Appendix A

Proposed Quarry Development Layout and Post Quarrying Catchment

Delineation Plans for Stage 2 Extension of the Austen Quarry

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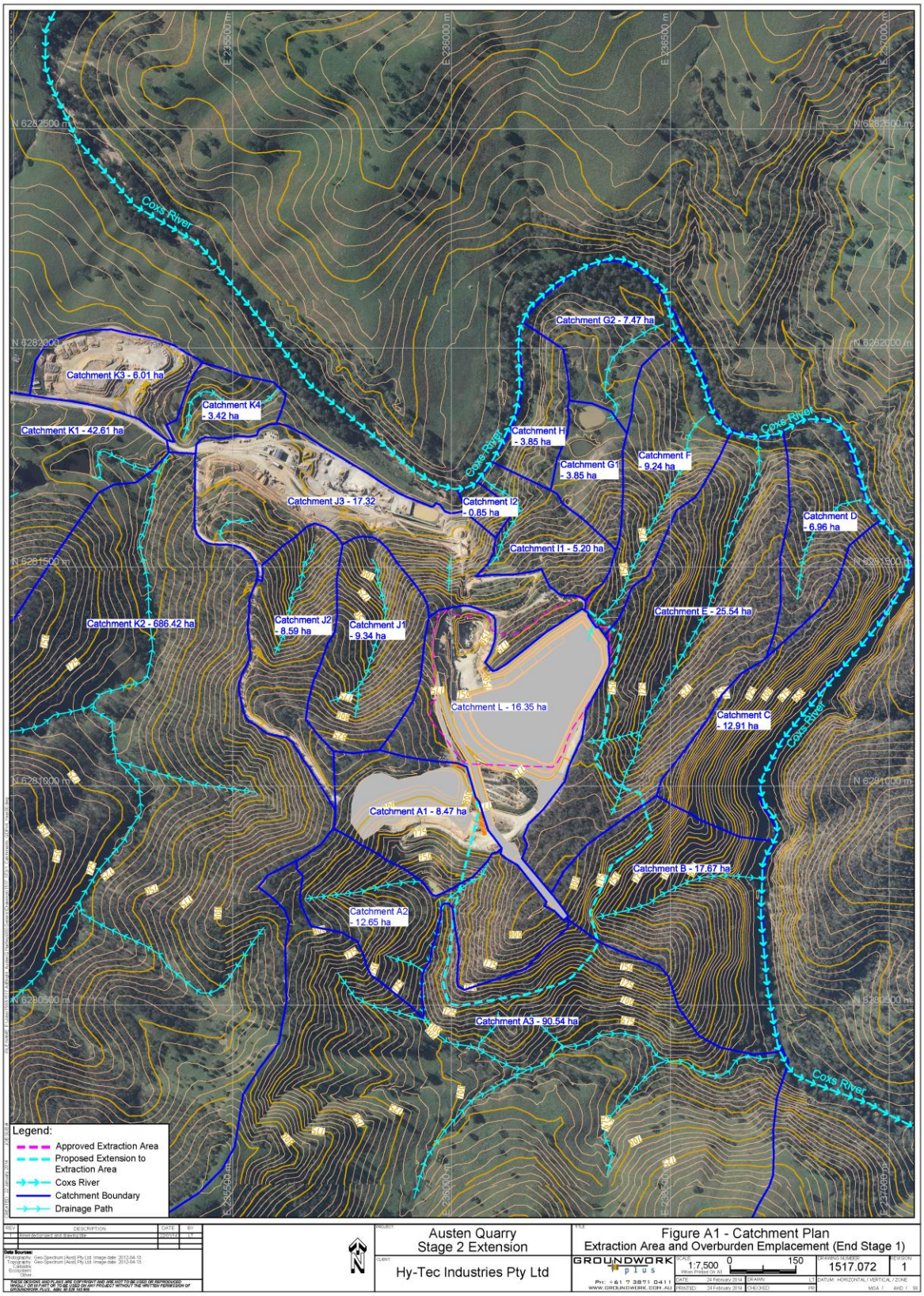
Coxs River
Catchment G2 - 7.47 ha
Catchment K3 - 6.01 ha
Catchment K4 - 3.42 ha
Catchment K1 - 42.61 ha
Catchment H - 3.85 ha
Catchment G1 - 3.85 ha
Catchment F - 9.24 ha
Catchment J3 - 17.32
Catchment I2 - 0.85 ha
Catchment D - 6.96 ha
Catchment I1 - 5.20 ha
Catchment E - 25.54 ha
Catchment K2 - 686.42 ha
Catchment J2 - 8.59 ha
Catchment J1 - 9.34 ha
Catchment L - 16.35 ha
Catchment C - 12.91 ha
Catchment A1 - 8.47 ha
Catchment B - 17.67 ha
Catchment A2 - 12.65 ha
Catchment A3 - 90.54 ha
Legend:
Approved Extraction Area
Proposed Extension to Extraction Area
Coxs River
Catchment Boundary
Drainage Path
Austen Quarry
Stage 2 Extension
Hy-Tec Industries Pty Ltd
Figure A1 - Catchment Plan
Extraction Area and Overburden Emplacement (End Stage 1)
GROUNDWORK plus
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1517.072
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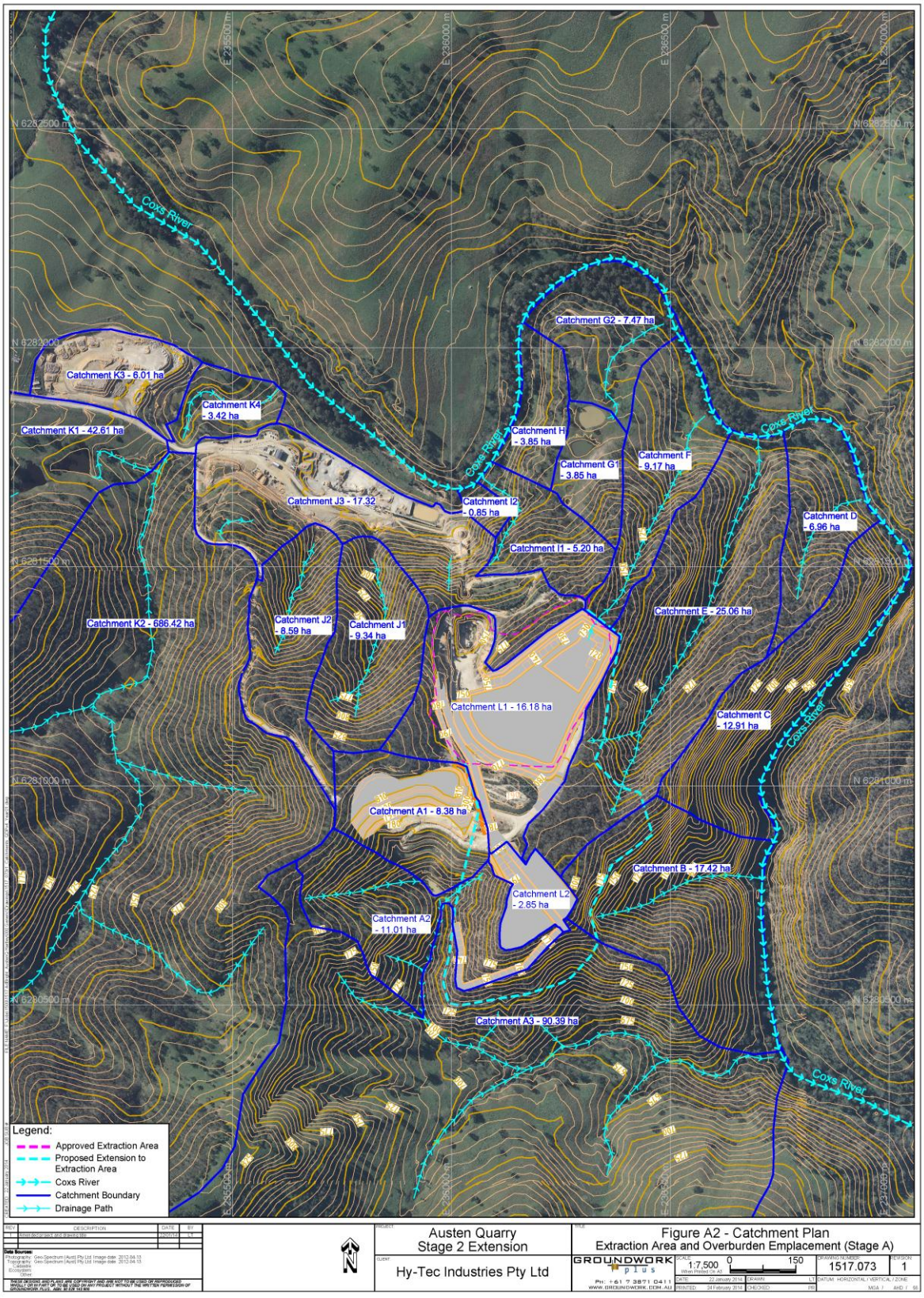
Coxs River
Catchment G2 - 7.47 ha
Catchment K3 - 6.01 ha
Catchment K4 - 3.42 ha
Catchment K1 - 42.61 ha
Catchment H - 3.85 ha
Catchment G1 - 3.85 ha
Catchment F - 9.17 ha
Catchment J3 - 17.32
Catchment I2 - 0.85 ha
Catchment D - 6.96 ha
Catchment I1 - 5.20 ha
Catchment E - 25.06 ha
Catchment K2 - 686.42 ha
Catchment J2 - 8.59 ha
Catchment J1 - 9.34 ha
Catchment L1 - 16.18 ha
Catchment C - 12.91 ha
Catchment A1 - 8.38 ha
Catchment B - 17.42 ha
Catchment L2 - 2.85 ha
Catchment A2 - 11.01 ha
Catchment A3 - 90.39 ha
Legend:
Approved Extraction Area
Proposed Extension to Extraction Area
Coxs River
Catchment Boundary
Drainage Path
Austen Quarry
Stage 2 Extension
Hy-Tec Industries Pty Ltd
Figure A2 - Catchment Plan
Extraction Area and Overburden Emplacement (Stage A)
GROUNDWORK plus
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1517.073
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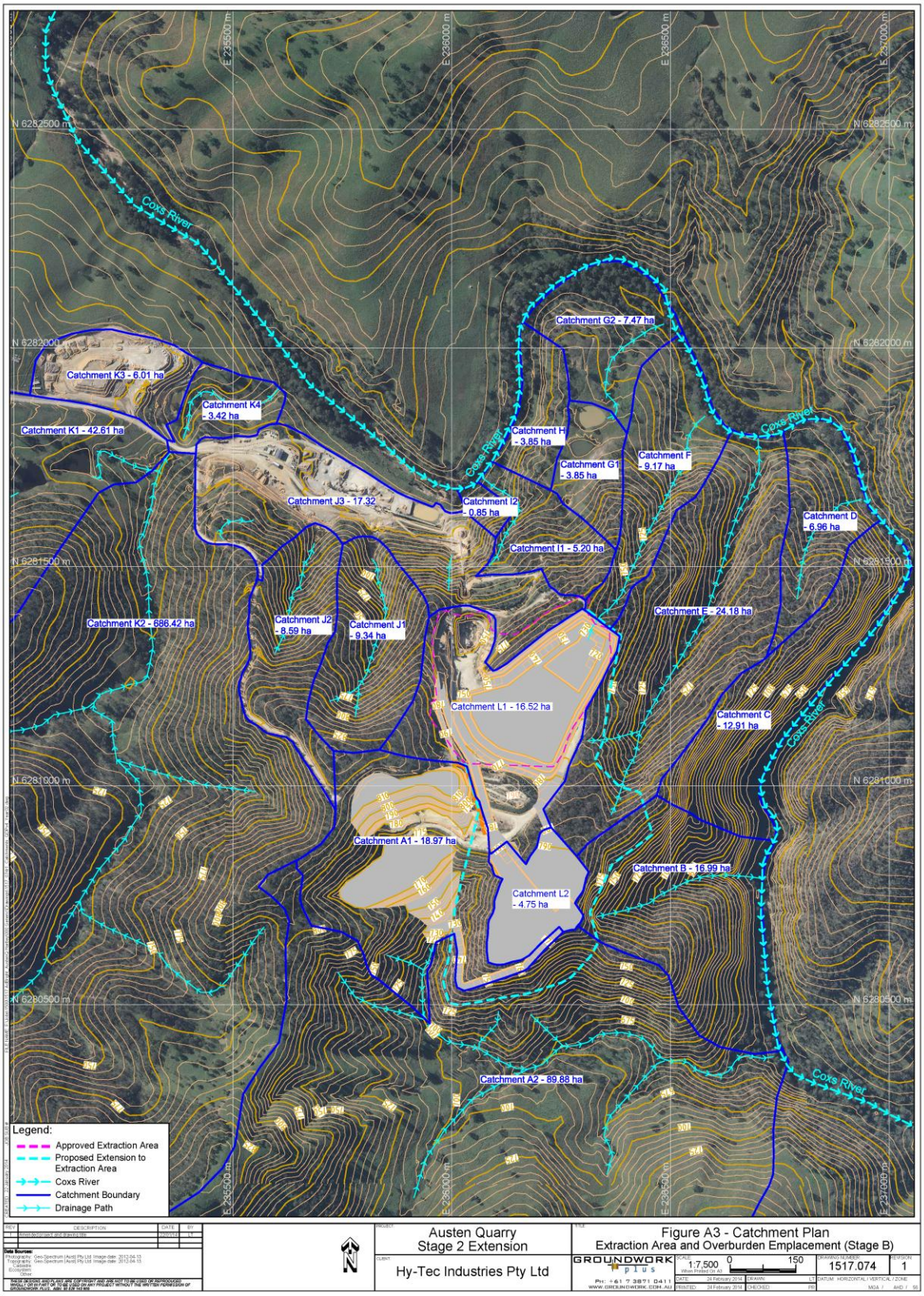
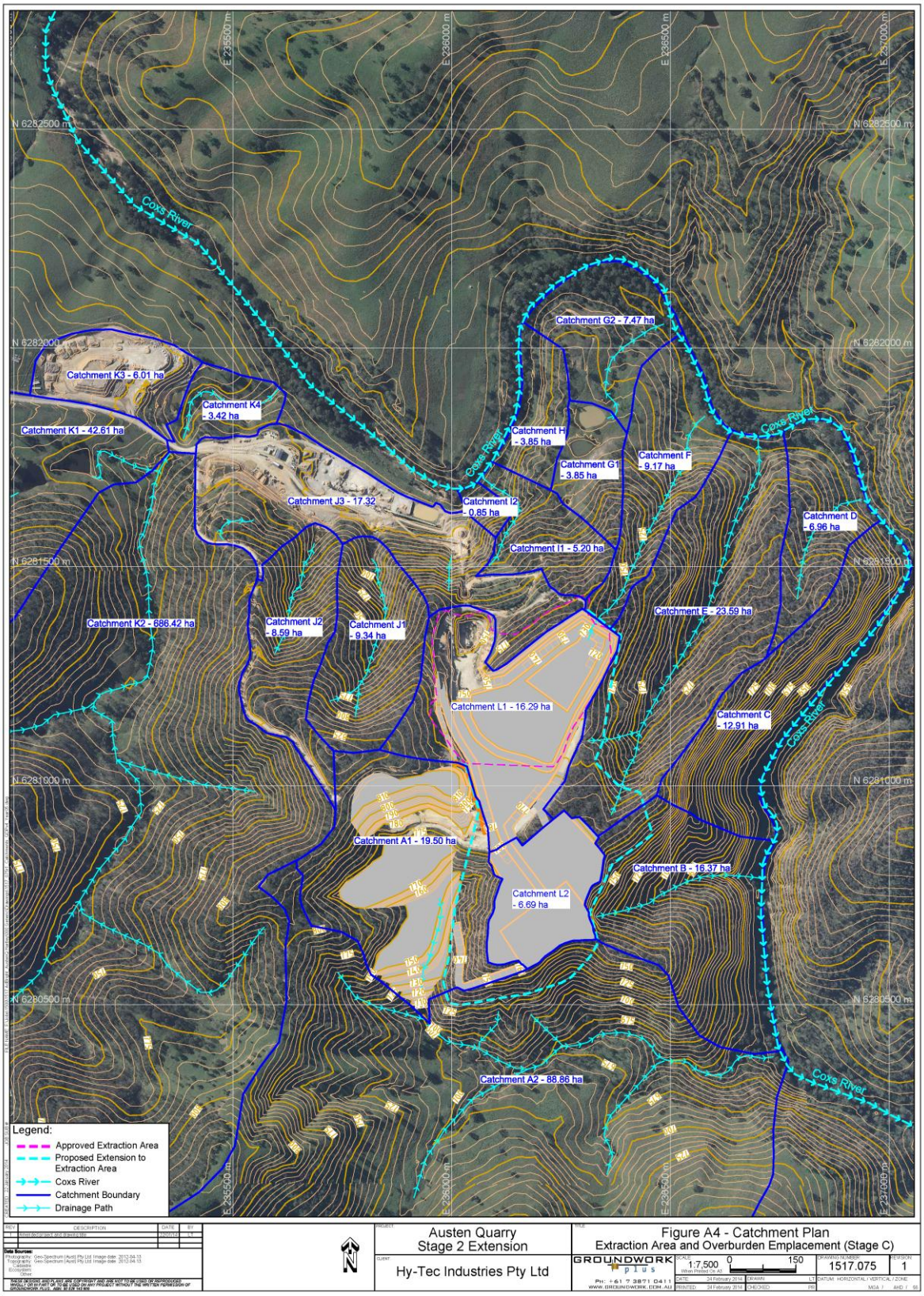

