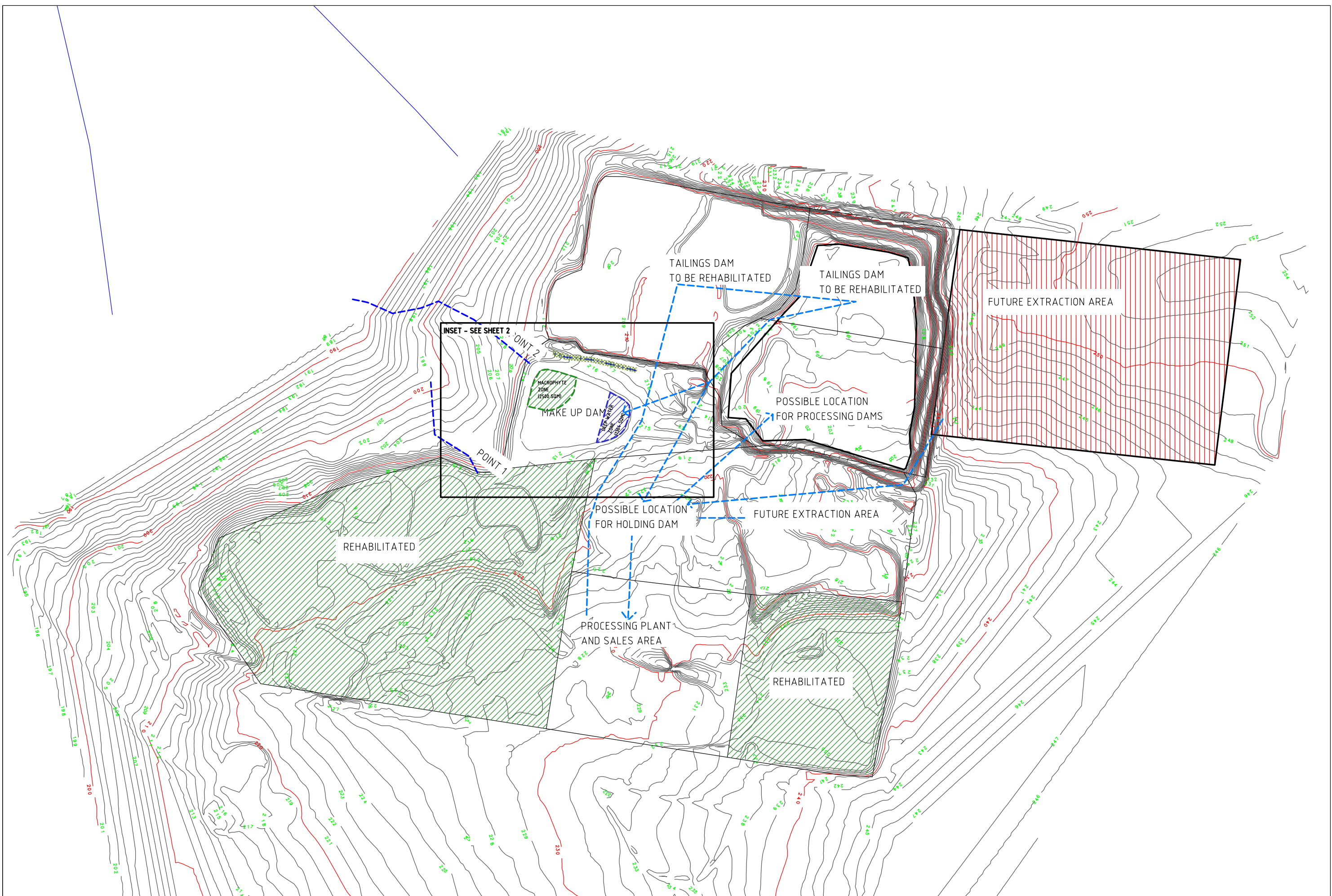


Martens & Associates Pty Ltd ABN 85 070 240 890		Environment Water Wastewater Geotechnical Civil Management	
Drawn:	MLB	Western Pit Now Utilised as a Tailings Dam Photo taken 30/07/09	Drawing No:
Approved:	AN		FIGURE 7
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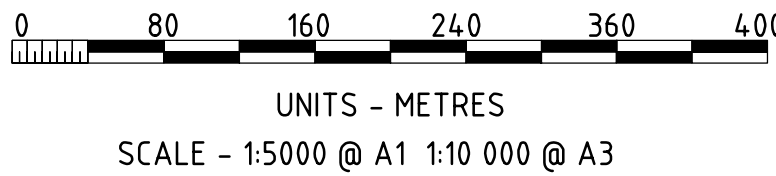
**11 Attachment C – Existing and Proposed Water Cycle
Management Plan**