Coxs River
Catchment G2 - 7.47 ha
Catchment K3 - 6.01 ha
Catchment K4 - 3.42 ha
Catchment K1 - 42.61 ha
Catchment H - 3.85 ha
Catchment G1 - 3.85 ha
Catchment F - 9.17 ha
Catchment J3 - 17.32
Catchment I2 - 0.85 ha
Catchment I1 - 5.20 ha
Catchment D - 6.96 ha
Catchment K2 - 686.42 ha
Catchment J2 - 8.59 ha
Catchment J1 - 9.34 ha
Catchment E - 24.18 ha
Catchment L1 - 16.52 ha
Catchment C - 12.91 ha
Catchment A1 - 18.97 ha
Catchment B - 16.99 ha
Catchment L2 - 4.75 ha
Catchment A2 - 89.88 ha
Legend:
Approved Extraction Area
Proposed Extension to Extraction Area
Coxs River
Catchment Boundary
Drainage Path
Austen Quarry
Stage 2 Extension
Hy-Tec Industries Pty Ltd
Figure A3 - Catchment Plan
Extraction Area and Overburden Emplacement (Stage B)
GROUNDWORK plus
1:7,500
1517.074


Coxs River
Catchment G2 - 7.47 ha
Catchment K3 - 6.01 ha
Catchment K4 - 3.42 ha
Catchment K1 - 42.61 ha
Catchment H - 3.85 ha
Catchment G1 - 3.85 ha
Catchment F - 9.17 ha
Catchment J3 - 17.32
Catchment I2 - 0.85 ha
Catchment D - 6.96 ha
Catchment I1 - 5.20 ha
Catchment K2 - 686.42 ha
Catchment J2 - 8.59 ha
Catchment J1 - 9.34 ha
Catchment E - 23.59 ha
Catchment L1 - 16.29 ha
Catchment C - 12.91 ha
Catchment A1 - 19.50 ha
Catchment B - 16.37 ha
Catchment L2 - 6.69 ha
Catchment A2 - 88.86 ha
Legend:
Approved Extraction Area
Proposed Extension to Extraction Area
Coxs River
Catchment Boundary
Drainage Path
Austen Quarry
Stage 2 Extension
Hy-Tec Industries Pty Ltd
Figure A4 - Catchment Plan
Extraction Area and Overburden Emplacement (Stage C)
GROUNDWORK plus
1:7,500
1517.075
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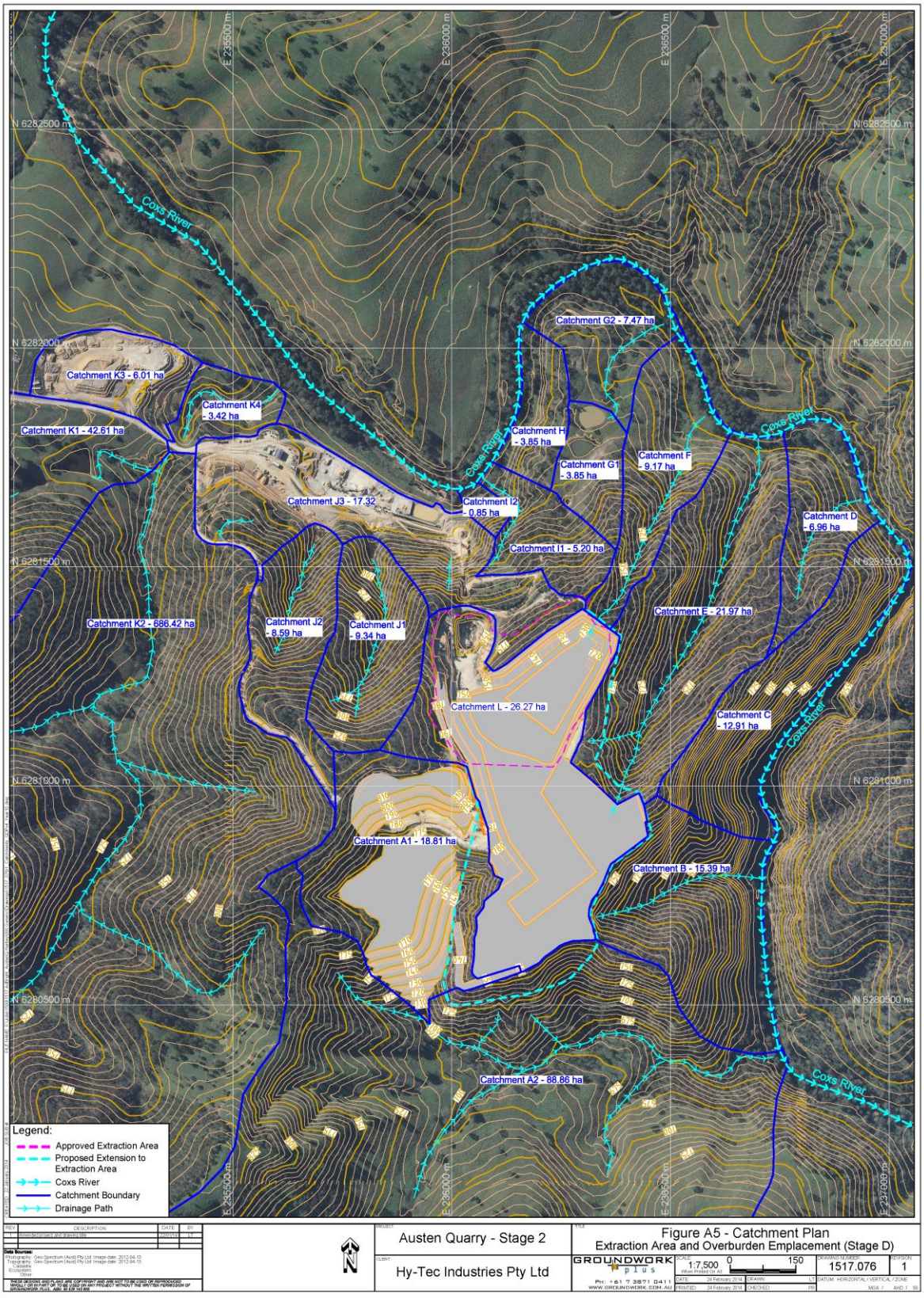
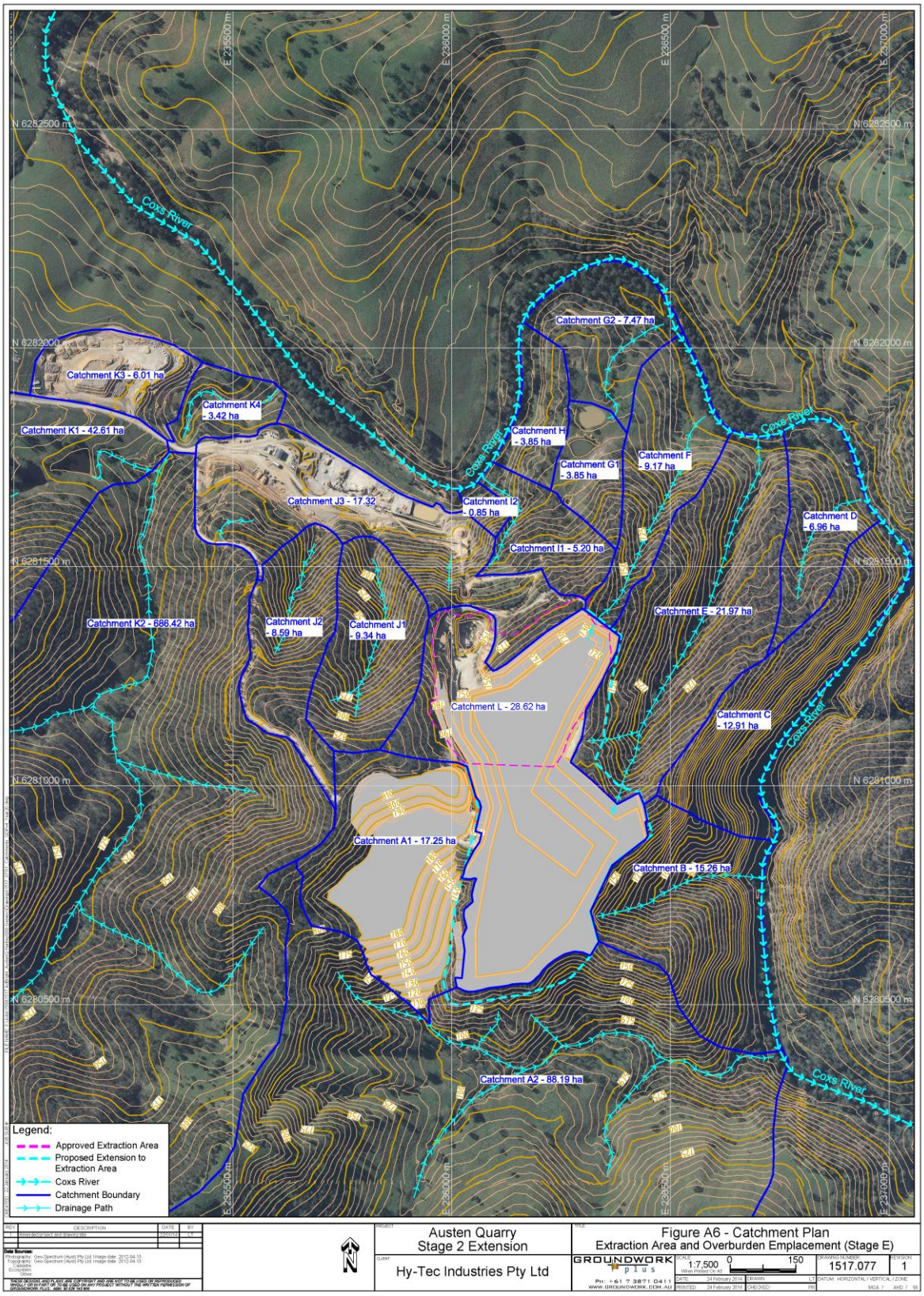
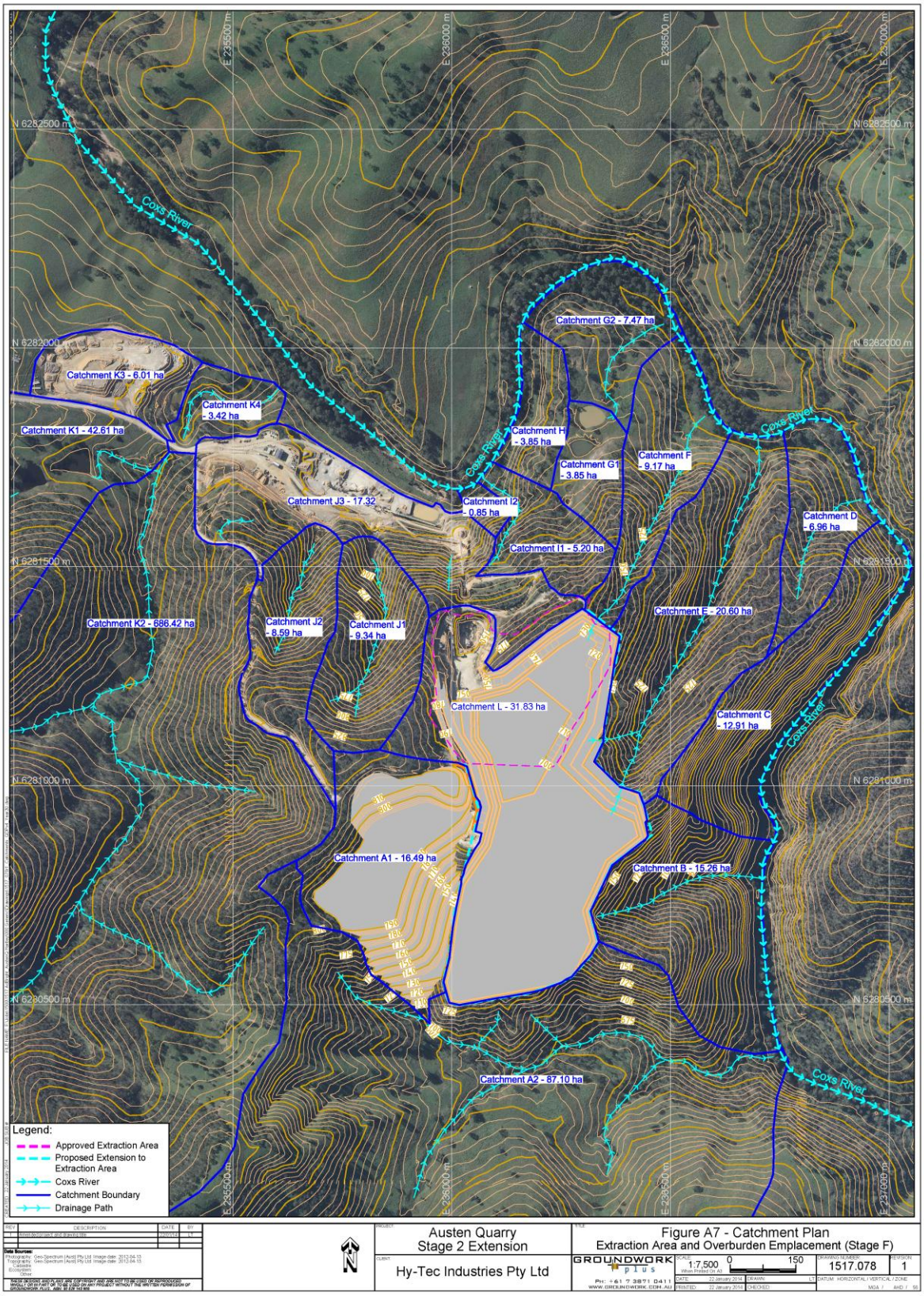
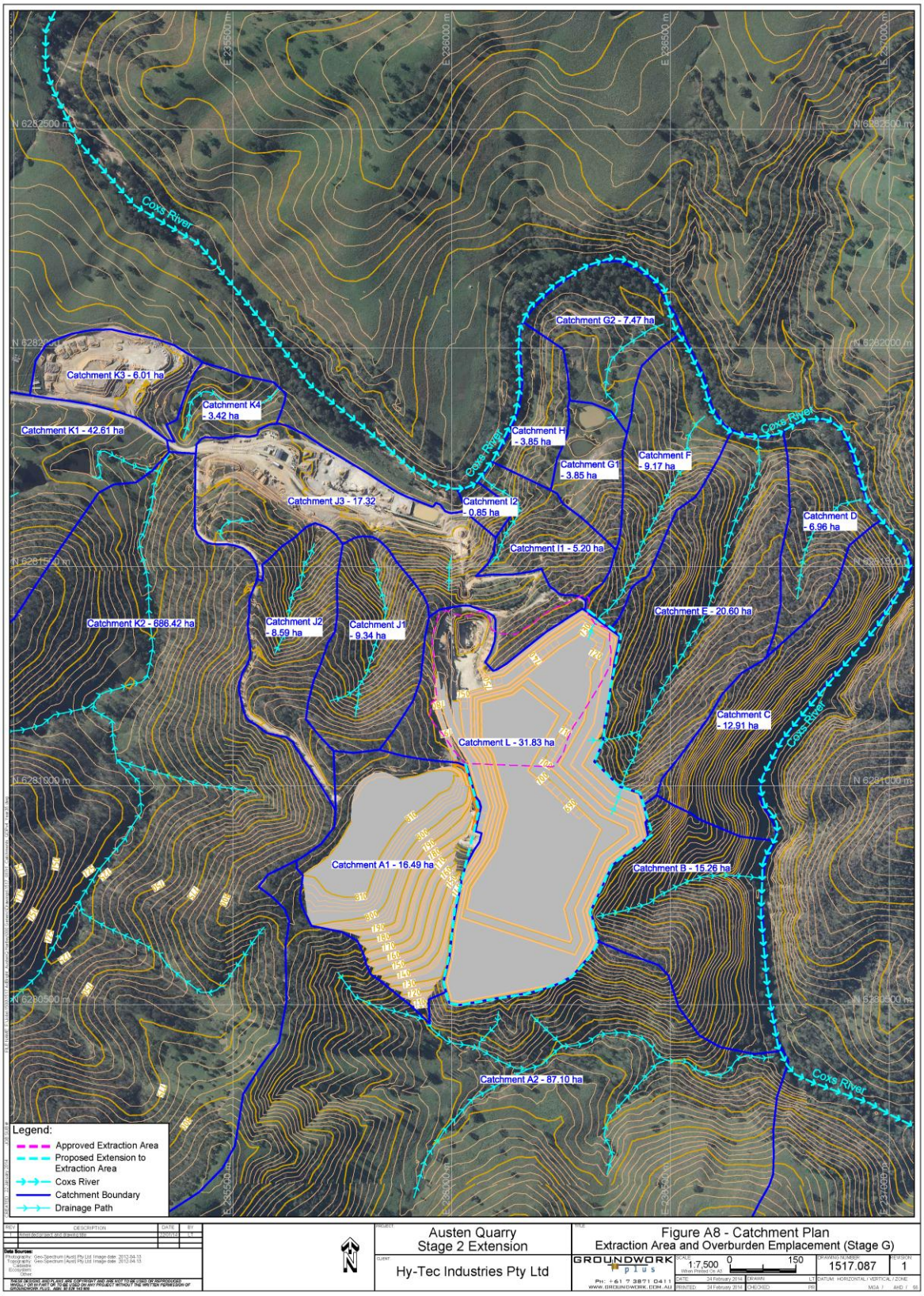

Coxs River
Catchment G2 - 7.47 ha
Catchment K3 - 6.01 ha
Catchment K4 - 3.42 ha
Catchment K1 - 42.61 ha
Catchment H - 3.85 ha
Catchment G1 - 3.85 ha
Catchment F - 9.17 ha
Catchment J3 - 17.32
Catchment I2 - 0.85 ha
Catchment I1 - 5.20 ha
Catchment D - 6.96 ha
Catchment K2 - 686.42 ha
Catchment J2 - 8.59 ha
Catchment J1 - 9.34 ha
Catchment E - 21.97 ha
Catchment L - 26.27 ha
Catchment C - 12.91 ha
Catchment A1 - 18.81 ha
Catchment B - 15.39 ha
Catchment A2 - 88.86 ha
Legend:
Approved Extraction Area
Proposed Extension to Extraction Area
Coxs River
Catchment Boundary
Drainage Path
Austen Quarry - Stage 2
Hy-Tec Industries Pty Ltd
Figure A5 - Catchment Plan
Extraction Area and Overburden Emplacement (Stage D)
GROUNDWORK plus
1:7,500
1517.076


Coxs River
Catchment G2 - 7.47 ha
Catchment K3 - 6.01 ha
Catchment K4 - 3.42 ha
Catchment K1 - 42.61 ha
Catchment H - 3.85 ha
Catchment G1 - 3.85 ha
Catchment F - 9.17 ha
Catchment J3 - 17.32
Catchment I2 - 0.85 ha
Catchment I1 - 5.20 ha
Catchment D - 6.96 ha
Catchment K2 - 686.42 ha
Catchment J2 - 8.59 ha
Catchment J1 - 9.34 ha
Catchment E - 21.97 ha
Catchment L - 28.62 ha
Catchment C - 12.91 ha
Catchment A1 - 17.25 ha
Catchment B - 15.26 ha
Catchment A2 - 88.19 ha
Legend:
Approved Extraction Area
Proposed Extension to Extraction Area
Coxs River
Catchment Boundary
Drainage Path
Austen Quarry
Stage 2 Extension
Hy-Tec Industries Pty Ltd
Figure A6 - Catchment Plan
Extraction Area and Overburden Emplacement (Stage E)
GROUNDWORK plus
1:7,500
1517.077
1


Coxs River
Catchment G2 - 7.47 ha
Catchment K3 - 6.01 ha
Catchment K4 - 3.42 ha
Catchment K1 - 42.61 ha
Catchment H - 3.85 ha
Catchment G1 - 3.85 ha
Catchment F - 9.17 ha
Catchment J3 - 17.32
Catchment I2 - 0.85 ha
Catchment D - 6.96 ha
Catchment I1 - 5.20 ha
Catchment E - 20.60 ha
Catchment K2 - 686.42 ha
Catchment J2 - 8.59 ha
Catchment J1 - 9.34 ha
Catchment L - 31.83 ha
Catchment C - 12.91 ha
Catchment A1 - 16.49 ha
Catchment B - 15.26 ha
Catchment A2 - 87.10 ha
Legend:
Approved Extraction Area
Proposed Extension to Extraction Area
Coxs River
Catchment Boundary
Drainage Path
Austen Quarry
Stage 2 Extension
Hy-Tec Industries Pty Ltd
Figure A7 - Catchment Plan
Extraction Area and Overburden Emplacement (Stage F)
GROUNDWORK plus
1:7,500
1517.078


Coxs River
Catchment G2 - 7.47 ha
Catchment K3 - 6.01 ha
Catchment K4 - 3.42 ha
Catchment K1 - 42.61 ha
Catchment H - 3.85 ha
Catchment G1 - 3.85 ha
Catchment F - 9.17 ha
Catchment J3 - 17.32
Catchment I2 - 0.85 ha
Catchment I1 - 5.20 ha
Catchment D - 6.96 ha
Catchment K2 - 686.42 ha
Catchment J2 - 8.59 ha
Catchment J1 - 9.34 ha
Catchment E - 20.60 ha
Catchment C - 12.91 ha
Catchment L - 31.83 ha
Catchment A1 - 16.49 ha
Catchment B - 15.26 ha
Catchment A2 - 87.10 ha
Legend:
Approved Extraction Area
Proposed Extension to Extraction Area
Coxs River
Catchment Boundary
Drainage Path
Austen Quarry
Stage 2 Extension
Hy-Tec Industries Pty Ltd
Figure A8 - Catchment Plan
Extraction Area and Overburden Emplacement (Stage G)
GROUNDWORK plus
1:7,500
1517.087
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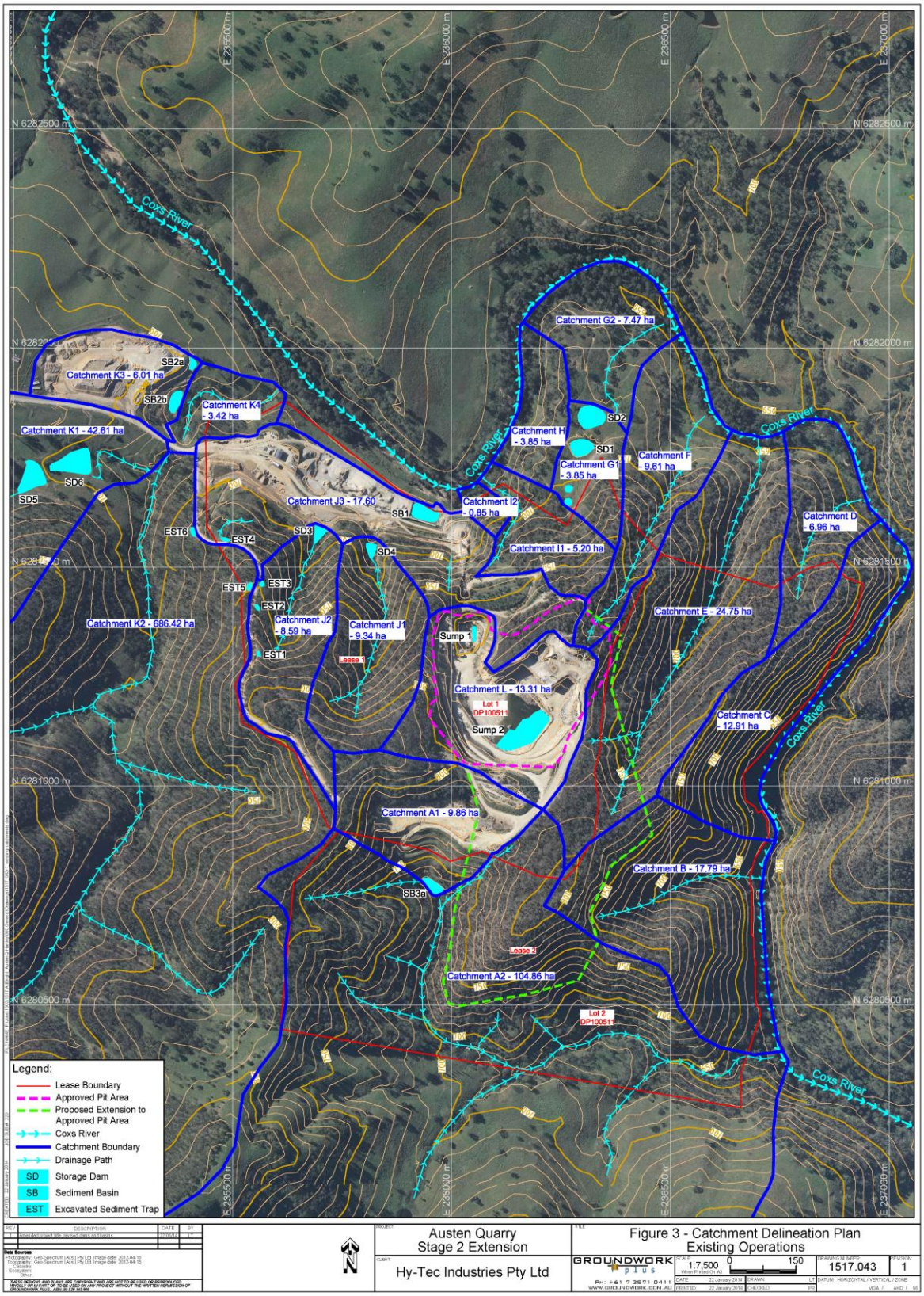
Coxs River
Catchment G2 - 7.47 ha
SB2a
Catchment K3 - 6.01 ha
SB2b
Catchment K4 - 3.42 ha
Catchment K1 - 42.61 ha
SD6
SD5
Catchment J3 - 17.60
SB1
Catchment I2 - 0.85 ha
Catchment H - 3.85 ha
SD2
SD1
Catchment G1 - 3.85 ha
Catchment F - 9.61 ha
Catchment D - 6.96 ha
EST6
EST4
SD3
SD4
Catchment I1 - 5.20 ha
EST5
EST3
EST2
Catchment J2 - 8.59 ha
Catchment J1 - 9.34 ha
Catchment K2 - 686.42 ha
EST1
Lease 1
Sump 1
Catchment E - 24.75 ha
Catchment L - 13.31 ha
Lot 1 DP100511
Sump 2
Catchment C - 12.91 ha
Catchment A1 - 9.86 ha
Catchment B - 17.79 ha
SB3a
Lease 2
Catchment A2 - 104.86 ha
Lot 2 DP100511
E 235500 m
E 236000 m
E 236500 m
E 237000 m
N 6282500 m
N 6282000 m
N 6281500 m
N 6281000 m
N 6280500 m
Legend:
Lease Boundary
Approved Pit Area
Proposed Extension to Approved Pit Area
Coxs River
Catchment Boundary
Drainage Path
SD Storage Dam
SB Sediment Basin
EST Excavated Sediment Trap
Austen Quarry
Stage 2 Extension
Hy-Tec Industries Pty Ltd
Figure 3 - Catchment Delineation Plan
Existing Operations
GROUNDWORK plus
1:7,500
1517.043
1