EXISTING WATER CYCLE MANAGEMENT PLAN



PROPOSED WATER CYCLE MANGEMENT PLAN



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martens
6/37 Leighton Place
Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999
Fax: (02) 9476 8767
Email: mail@martens.com.au
Internet: http://www.martens.com.au

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TITLE
**WATER CYCLE MANGEMENT PLAN
SOMERSBY QUARRY**

PROJECT MANAGER:
ANDREW NORRIS

DRAWING NUMBER:
P0701949JD06_v3

DESIGNED:
MLB

DRAWN:
MLB

REVIEWED:
AN

DATUM:
mAHd

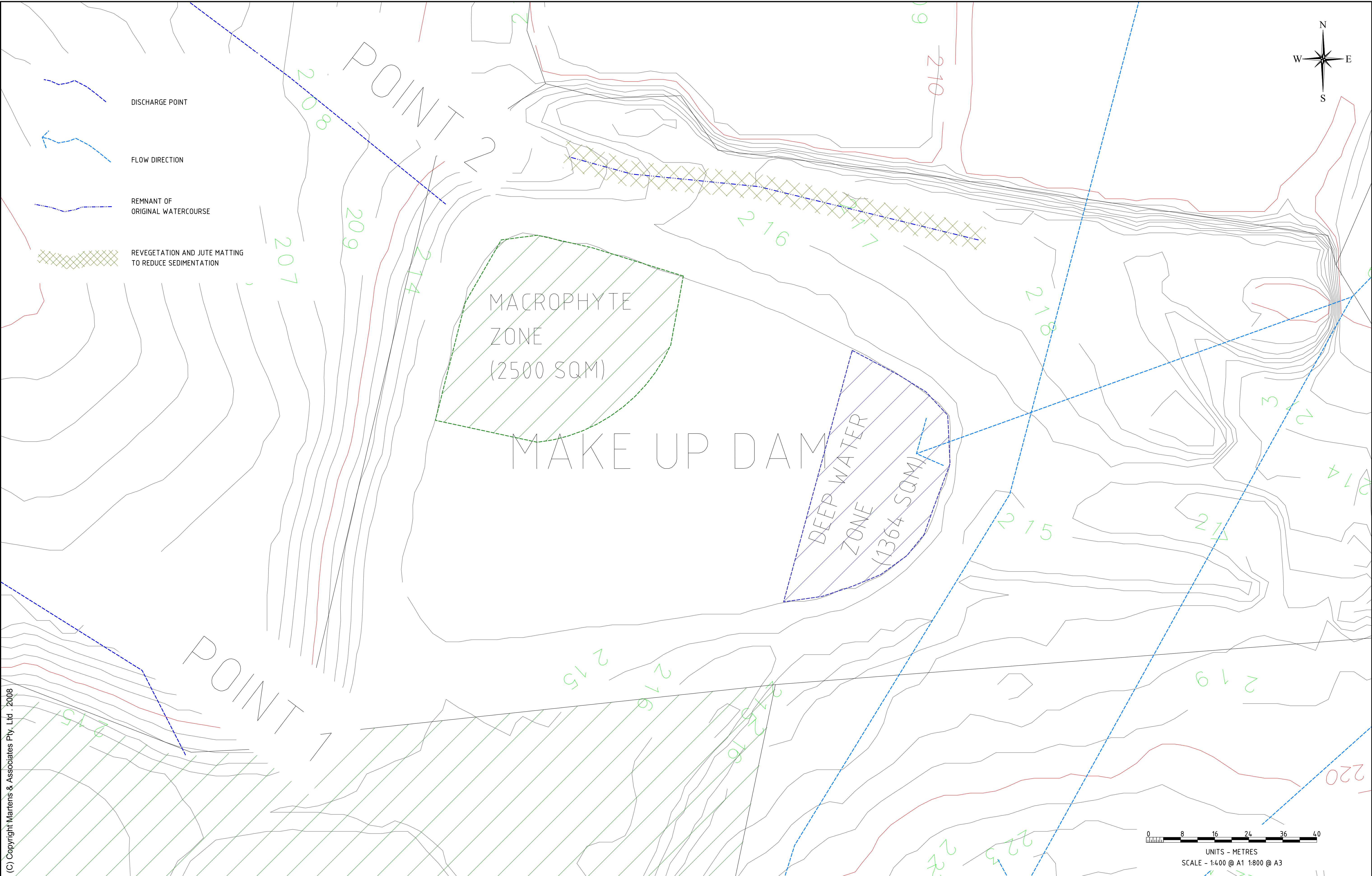
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2	SURFACE WATER ASSESSMENT	27.10.2009	AN
3	SURFACE WATER ASSESSMENT	04.01.2009	AN



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