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Appendix B

Soil and Water Management Plan, RW Corkery (July 2006)

Note: This Appendix is only available on the Project CD

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Adelaide Brighton Limited
ABN: 15 007 596 018

Soil and Water Management Plan

for the

Austen Quarry, Hartley

Prepared by:

R.W. CORKERY & CO. PTY. LIMITED

in conjunction with:

GSS Environmental

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Adelaide Brighton Limited
ABN: 15 007 596 018

Soil and Water Management Plan

for the

Austen Quarry, Hartley

Prepared by:

R.W. Corkery & Co. Pty. Limited
Geological & Environmental Consultants
75 Kite Street
ORANGE NSW 2800

ABN: 31 002 033 712

Telephone: (02) 6362 5411
Facsimile: (02) 6361 3622
Email: RWC@cww.octec.org.au

In conjunction with:

GSS Environmental
55 Tumbi Road
WAMBERAL NSW 2260

July 2006

On behalf of:
Adelaide Brighton Limited
Level 1, 157 Grenfell Street
ADELAIDE SA 5000

ABN: 15 007 596 018

Mobile: (0437) 773 343

Ref No. 652/05

R. W. CORKERY & CO. PTY. LIMITED

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R. W. CORKERY & CO. PTY. LIMITED

FOREWORD

This Soil and Water Management Plan (SWMP) for the Austen Quarry, has been prepared in compliance with *Condition 9(a)* of a development consent (development application No. 103/94) issued by the Council of the City of Greater Lithgow (now Lithgow City Council) for the quarry site. It represents an update of an Erosion and Sediment Control Plan for the Hartley Rhyolite Quarry Site Access Road. This was prepared by the Department of Land and Water Conservation in 1995, which prior to the purchase of the quarry site by Adelaide Brighton Limited in March 2002 has, in conjunction with a Rehabilitation and Environmental Management Plan (IEC, 1999), been viewed as the SWMP for the quarry.

This SWMP expands and updates the concepts presented in these documents through reference to relevant guidelines such as the Department of Housing guideline *"Managing Urban Stormwater: Soils and Construction"* Vol. 1, 4th eds. (Landcom, 2004).

GLOSSARY OF ACRONYMS AND REFERENCE TERMS

GLOSSARY

BMP	-	Best Management Practice
CB	-	Catch Bank
DB	-	Diversion Bank
DEC (EPA)	-	Department of Environment and Conservation (Environment Protection Authority)
DNR	-	Department of Natural Resources
DoP	-	Department of Planning
EIS	-	Environmental Impact Statement
ESCP	-	Erosion and Sediment Control Plan
LS	-	Level Spreader
RS	-	Rock-lined Spillway
SB	-	Sediment Basin
SD	-	Clean Water Storage Dam
SeD	-	Sediment Dam
SpD	-	Spoon Drain
SWMonP	-	Surface Water Monitoring Program
SWMP	-	Soil and Water Management Plan
TSS	-	Total Suspended Solids
WW	-	Waterway

TERMS

Conveyor System	Series of conveyors and towers to transfer the rhyolitic material from the primary crusher to the processing infrastructure of the processing area.
Extraction Area	12.9ha area designated for the extraction of rhyolitic material.
Primary Crusher	Crushing plant located on the 737m bench of the extraction area.

TERMS (CONTINUED)

Processing Area	3.2ha constructed hardstand area adjacent to the Coxs River designated for the secondary and tertiary crushing and screening of extracted rhyolitic material, product stockpiling and storage of surface water.
Processing Pad	Area within the processing area designated for rhyolitic material crushing, screening and stockpiling.
Processing Area Bund	Bund constructed between the processing area and Coxs River to prevent the discharge of surface water.
Quarry	The combination of the extraction area, processing area and all related roads.
Quarry Access Road	Constructed road between the processing area and extraction area.
Site Access Road	Constructed and eventually sealed road between the processing area and Jenolan Caves Road.
Visual Bund	Earthen and vegetated bund constructed to provide a visual screen to vantage points to the north and west.
Yorkeys Creek Crossing	Crossing of Yorkeys Creek constructed at the instruction of DPI (MR).

CONTENTS

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APPENDICES

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FIGURES

TABLES

1 INTRODUCTION

This Soil and Water Management Plan (SWMP) for the Austen Quarry ("the quarry site"), has been prepared in compliance with *Condition 9(a)* of a development consent (DA No. 103/94) issued by the Council of the City of Greater Lithgow (now Lithgow City Council). It has been prepared in accordance with the Landcom document *Managing Urban Stormwater: Soils and Construction, Vol. 1, 4th eds.* (Landcom, 2004).

The Austen Quarry has been owned and operated by Adelaide Brighton Limited (ABL) since March 2002. The SWMP updates and replaces water management features and concepts presented in an "Erosion and Sediment Control Plan for the Hartley Rhyolite Quarry Site Access Road" (DLWC, 1995) and the "Rehabilitation and Environmental Management Plan" (IEC, 1999) prepared on behalf of the previous owner of the Austen Quarry, Aus10 Rhyolite Pty Limited of the Premier Resource Group. The SWMP incorporates:

- an identification and categorisation of the water catchments of the quarry site and associated infrastructure (**Section 2**);
- a description of the local soil types and their potential influence on the design and construction of water management structures (**Section 3**);
- an assessment of constraints posed by the location of the quarry site and characteristics of the local soils and surface water catchments (**Section 4**);
- a description of soil and water management at the quarry site including:
  - soil and water management objectives (**Section 5.1**);
  - soil best management practices (**Section 5.2**);
  - water best management practices including a description of the structures used on the quarry site to control and store water flows (**Section 5.3**);
  - a water balance and internal water transfer regime for the quarry site (**Section 5.4**).
- an Erosion and Sediment Control Plan (ESCP) (**Section 6**); and
- a Surface Water Monitoring Program (SWMonP) (**Section 7**).

For management purposes, the water within the quarry site has been divided into two classes.

1. **"Clean" water** - surface runoff from rehabilitated catchments or catchments undisturbed or relatively undisturbed by extraction, processing or related activities.
2. **"Dirty" water** - surface runoff from disturbed catchments such as the active extraction area and overburden emplacement, processing area, quarry site product stockpiles, internal roads, soil and subsoil stockpiles and rehabilitated areas (until stabilised), all of which could produce significant concentrations of suspended sediment.

2 CATCHMENTS OF THE AUSTEN QUARRY

Figure 1 presents the regional catchments of the Austen Quarry, identified as Catchments 1, 2, 3 and 4. **Table 2.1** presents information on the area covered by, and the type of quarry site related disturbance to occur in each.

Table 2.1
Austen Quarry Catchments

Catchment	Area (ha)	Quarry site Related Disturbance
1	103	Extraction area, processing area, Quarry Site Access Road, and quarry site facilities
2	115	Overburden emplacement
3	740	Site Access Road, Yorkeys Creek Crossing
4	195	Site Access Road

Figure 2a presents the local sub-catchments surrounding the quarry site, overburden emplacement, processing area and Quarry Access Road. **Figure 2b** presents the identified sub-catchments surrounding the Site Access Road. These sub-catchments are categorised as either clean, partially disturbed or disturbed, where each category is as follows:

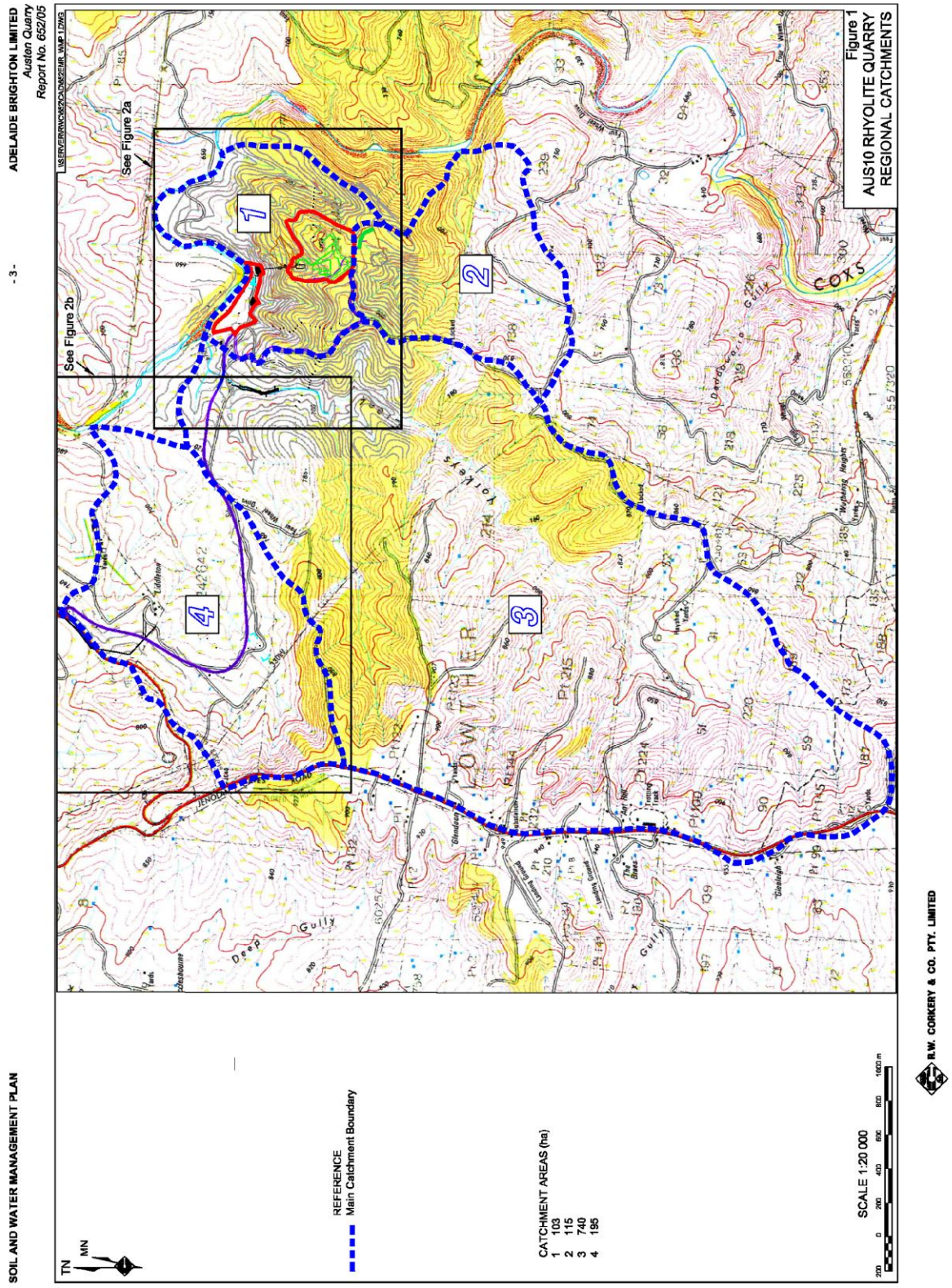
- **Clean catchments** reference those which do not include any areas of quarry related disturbance.
- **Partially disturbed catchments** reference those which include only areas of minor quarry site related disturbance or rehabilitation under maintenance.
- **Disturbed catchments** reference those which include areas of major quarry related disturbance.

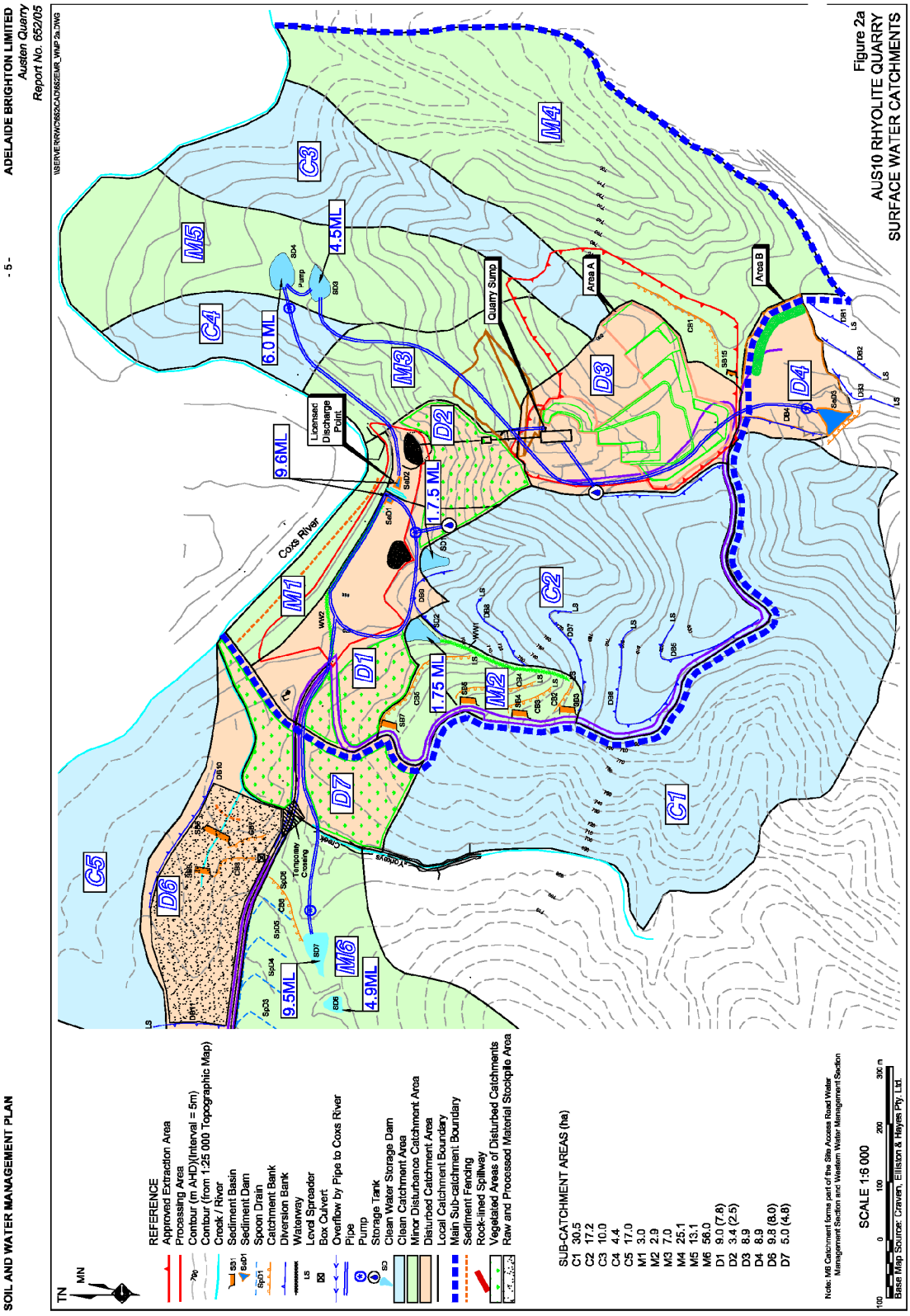
Table 2.2 presents the area of each of these sub-catchments as calculated from the surveyed and interpreted topographic base of **Figure 2**. **Table 2.2** also identifies the water storage structures within each of the nominated catchments.

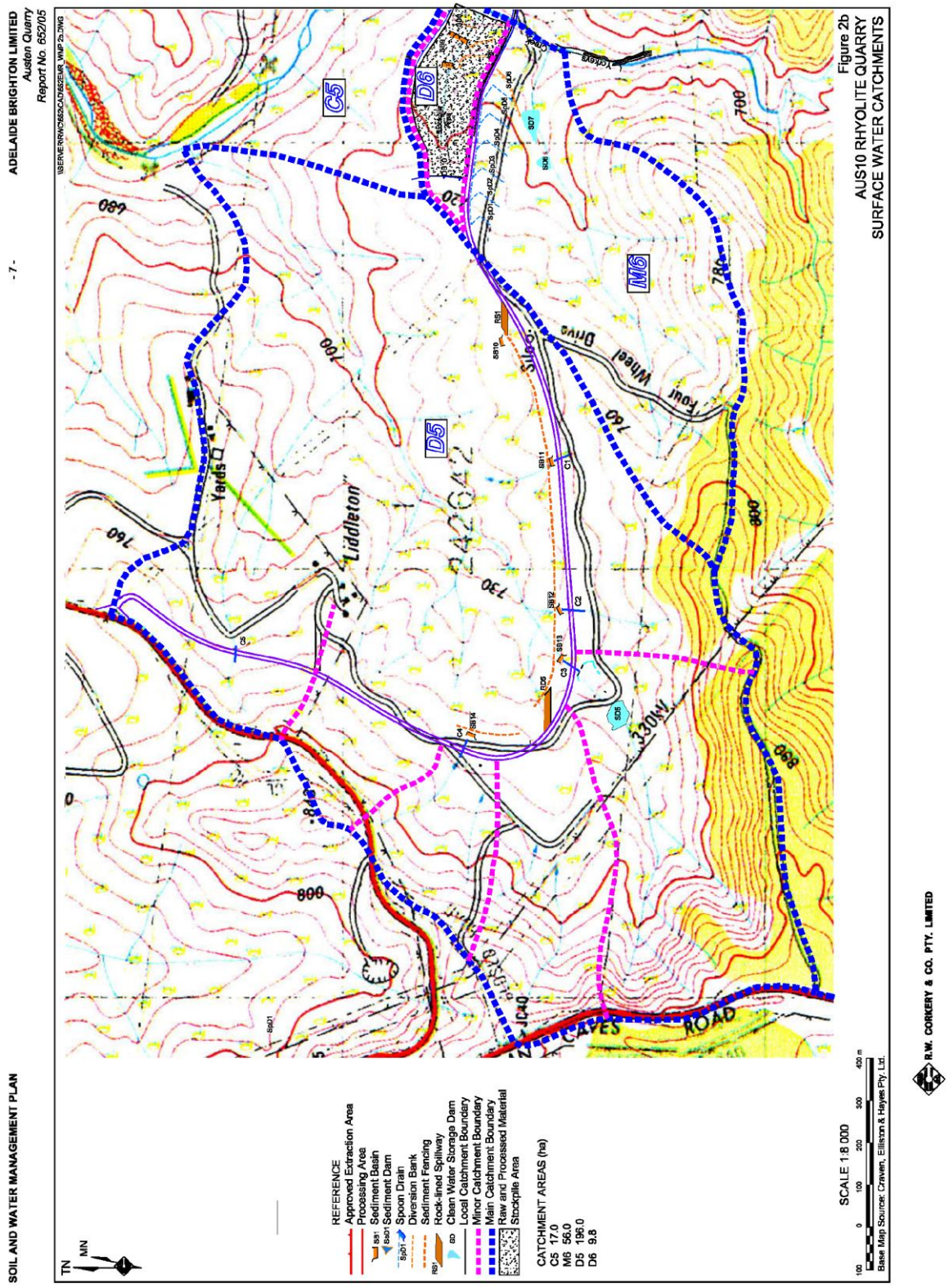
Table 2.2
Austen Quarry Catchments

Clean Catchments#			Partially Disturbed Catchments#			Disturbed Catchments#		
	Area	Water Storages*		Area	Water Storages*		Area	Water Storages*
C1	30.5	-	M1	3.0	-	D1	9.0	SeD1
C2	17.2	SD1	M2	2.9	SB3, SB4, SB5, SB7, SD2	D2	3.4	SeD2
C3	10.0	-	M3	7.0	-	D3	8.9	Quarry Sump
C4	4.4	-	M4	25.1	SB13	D4	3.1	SeD3
C5	17.0	-	M5	13.1	SD3, SD4	D5	196.0	SD5, SB10 – SB12
			M6^	56.0	SD6, SD7	D6	9.8	SB8, SB9
						D7	5.0	

\# Refer to **Figure 2a** * Refer to Sections 5.3.3.6 and 5.3.4.3 for detail
^ It is the objective of water management on the site to operate sub-catchment M6 as a clean water catchment following the completion of road construction and installation of associated erosion and sediment controls


ADELAIDE BRIGHTON LIMITED
Austen Quarry
Report No. 652/05
- 3 -
SOIL AND WATER MANAGEMENT PLAN
Figure 1
AUS10 RHYOLITE QUARRY
REGIONAL CATCHMENTS
See Figure 2a
See Figure 2b
1
2
3
4
COXS
LOWTHER
Deep Gully
REFERENCE
Main Catchment Boundary
CATCHMENT AREAS (ha)
1 103
2 115
3 740
4 196
SCALE 1:20 000
TN
MN
R.W. CORKERY & CO. PTY. LIMITED


SOIL AND WATER MANAGEMENT PLAN
ADELAIDE BRIGHTON LIMITED
Austen Quarry
Report No. 652/05
- 5 -
Figure 2a
AUS10 RHYOLITE QUARRY
SURFACE WATER CATCHMENTS
R.W. CORKERY & CO. PTY. LIMITED
TN
MN
REFERENCE
Approved Extraction Area
Processing Area
Contour (m AHD)(Interval = 5m)
Contour (from 1:25 000 Topographic Map)
Creek / River
Sediment Basin
Sediment Dam
Spoon Drain
Catchment Bank
Diversion Bank
Waterway
Level Spreader
Box Culvert
Overflow by Pipe to Coxs River
Pipe
Pump
Storage Tank
Clean Water Storage Dam
Clean Catchment Area
Minor Disturbance Catchment Area
Disturbed Catchment Area
Local Catchment Boundary
Main Sub-catchment Boundary
Sediment Fencing
Rock-lined Spillway
Vegetated Areas of Disturbed Catchments
Raw and Processed Material Stockpile Area
SUB-CATCHMENT AREAS (ha)
C1 30.5
C2 17.2
C3 10.0
C4 4.4
C5 17.0
M1 3.0
M2 2.9
M3 7.0
M4 25.1
M5 13.1
M6 58.0
D1 9.0 (7.8)
D2 3.4 (2.5)
D3 8.9
D4 8.9
D6 9.8 (8.0)
D7 5.0 (4.8)
Note: M6 Catchment forms part of the Site Access Road Water Management Section and Western Water Management Section
SCALE 1:6 000
100 0 100 200 300 m
Base Map Source: Craven, Elliston & Hayes Pty. Ltd.
Coxs River
Quarry Sump
Area A
Area B
Licensed Discharge Point
Temporary Crossing
6.0 ML
4.5ML
9.6ML
1.75 ML
1.7.5 ML
9.5ML
4.9ML


ADELAIDE BRIGHTON LIMITED
Austen Quarry
Report No. 652/05
- 7 -
SOIL AND WATER MANAGEMENT PLAN
Figure 2b
AUS10 RHYOLITE QUARRY
SURFACE WATER CATCHMENTS
C5
D6
D5
M6
Liddleton
Four Wheel Drive
CRAVES ROAD
REFERENCE
Approved Extraction Area
Processing Area
Sediment Basin
Sediment Dam
Spoon Drain
Diversion Bank
Sediment Fencing
Rock-lined Spillway
Clean Water Storage Dam
Local Catchment Boundary
Minor Catchment Boundary
Main Catchment Boundary
Raw and Processed Material
Stockpile Area
CATCHMENT AREAS (ha)
C5 17.0
M6 56.0
D5 196.0
D6 9.8
TN
MN
SCALE 1:8 000
Base Map Source: Craven, Ellison & Hayes Pty. Ltd.
R.W. CORKERY & CO. PTY. LIMITED

It is worthy of note that water captured within the sub-catchments of D3 and D4 will be pumped to SD3 / SD4 within catchment M5 following an accumulation of water in the either SeD3 or the Quarry Sump. As a consequence, catchment M5 has been classified as a partially disturbed catchment.

A basic objective of water management on any quarry site is to segregate clean and dirty water. To aid in achieving this objective at the Austen Quarry, the sub-catchments of the quarry site, (ie. those identified in **Figure 2a)**, have been further categorised into water management sections (WMS') for either clean or dirty water (see **Figure 3**).

Dirty Water

- Eastern WMS – which incorporates sub-catchments D3, D4 & M5 for a total catchment area of 25.1ha. Dirty water will be stored in SD4 for operational use whereas SeD3 and SD3 will be kept largely empty to ensure the capture and storage of water during and following a 20 day 95th percentile rain event. Dirty water will be pumped to SD5 as required with this water treated with a flocculant, sampled and analysed prior to discharge.
- Processing Area WMS – which incorporates sub-catchments D1, D2 and M2 for a total catchment of 15.3ha. It will also include runoff from the Quarry Access Road from the top of the ridge to the processing area. All water storage structures within this WMS will be operated predominantly as sediment retention structures and therefore will be preferentially kept dry. As such, settled water will be transferred to SD4 within the Eastern WMS as required. It is noted that this represents a variation from water management on the processing area proposed in the EIS. It is considered appropriate to minimise the volume of water in and around the more disturbed areas of the quarry and thereby reduce the risk of incidents related to the discharge of dirty water from the processing area.
- Yorkeys Creek WMS – which incorporates sub-catchments D6 and D7 for a total catchment of 14.8ha. These sub-catchments will not contribute to water storage, rather, they will be managed such that water flowing to Yorkeys Creek has been sufficiently treated through diversion and/or settlement as not to pollute the creek or Coxs River further downstream.

Clean Water

- Central WMS – which incorporates sub-catchment C2 only for a total catchment area of 17.2ha. Diversion structures will direct water to SD1 from where the water may be pumped directly to the Coxs River or transferred to SD7 for storage.
- Western WMS – which incorporates sub-catchment M6 only for a total catchment area of 56.0ha. This WMS will capture natural flows from within the M6 sub-catchment as well as water discharged via spoon drains from a 0.35ha area of the Site Access Road. SD6 and SD7 may also accept water from SD1.

By considering water management on the quarry site within these dirty and clean WMS', segregation of clean and dirty water will be achieved while also allowing for sediment retention structures to be kept empty, thereby maximising their water storage / sediment retention capacity during and following heavy rain.

ADELAIDE BRIGHTON LIMITED - 10 - **SOIL AND WATER MANAGEMENT PLAN**
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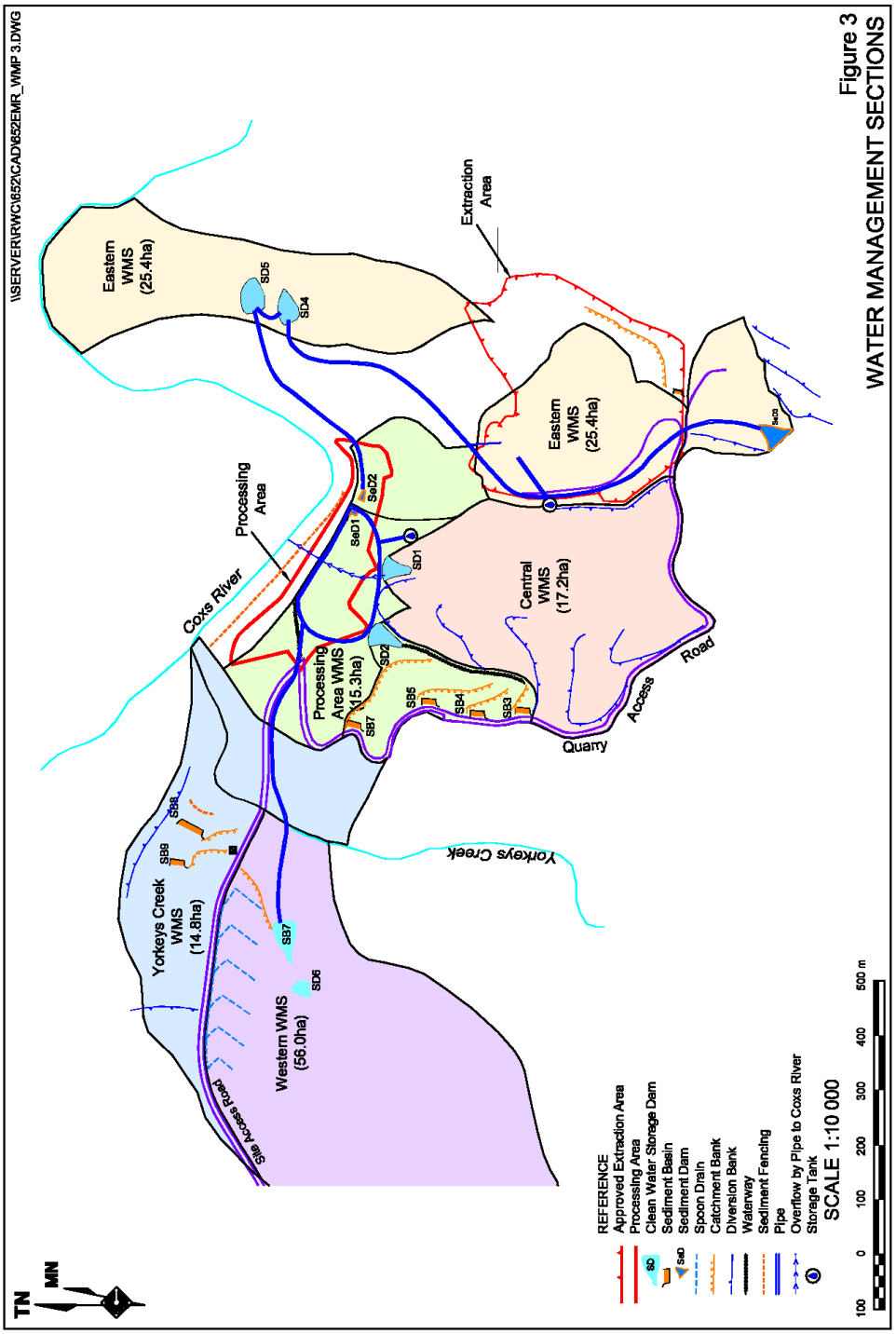

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3 SOILS OF THE AUSTEN QUARRY

3.1 Introduction

With the exception of a single soil horizon sample, analysed in September 1995, no specific assessment of quarry site soils has been undertaken. A description of quarry site soils has been based on three primary sources.

(i) Definition of the Marangaroo soil landscape from the Katoomba 1:100 000 soil landscapes mapsheet area (King, 1994).

(ii) Environmental Impact Statement prepared for the Hartley Rhyolite Quarry by Sinclair Knight Merz (1994).

(iii) Erosion and Sediment Control Plan for Hartley Rhyolite Quarry Access Road prepared by the Department of Land and Water Conservation (1995).

3.2 Quarry Soils and Soil Erodibility

The quarry site is located within the Katoomba 1:100 000 scale soil landscapes map sheet area (King 1994). On this map sheet area, limited areas to the south of the quarry site access road are located on the Round Mount Soil Landscape with the quarry site activities located predominantly on the Marangaroo Soil Landscape. Soils of the Marangaroo Soil Landscape generally display the following characteristics.

- Location: Generally occurring on rolling hills and narrow flat to rounded converse crests of Carboniferous granites, local relief to 90m and slopes <30°.
- Texture: Shallow (<80cm) loamy sand to sandy loam above clayey sand changing to coarse, gravely sand or sandy clay at depth.
- pH: Moderately to slightly acid in topsoil layers. Subsoil is slightly acid to slightly alkaline (6.5 to 8.0).
- Permeability: Highly permeable with low water holding capacity.
- Fertility: Low fertility.
- Erodibility: High erodibility. King (1994) attributes a USLE K factor of between 0.024 and 0.031.

Soils of the Marangaroo Soil Landscape are considered to show slight dispersibility (EAT Classes 3(1), 3(2) and 5) and generally moderate dispersion (0% - 60%) (King, 1994).

Based on this description of the soil, careful management is required to reduce the erosion hazard.

3.3 Implications for Soil and Water Management of the Quarry

The soil characteristics described in Section 3.2 would suggest that unless carefully controlled, surface water flows on the quarry site will tend to cause erosion. However, due to the slight dispersibility and generally moderate dispersion of the soil (King, 1994), settlement time for captured surface water may be relatively low, which could therefore, reduce the size of the storage structures required.

Ultimately the location and size of surface water management and storage structures will need to account for soil type and catchment size.

4 ASSESSMENT OF CONSTRAINTS

4.1 Introduction

As noted in Landcom (2004), a proper assessment of site constraints is a prerequisite to the preparation and implementation of a SWMP. Constraints are classified as either:

(i) on-site, ie. relating to soils, landforms, ecology pollutants and hydrology occurring on the site of the proposed or approved activities; or

(ii) downstream, ie. relating to aquatic ecosystem sensitivity and the social and aesthetic values of the community.

Based on the identified constraints and opportunities, best management practices (BMPs) can be developed for the site to minimise the potential degradation of soil and water resources and/or other aesthetic/environmental assets while maximising the achievement of outcomes in accordance with principles of Ecologically Sustainable Development (ESD).

It is noted that an assessment of constraints is generally undertaken at the conceptual stage of project development. Despite the fact that conceptual planning for the Austen Quarry occurred over ten years previous to the preparation of this SWMP, it is still considered appropriate to consider the constraints of the site given that the SWMP is to become the focal document in the management of soil and water resources.

4.2 Riparian Lands

Waterfront Lands (formally known as Riparian Lands under the *Rivers and Foreshores Improvement Act 1948*) are those vegetated lands immediately next to waterbodies such as rivers, creeks, estuaries, lakes and wetlands. The Austen Quarry includes development on riparian lands and therefore is constrained:

(i) to protect and enhance the social, economic, cultural, spiritual and heritage values of waterfront land for aboriginal groups and the wider community; and

(ii) to avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, salinity hazards and decline of native vegetation.

4.3 Flooding

A 1 in 150 year ARI storm of 1 February 2005 (Parsons Brinkerhoff, 2005) has illustrated that the processing area of the quarry site is not affected (and therefore not constrained) by local flooding.

Local flooding of Yorkeys Creek during 1 in 100 year, 72 hour ARI or greater events is, however, a constraint on the design and construction of the crossing of Yorkeys Creek. Flooding levels recorded following the February 2005 storm event identified a high water mark of 5.2m above the bed of Yorkeys Creek at a location approximately 150m upstream of the crossing (see **Figure 4**). These historic values must be accounted for in crossing design and construction management.

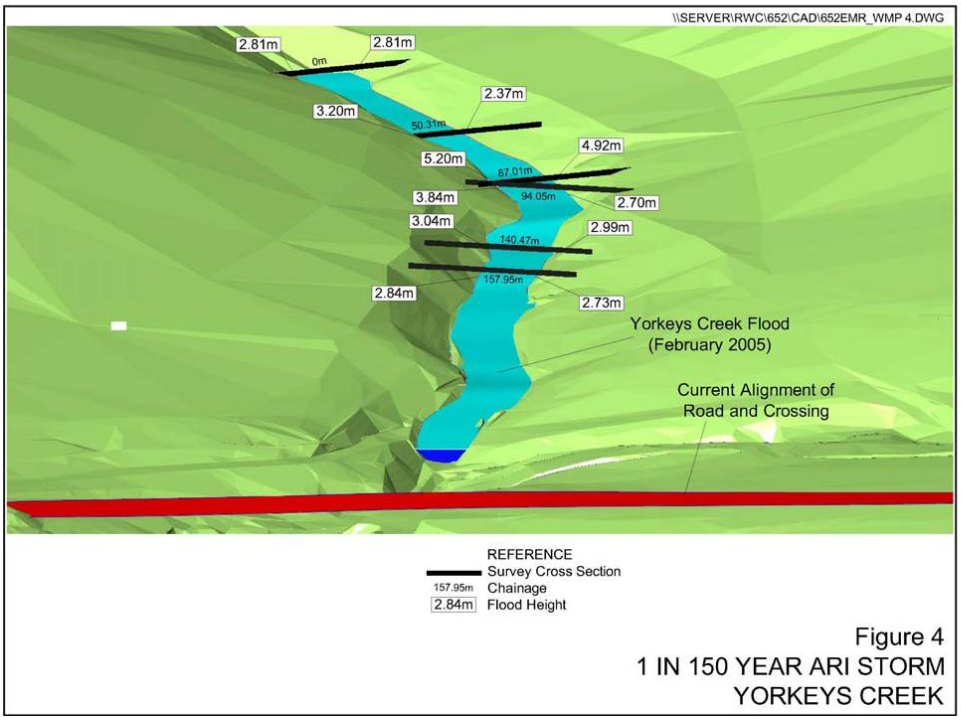

Figure 4
1 IN 150 YEAR ARI STORM
YORKEYS CREEK

4.4 Erosion (Rainfall Erosivity, Soil Erobility and Soil Erosion Hazard)

4.4.1 Rainfall Erosivity

The rainfall erosivity factor, R, is a measure of the ability of rainfall to cause erosion. It is the product of two components:

- total energy; and
- maximum 30 minute intensity for each storm.

Based on Map 10 of Landcom (2004), the Austen Quarry is located within a rainfall erosivity zone between 1 500 and 2 000. As the bulk of ground disturbing activities occur on slopes of 10% or less, the Austen Quarry presents a generally low erosion hazard (see Figure 4.6 of Landcom (2004)). Where the slope of land on which activities are to occur is greater than 10°, the design and development of these areas is constrained by a potentially high erosion hazard.

4.4.2 Soil Erodibility

Soil erodibility is a measure of the susceptibility of individual soil particles to detachment and transport by rainfall and runoff. Soil texture is the principal component affecting soil erodibility, but structure, organic matter and permeability also contribute.

As no comprehensive laboratory analysis of quarry soils has been completed, the soil erodibility can not be accurately determined. It is noted however, that soils of the Marrangaroo soil landscape tend to display moderate to high erodibility (King, 1994) and as such, the implementation of appropriate erosion and sediment controls will constrain development.

4.4.3 Soil Erosion Hazard

Soil erosion hazard refers to the susceptibility of land to the prevailing agents of erosion and must be distinguished from soil erodibility. Where soil erodibility is measured only on a sample of soil taken from the field to a laboratory and put through certain tests, soil erosion hazard is considerate of field conditions and is dependent on a number of factors, including climate (rainfall erosivity), landform, soils (soil erodibility), ground cover and land management.

A soil loss class for the quarry site is conservatively considered Class 4 to 5, moderate to high erosion hazard, with activities constrained by the implementation of the best management practise erosion and sediment controls, especially between December and February (when Landcom (2004) notes the erosion hazard is greatest).

4.5 Soil Characteristics

Section 3 provided a general description of the type of soils to be encountered at the quarry site. These will generally be Class C or F soils which are only moderately dispersible. As a consequence, soil characteristics do not pose a major constraint to soil and water management.

4.6 Surface Water Runoff

Given the steep relief within several quarry site sub-catchments, surface water runoff will be an important consideration in the design and location of best management practice water storages and catchment/diversion structures. The runoff coefficients of land within the quarry site sub-catchment will need to be accounted for in the preparation of a site water balance and best management practice erosion and soil control.

4.7 Groundwater Table

As the development and operation of the Austen Quarry is unlikely to have a significant impact on local water tables (SRK, 1994), this will not constrain development of best management practices water management.

4.8 Salinity and Acid Sulphate Soils

Soils of the Marrangaroo Soil Landscape do not pose a salinity or acid sulphate soil hazard.

4.9 Contaminated lands

Soil contamination can result from the actions associated with previous land uses where chemical concentrations have accumulated over time and, now, pose significant health risks to potential new occupiers and to the environment. To date no contaminated lands have been encountered, and none are expected, at the Austen Quarry. Should contaminated lands be identified soil and water management will be constrained by the guidelines prepared by the DEC.

4.10 Mass Movement

The soil layer on the steeper slopes of the quarry site is shallow and of low plasticity above a competent rock base. The potential for mass movement of soil is considered low and this will not constrain soil and water management of the quarry site.

5 SOIL AND WATER MANAGEMENT

5.1 Objectives

The principal objectives of soil and water management are as follows.

(i) To manage the soil resources of the site to minimise the risk of erosion and maximise the potential use of any stripped/disturbed soil in ongoing rehabilitation of the site.

(ii) To ensure appropriately designed and located water management structures are constructed and maintained to segregate “dirty” water from “clean” water.

(iii) To ensure that "dirty" water captured within the disturbed and partially disturbed sub-catchments of the quarry site is retained, retention time maximised and water appropriately treated such that any discharge occurs at the licensed discharge point and this meets the water quality objectives as follows:

- pH - 6.5 – 8.5;
- Oil and grease - 10 mg/L;
- Electrical Conductivity - <1500 us/cm;
- Total Suspended Solids - <30 mg/L; and
- Biochemical Oxygen Demand - 20.

(iv) To ensure sufficient quantities of water can be obtained through the capture of surface water to meet the operational and dust suppression requirements of the quarry site.

(v) To minimise erosion and sedimentation from all active and rehabilitated areas of the quarry site.

(vi) To monitor the effectiveness of surface water erosion and sediment controls such that the quarry site has no adverse impact on the water quality of the Cox's River.

The following sub-sections have been structured and prepared to provide appropriate best management practises (BMPs) to maximise the potential to achieve each of these objectives.

- Section 5.2 presents the soil BMPs to be adopted by ABL at the Austen Quarry.
- Section 5.3 presents the water BMPs to be adopted by ABL at the Austen Quarry. This includes a description of water management within the riparian zones on the quarry site, the internal pumping system installed to allow for the movement of water between various site storages and the design features and locations of structures constructed to control the flow of water on the quarry site.
- Based on the predicted runoff received within the quarry site sub-catchments, the location of the water management structures described in Section 5.3, and the operational requirements of the Austen Quarry, Section 5.4 presents a water balance for the quarry site. The water balance provides further details on the internal pumping system of the site and the likely requirement to move water between water storages in dry, average and wet years. This section also reviews the critical storage capacity of the site over which a controlled discharge to the Coxs River will be required.

5.2 Soil BMPs

Minimising the area of soil exposed to surface water flows, either as cleared surfaces ahead of extraction, soil stockpiles or respread soils over rehabilitated surfaces, is the primary aim of soil management. The secondary aim is to provide exposed soils with adequate protection to minimise disturbance caused by surface water flows. These aims are achieved through the adoption of the following BMPs, the detailed implementation of which is provided in *Procedure 3 - Soil Management.*

Planning Considerations

- As far as practical, ground disturbing activities (vegetation clearing, soil stripping and site development works) will be scheduled such that the time from commencement to completion is less than six months.
- Generally disturbance will begin at a point most distant from a waterway or drainage line and move closer.
- Genuine attempts will be made to minimise the areas cleared ahead of extraction.
- Access to areas designated for ground disturbing activities are to be limited to within 10m (and preferably 5m) of the designated area and identified with fencing, flagging or other methods.
- Prior to the commencement of any ground disturbing activities, upslope diversion banks (see Section 5.3.3.2) and downstream sediment fencing and/or other sediment retention structures (Section 5.3.5.2) are to be constructed / installed.
- The length of any exposed slope will be restricted to 80m or less prior to forecast rain or periods of non-activity in that area. On steeper slopes, mid-slope berms or up-slope water diversion works will be constructed.

Handling Soils

- Soil stripping areas will be clearly defined and marked prior to commencement.
- Ideally, grass and shrub layer will be stripped along with the soil.
- The topsoil will be stripped to a depth of between 100mm and 150mm and either transferred directly to rehabilitation area or placed in designated stockpile areas.

Soil Stockpiling

- Soil Stockpiles are to be managed in accordance with *Procedure No. 3 – Soil Management*, ie. no higher than 3m with a slope of <2:1(V:H) and the stockpile surface left roughened. Placement within natural or constructed drainage lines will be avoided, however, if unavoidable, upstream and downstream protection, in the form of diversion banks (see Section 5.3.3.2) and downstream sediment retention structures (see Sections 5.3.4 and 5.3.5) will be constructed/installed prior to commencement of stockpiling.
- Soil retained in stockpile for >3 months, will be stabilised in accordance with *Procedure No. 6 – Site Stabilisation and Short Term Rehabilitation.*

Soil Respreading

- Before soil respreading the ground surface will be scarified or ripped along the line of the contour to break any compacted and smooth surfaces and assist in keying the respread soil.
- Soil respread over areas of rehabilitation will be approximately 100mm on flat or shallow slopes (>4(H):1(V)) and no greater than 50mm on steeper slopes (<4(H):1(V)).

- The respread soils will be left with a roughened surface and sown with native grass species (or a non-persistent cover crop) as soon as possible to stabilise the soils.

5.3 Water BMPs

5.3.1 Introduction

Best management practises (BMPs) for water on the Austen Quarry consider the water management system of the Austen Quarry in it's entirety:

(i) management of water within riparian corridors of the quarry site;

(ii) the diversion and storage of clean water within a predominantly segregated clean water system;

(iii) the capture, storage and settling/treatment of dirty water within a segregated dirty water system;

(iv) the discharge of water from the quarry site;

(v) a water balance for the nominated clean and dirty water systems and an appropriate pumping regime to maximise storage capacity of the quarry site; and

(vi) capacity requirements, or management protocols, of the various water storages to retain sufficient capacity to handle a 20 day 95th percentile rain event without overflow to the Cox River.

Detail is provided to the extent considered necessary to illustrate the concepts and objectives of water management implemented at the Austen Quarry and describe the appropriate design and function of the various water BMPs used to achieve these concepts and objectives. Specific design features for the water BMPs, as provided by GSS Environmental, are presented with detail on the construction and maintenance of the various structures described in the following sections provided in the following procedures:

(i) *Procedure No. 4 – Erosion and Sediment Control Design and Construction.*

(ii) *Procedure No. 5 – Erosion and Sediment Control Maintenance.*

5.3.2 Works within Riparian Corridors

The Austen Quarry has been approved to undertake operations that fall within, or adjacent to natural water bodies, namely:

- construction of a crossing of Yorkeys Creek; and
- construction of a processing area that encroaches within 40m of the Coxs River.

Management of works within these zones is as follows.

Yorkeys Creek Crossing

Given the level of disturbance required within Yorkeys Creek, ie. construction of a crossing sufficient for heavy vehicle traffic, and the ephemeral nature of the water body, this is considered Category 3 riparian land (Landcom, 2004) and is to be managed to ensure the maintenance of bank stability and water quality.

As a consequence of a 1 in 150 year ARI storm in the first quarter of 2005 (Parsons Brinkerhoff, 2005), construction of a DIPNR designed crossing was compromised and the partially completed structure washed away. At the request of the Department of Primary Industries (Mineral Resources), a replacement crossing has been constructed. The construction of this replacement crossing considered the recommendations of Landcom (2004) and incorporates the following design features:

- It was constructed using a 3m wide culvert to carry water beneath a raised gravel/rock carriageway.
- The rock used in the construction of the carriageway was sourced from the extraction area.
- The height of the carriageway at its most elevated point above the bed of Yorkeys Creek is approximately 8m. This reduces the slope of the Site Access Road entering and exiting the crossing.
- The carriageway is 7m in width with the culvert extending beyond the toe of the rock embankment.

Management of the replacement crossing will be as follows.

- The culvert will be regularly inspected and cleared of debris that might compromise its capacity or lead to blockage of the pipe.
- Regular inspections will be undertaken to observe whether any of the rock used in the construction of the carriageway and embankment have moved following rainfall events. Any material found to have moved will be replaced at the base of the embankment or disposed of in the overburden emplacement.
- A vegetative cover on the exposed slopes of the washed out crossing will be established and maintained. Where considered necessary, additional stabilisation works will be undertaken.
- If and when a replacement crossing is required, the existing crossing will be removed and the site rehabilitated in accordance with the site Stage Specific Management Plan (in preparation).

Processing Area

During the construction phase of the Austen Quarry it became apparent that the processing area, as designed, encroached within 40m of the Coxs Rover. Although this section of the Coxs River bank had been previously cleared, and as a consequence supported predominantly exotic vegetation, the area required for the construction of the processing area is considered Category 2 riparian land (Landcom, 2004). As such, it is to be managed as terrestrial and aquatic habitat and therefore must maintain the natural function of the river to:

- maintain and improve the viability of riparian vegetation;
- maintain/provide suitable habitat for terrestrial and aquatic fauna;
- provide bank stability; and
- protect water quality.

A permit under the *Rivers and Foreshores Improvement Act 1948* has been issued for operations within the 40m of the Coxs River (PAR9012617) and the construction, operations and rehabilitation of the processing area and processing area bund wall within this zone managed in accordance with PAR9012617. In summary, construction, operations and rehabilitation will be managed as follows.

- The processing area bund wall has been constructed with competent rock extracted from the quarry area and topsoil excavated from the site of the bund wall.[1]
- The bund wall was constructed in such a way as to not impact on the natural flow path, including riffles and pools, of the Coxs River.
- At the instruction of DIPNR, the topsoil was not compacted to encourage the establishment of riparian vegetation.
- The discharge of surface water from the processing area to the Coxs River will be prevented.
- Sediment fencing will be maintained between the toe of the bund wall and the main flow channel of the Coxs River and inspected fortnightly or after major rainfall events.
- Access within the riparian corridor created by the construction of the bund wall will be restricted to ABL personnel undertaking rehabilitation or maintenance activities and the land owner.
- The bund wall and parts of the processing area will be progressively revegetated in accordance with a Vegetation Management Plan (VMP) prepared by Geoff Cunningham Natural Resource Consultants Pty Limited (GCNRC, 2005).
- ABL will supply the Department of Natural Resources (DNR) a brief maintenance report on the status of activities within areas covered by PAR9012617 every 6 months (for as long as required) and respond in a timely fashion to recommendations and maintenance orders supplied by DNR.

[1] Following initial construction of the processing area bund wall of SED1 and SED2, a structural failure was identified leading to the discharge of water, within these structures discharging to the Cox's River. Subsequent investigations into the geotechnical characteristics were undertaken with additional clay lining and compaction to be included in the repair and reconstruction of SED1 and SED2.

5.3.3 Clean Water Diversion and Storage

5.3.3.1 Introduction

A primary objective of the management of water on the quarry site will be to segregate clean and dirty water flows (see Section 5.1) and diverting surface water flows away from areas of active disturbance or rehabilitating lands will assist in achieving this objective. Diverting water flowing over undisturbed areas of the quarry site, away from the active areas of disturbance and directing this water either to water storages or discharge points at non-erosive velocities, will also greatly reduce the risk of erosion, and therefore sedimentation.

The following section presents the surface water BMP structures to be employed on the quarry site to divert and store clean water.

Procedure No. 4 provides additional detail on the design and construction of these structures.

5.3.3.2 Diversion Banks (Low Flow)

These structures are simple earth banks which are generally constructed with a circular, parabolic or trapezoidal drain. They are designed to divert surface water flows from shallow to moderate slopes where the upslope length is less than 80m or within small or well vegetated catchments. The gradient of the diversion bank should be between 1% and 5% and the height of the bank at least 300mm. Within 10 days of construction, a grass cover, or some other form of stabilisation should be established to prevent the erosion of the bank and drain.

Depending on the volume of water carried by the diversion bank a level spreader (or sill) or rock-lined spillway (see Section 5.3.2.4) may be constructed at the bank discharge point to reduce the risk of erosion at this point.

The location of diversion banks on the quarry site are presented on **Figures 2a** and **2b** and are denoted by the prefix "DB". The specific design features of the diversion banks of the quarry site are presented in **Table 5.1**.

These structures will be inspected fortnightly, or following a significant rain event to ensure that they are capable of carrying the surface water flow of the catchment at non-erosive velocities or concentrations. In the event that significant erosion is observed, the diversion bank will be upgraded to cater for high flows (see Section 5.3.4.2).

Table 5.1
Diversion Bank Specifications

Diversion Bank ID	Catchment Area (ha)	Channel Bottom Width (m)	Channel Grade (%)	Bank Height (m)	Sill Width (m)
DB1	0.23	3	1	0.7	4
DB2	1.12	3	1	0.7	4
DB3	0.79	3	1	0.7	4
DB4	0.26	3	1	0.7	4
DB5	0.75	3	1	0.7	4
DB6	1.25	3	1	0.7	4
DB7	1.32	3	1	0.7	4
DB8	0.90	3	1	0.7	4
* This is the maximum catchment area for the structure although it is noted this will vary dependant on the progress of mine and site development.					
Source: GSS Environmental (see Appendix 1)					

Appendix 1 presents the standard drawing and construction notes for a low flow diversion bank, as recommended by Landcom (2004).

5.3.3.3 Level Spreaders and Rock-lined Spillways

A level spreader, also known as a sill, is a shallow channel excavated at the outlet of a diversion bank or catchment banks/channels. A rock-lined spillway, as the name suggests, is a low gradient, rock-lined area at the discharge point of a bank, channel or water storage structure.

Appendix 1 presents the standard drawing and construction notes for a level spreader, as recommended by Landcom (2004).

In general, a level spreader (denoted by the prefix LS on **Figures 2a** and **2b**) will be constructed at the discharge point of a clean water diversion bank and a rock-lined spillway (denoted by the prefix RS on **Figures 2a** and **2b**) at the overflow point of sediment retention or water storage structures. *Procedure No. 4* provides the generalised design and construction details for these structures, the locations of which are presented in **Figures 2a** and **2b**.

These structures will be inspected at the same time as the diversion banks for signs of erosion and sedimentation. As noted in Section 5.3.3.2, any identified maintenance work is to be completed within 7 days of the inspection.

5.3.3.4 Culverts

Culverts are structures designed to carry water from one side of a constructed obstruction to the other. These structures may be open drains or pipe structures with pipe culverts generally constructed in preference to open drainage structure when the flow-through of water may adversely impact on operations. At the Austen Quarry 0.3m diameter (approximately) pipe culverts have been constructed to carry water beneath the Site Access Road at points C1 to C5, and a 3m pipe culvert installed as part of the replacement Yorkeys Creek Crossing.

The dimensions of these culverts were originally determined by DLWC (1995). Each culvert has been constructed with inlet and outlet protection in the form of rock lining with competent rock >80mm.

Inspections are to occur at least fortnightly with maintenance work completed within 7 days of the inspection.

5.3.3.5 Spoon Drains

Spoon drains are open drains constructed with a parabolic or trapezoidal channel and used to divert water flows from road side drainage to vegetated or otherwise erosion protected areas. The primary function of the spoon drain is to reduce the concentration and velocity of water flows within the road side drainage and therefore minimise the potential for erosion and transport of sediment to discharge points. Given that sections of the Site Access Road have been constructed at a relatively steep gradient, most notably within the 500m of the Yorkeys Creek Crossing, six spoon drains have been constructed along this section, namely SpD1 to SpD6 (see **Figures 2a** and **2b**).

Each spoon drain will be inspected at least fortnightly with particular emphasis on the condition of land immediately down-slope of the discharge point. Any maintenance work will be completed within 7 days of the initial inspection and commented on in the subsequent inspection sheet.

5.3.3.6 Water Storage Dams

Water Storage Dams (SDs) are water storage structures that hold clean water diverted around the areas of disturbed ground.

Soil type is crucial in determining the size and type of storage structure required. As noted in Section 3.2, the silt/clay content of the soils of the quarry site is low resulting in a low to moderate dispersibility and dispersion potential. The proportion of <0.02mm sediment of the quarry site soil is anticipated to be <15%, however, in order to provide for higher silt and clay content soils, Type F Soils (>33% silt and clay content (Landcom, 2004)) are assumed.

An inspection of the six SDs indicates that SD3, SD4, SD6 and SD7 are effectively modified agricultural dams. These have, however, operated effectively in storing water pumped from the extraction area and as such it is considered unnecessary to undertake any modification works to meet the design criteria of Landcom (2004). SD1 and SD2 appear to have been constructed generally in accordance with the criteria for a wet earth basin for Type F soils although the compaction of materials cannot be determined. As the water level with SD1 rises it will overflow through a pipe where it may either be transferred to SD7 or discharged to the Coxs River.

Figure 2a identifies the six SDs on the quarry site, and **Table 5.2** presents the dimensions of each storage dam identified on **Figure 2a** and **Figure 2b**.

Table 5.2
Storage Dam Specifications

Storage Dam ID	Effective Catchment Area (ha)*	Storage Capacity (ML)
SD1	17.2	1.75
SD2	2.9	1.75
SD3	25.1	4.5
SD4		6.0
SD6	56.0	4.6
SD7		9.5
* Effective catchment area refers to the total catchment of water reporting to this structure and may include water pumped from other catchments.		

Procedure No. 4 provides the generalised design and construction details for a storage dam for Type F soils and **Appendix 1** presents the standard drawing and construction notes for these, as recommended by Landcom (2004).

SD4 and SD7 will be maintained as the primary storage structures for dirty and clean water respectively. The remaining four structures will be operated to capture runoff following rain but will be regularly emptied (through the transfer of water to either SD4 or SD7) such that storage capacity is maximised and able to manage runoff during and following a 20 day 95th percentile rain event. The maintenance of storage capacity for such an event is discussed in greater detail in Section 5.4.6, however, in summary, as storage capacity of all water storages combined reduces to below that required to manage a 20 day 95th percentile rain event, actions will be initiated to undertake a controlled discharge of water to the Coxs River.

A weekly inspection of all water storages on the quarry site will be undertaken where the following information is recorded.

- General condition.
- Water colour, eg. highly turbid, brown, clear etc.
- Evidence of overflow / erosion.
- Approximate retained capacity.

5.3.4 Dirty Water Capture and Settlement

5.3.4.1 Introduction

Diverting water away from disturbed land on the quarry site will not always be possible. However, by ensuring surface water which falls or flows over these areas is captured and diverted to structures designed to allow for the sediment of this water, the potential for downstream pollution of clean waters and/or lands will be minimised. The following sub-sections describe the design, location and construction of these structures aimed at diverting, capturing and settling dirty water on the quarry site.

5.3.4.2 Catch Bank (High Flow)

These structures are constructed channels and banks designed to carry concentrated water flows from the slopes of disturbed ground which will have an elevated run-off coefficient (≥0.5), overflow from sediment retention structures such as sediment basins or where the upslope length is greater than 80m. The gradient of the catchment bank should be ≤3%, the height of the bank at least 500mm and the depth of the channel at least 150mm. Each high flow catch bank constructed at the Austen Quarry requires the construction of a level spreader (see Section 5.3.3.4) at the discharge point to effectively manage erosion and sedimentation.

The location of catch banks at the Austen Quarry are presented on **Figures 2a** and **2b** and denoted by the prefix CB. **Table 5.3** presents the design details for each of these including length, channel width, depth and sill length

Table 5.3
Catch Bank Specifications

Catch Bank ID	Bank Length (m)	Channel Bottom Width (m)	Channel Grade (%)	Bank Height (m)
CB1	228	3	1	0.7
CB2	59	3	1	0.7
CB3	94	3	1	0.7
CB4	148	3	1	0.7
CB5	230	3	1	0.7
CB6	128	3	1	0.7
CB7	70	3	1	0.7
CB8	90	3	1	0.7
	Waterway Width (m)		**Bank Height (m)**	
WW1	2		0.5	
WW2	2		0.5	
Source: GSS Environmental (see Appendix 1)				

Within 10 days of construction, a grass cover, or some other form of stabilisation should be established to prevent the erosion of the bank and channel. The generalised design and construction of catch banks is provided by *Procedure No. 4*. **Appendix 1** presents the standard drawing and construction notes for a high flow catch bank, as recommended by Landcom (2004).

In addition to the catch banks, two waterways (prefix WW) will be constructed within sub-catchments M2 and D1/D2. These structures, which are essentially rock-lined channels, are designed to direct higher velocity surface water flows to a water storage or sediment retention structure. **Table 5.3** provides the design specifications for the two waterways, WW1 which directs water discharged from CB1 – CB4 to SD2, and WW2 which directs water discharged from the Quarry Access Road to SeD1/SeD2.

These structures will be inspected fortnightly, or following a significant rain event to ensure that they are capable of carrying the surface water flow of the catchment at non-erosive velocities or concentrations. Any maintenance work required will be undertaken within 7 days of the inspection.

5.3.4.3 Sediment Dams and Basins

A sediment dam or basin is located on a drainage line downstream of disturbed areas and is designed to intercept sediment laden runoff and retain the sediment. Sediment basins are generally smaller structures of <20m^3, designed to temporarily hold surface water runoff from smaller catchments. Sediment dams are larger structures designed to hold runoff from extended areas such as the quarry site processing area.

Sediment Dams

The sediment dams and the majority of the sediment basins of the quarry site are permanent structures.

Table 5.4 presents the specifications for each sediment dam identified on **Figure 2a**.

Table 5.4
Sediment Dam Specifications

Storage Dam ID	Effective Catchment Area (ha)*	Storage Capacity (ML)
SeD1	9.0	9.6
SeD2	3.4	
SeD3	3.1	>1.0

* Effective catchment area refers to the total catchment of water reporting to this structure and may include water pumped from other catchments.

The Sediment Dams will be regularly emptied (through the transfer of water to SD4) such that capacity is maintained within each to manage runoff from a 20 day 95th percentile rain event. The maintenance of storage capacity for such an event is discussed in greater detail in Section 5.4.6. In the event that the storage capacity of all dirty water storages combined is below that required to manage a 20 day 95th percentile rain event, actions will be initiated to treat the water such that a controlled discharge of water to the Coxs River may be undertaken (see Section 5.3.6).

Sediment Basins

Currently there are 12 sediment basins at the Austen Quarry, however, this is likely to change over the life of the quarry based on the location and extent of future disturbance. Any additional sediment basins will be constructed to the general design presented in *Procedure No. 4* (see also **Appendix 1**)

A weekly inspection of all sediment dams and basins on the quarry site will be undertaken where the following information is recorded.

- General condition.
- Evidence of overflow and condition of downstream catchment.
- Water colour, eg. highly turbid, brown, clear etc.
- Evidence of eroding surfaces.
- Evidence of sediment discharge.
- Approximate retained capacity.

5.3.4.4 Drop-Down Batter Drains

Drop-down batter drains ("drop-downs") are open drains constructed of erosion resistant material and used to convey runoff down slopes without causing erosion. Drop-downs are used on slopes where vegetation, biodegradable matting or other stabilising techniques has not established or been installed or would not effectively carry the runoff without causing erosion.

Drop-downs need to be large enough to carry runoff without washing out and therefore need to consider volume of water, gradient and length of slope. To prevent failure, the soil around the inlet may be compacted or stabilised using sandbags or similar materials. Geotextile under the entire structure may help to prevent failure of the structure. Energy dissipaters, ie. larger rocks may be required at the outlet to reduce the flow velocity.

At the Austen Quarry drop-downs are constructed of competent rock of >80mm in diameter and are located at two location along the Site Access Road (RD1 and RD2 – see **Figure 2b**).

Each drop-down will be inspected at least fortnightly with particular attention paid to the condition of the slope either side of the drain and land at the ultimate discharge point. Any maintenance work will be completed within 7 days of the initial inspection and commented on in the subsequent inspection sheet.

5.3.5 Additional Sediment Protection

5.3.5.1 Introduction

To ensure that water discharged from the quarry site, either as a natural discharge from undisturbed, partially disturbed or rehabilitating surfaces or controlled discharge from structures such as sediment basins, drop-downs and spoon drains, meets the TSS water quality objective of 30mg/L, additional sediment protection structures will be maintained at the Austen Quarry.

Additional protection will also be placed within catchment channels (such as the road side drainage of the Site Access Road) to reduce the velocity of flows and therefore reduce the potential for erosion within the channel and at the discharge point.

5.3.5.2 Sediment Fencing

A sediment fence (also known as a silt fence) is a temporary barrier of geotextile filter fabric, usually supported by steel wire and steel posts. A proprietary item known as Propex® Silt Stop Sediment Fence is used on the quarry site.

Sediment fences filter runoff flowing from the site, trapping the sediment and allowing filtered water to pass through.

Sediment fences have the following design limits:

- The area draining to the fence is 0.6 ha or less.
- The maximum slope gradient behind the fence is 2:1.
- The maximum slope length behind the fence is 60m.

Procedure No. 4 presents the general design features and construction notes to be adhered to when installing the sediment fencing (see also **Appendix 1**). It is noted that sediment fencing represents a secondary control in conjunction with other controls such as a sediment basin, rock lined spillway or vegetation and in no instance is it relied upon as the primary control.

Figures 2a and **2b** present the current locations of sediment fencing at the Austen Quarry although it is noted that these locations will vary over the life of the quarry.

Generally, these structures will be installed prior to disturbance within a catchment, however, they may also be installed in response to elevated sediment discharge levels observed on the quarry site.

5.3.5.3 Straw Bale Filters and Check Dams

A temporary barrier of straw bales laid end to end across the direction of flow, usually at the outlet of a drain or across a swale, diversion channel or waterway, provides for a similar level of protection as sediment fencing. That is, the straw bale filters are used to intercept and filter run off before it enters a channel and/or to direct water in low flow situations.

Check dams are primarily used to reduce the velocity of flow in channels and thus reduce erosion of the channel bed. These may be constructed of straw bale or gravel/aggregate material with the entrapment of sediment a secondary function of these structures as they are effective in catching course sediment only.

Procedure No. 4 presents the design features and construction notes for the installation of straw bale protection and check dams (see also **Appendix 1**).

5.3.5.4 Maintenance

More than any other structure, the additional sediment controls must be regularly inspected and maintained as these structures represent the final control point for water discharged from the quarry site. Each structure will be inspected weekly, or following significant rainfall and the general condition recorded, including:

- whether the structure(s) has been damaged or not;
- amount of sediment present upstream and downstream;
- breaches of the structure(s);
- presence of eroding surfaces; and
- requirement for maintenance.

In the event maintenance is required, this will be completed within 7 days of the inspection and status recorded on the following inspection sheet.

5.3.6 Water Discharge and Additional Water Treatment

There are two types of discharges from the quarry site.

Natural Discharge

As illustrated on **Figure 2a** and **2b**, a number of ephemeral drainage lines traverse the quarry site and Site Access Road. Within areas of the quarry site where there is none or minimal disturbance within the catchments of these drainage lines, water is allowed to discharge naturally following rainfall. At some points, notably along the Site Access Road, sediment fencing is installed given the rehabilitating surfaces within these catchments may not be completely stable.

Controlled Discharge

Water within the catchments identified on **Figure 2a** and **2b** is captured within clean water storages or sediment dams. These have been constructed to retain water from all but extreme rainfall events and to aide in the retention of water are linked together by an internal pumping system. As noted in Sections 5.3.3.6 and 5.3.4.3, these structures will be regularly inspected and the water contained within each pumped between them to ensure sufficient capacity is retained within each to hold water runoff following a 20 day 95th percentile rainfall event. In the event the retained storage capacity of all water storages combined is insufficient to capture runoff from the 20 day 95th percentile rainfall event, water will be discharged to the Coxs River via a DEC licensed discharge point (EP Licence 12323). This discharge point is currently adjacent to SeD2 on the processing area and will discharge water pumped from the clean water storage SD4. As a matter of urgency, EP Licence 12323 should be varied to include an additional discharge point direct from SD4. Water within SD4 is regularly treated with a flocculating agent (Ultiron 8187, manufactured by Nalco, active agent alum) to reduce the sediment loading of the water in preparedness for the immediate discharge of water.

Prior to discharge, a sample of the water will be taken and analysed by a NATA accredited laboratory against DEC criteria of pH, TS, EC and oil and grease. If the sample is within the criteria limits, up to 7ML of water will be discharged to the Coxs River. The results of the lab analysis will be forwarded to the DEC to confirm a compliant release of water. In the unlikely circumstance that water non-compliant with the DEC nominated criteria is discharged, the DEC will be immediately notified of the non-compliant discharge. Greater detail on monitoring associated with the controlled discharge is provided in *Procedure E1 – Surface Water Monitoring*.

5.4 Site Water Balance

5.4.1 Introduction

Water for operational use, ie. sprays on the crushing and screening plant and other dust suppression, will be preferentially sourced from the capture of dirty water, however, supplementary water supplies will be sourced from clean water storages. This section reviews site water requirements and available water storage against water availability in order to present a water balance for the quarry site. This water balance is provided for dry, average and wet years (10th, 50th and 90th percentile rainfall years respectively) and to account for major rainfall events (20 day 95th percentile rain event). Previous assessments of the Austen Quarry used the

1 in 100, 72 hour ARI rain event as a guide to designing water storages to retain water from major rainfall events. Best practice water management has since moved away from using this type of event to design water management structures and as such, the conservative 20 day 95th percentile rainfall event, recommended in Landcom (2004), has been referenced in determining the critical capacities required within the quarry water storages.

5.4.2 Site Water Requirements

Dust suppression is the major on-site water use and annual usage is approximately 25.0ML and includes:

- Dust suppression on the quarry floor, haul roads and hardstand area;
- Dust control during truck unloading and crushing operations; and,
- Dust suppression at all conveyor discharge and transfer points.

Smaller quantities of water will be required over the life of the Austen Quarry for activities such as truck washing, housekeeping, routine maintenance, and irrigation of rehabilitated areas. These volumes are not captured for water balance purposes as they will vary from year to year, however, by assuming a maximum dust suppression rate of 25.0ML/year, which accounts for dust suppression activities 10 hours per day, 200 days per annum, these other relatively minor water usages will be accounted for.

Table 5.5 provides a detailed breakdown of water usage for dust suppression at the Austen Quarry.

Table 5.5
Site Water Usage

Location		Water Usage (L)		
	No. of Sprays	Per hour*	Per day**	Per year***
Extraction Area				
Crusher Bin	8	160	800	160 000
Primary crusher	4	80	400	80 000
Transfer 1	6	120	600	120 000
Scalps plant	12	240	1 200	240 000
Transfer 2	6	120	600	120 000
Processing Area				
Conveyor discharge	4	80	400	80 000
Secondary Bin	8	160	800	160 000
Transfer 3	6	120	600	120 000
Secondary crusher 1	6	120	600	120 000
Screens	24	480	2 400	480 000
Secondary crusher 2	6	120	600	120 000
Screens	24	480	2 400	480 000
Discharge to stockpile	12	240	1 200	240 000
Quarry Site				
Roads		10 000	100 000	20 000 000
Total				**25 040 000**

*Note: Micro Dust sprays use 10 L/Hr **Operating 10 hours per day ***200 days per year
Source: ABL

An estimated 9.6ML/year will be lost as a result of evaporation, based on annual average evaporation rates. Therefore, total water requirement for the Austen Quarry is approximately 34.6ML/year.

5.4.3 Water Sources, Availability and Storage

Surface Water Runoff

Water for operational purposes (including dust suppression) will be predominantly sourced from surface water flows captured within six Storage Dams (SD1 – SD4 & SD6 – SD7). In addition, three sediment dams (SeD1 – SeD3) have been designed and constructed on the quarry site with a primary function being to allow for the settlement of suspended sediment. Noting the internal pumping system of the Austen Quarry, water stored within these Sediment Dams is also available for operational use or transfer to one of the Storage Dams[2].

Table 5.6 notes the storage capacity of the storage and settlement structures dams. These have been categorised as predominantly clean or dirty water structures.

Table 5.6
Quarry Site Water Storage and Settlement Structures

Storage or Settlement Structure	Catchment	Capacity (ML)	
		Dirty Water	Clean Water
SeD1/SeD2	D1/D2	9.6*	
SeD3	D4	1.0*	
SD2	M2	1.75#	
SD3	D3/M5	4.5*	
SD4		6.1	
SD1	C2		1.75#
SD6	M6		4.9*
SD7			9.5
Total Available Storage*		**7.85**	**11.25**

*Note: Given there function as water settlement structures, SD3, SD6 SeD1, SeD2 and SeD3 are to be kept empty to provide a buffer for storage following a large rainfall event.
#Note: Estimated size based on dam design of EIS (SKM, 1994).

Water will be preferentially sourced from dirty water storage (7.85ML capacity) with the clean water storage providing back-up supply during extended periods of limited precipitation. The available storage of the Austen Quarry (as calculated in **Table 5.6**) does not include the storage capacity of the water settlement structures (SD3, SD6, SeD1, SeD2 and SeD3) as water retained within these will be preferentially transferred to one or more of the Storage Dams[1].

Two water storage tanks will also be used to store water on the quarry site (see **Figure 2a**). The capacity of these storage tanks will be relatively minor and sufficient only to provide a surge head to initiate the pumping of water to either the extraction area or processing area. The storage tank located above the extraction area has a capacity of 15kL (0.015ML) and the storage tank located above the processing area a capacity of only 4kL (0.004ML).

Coxs River Water

[2] SD3/SD4 have been identified as the preferential storages of dirty water

ABL has obtained from the land owner (HPC) a licence to extract up to 20ML/year from the Coxs River. This licence allocation will only be taken up in the event that insufficient water is available on the quarry site for ongoing operational and dust suppression purposes.

Groundwater

ABL does not hold a groundwater pumping licence to obtain water. Following significant rainfall, infiltrating water seeps into the quarry pit through fractures in the rock for up to several days, ultimately reporting to the Quarry Sump. As a consequence, small quantities of groundwater will be used. The water balance does not account for this minor groundwater contribution, as given the water is effectively infiltrating surface water, it is already included through calculations to determine surface water runoff (see **Table 5.6**).

5.4.4 Surface Water Rainfall and Runoff

The water balance considers rainfall and runoff generated by low (annual 10th percentile), average (annual 50th percentile) and high (annual 90th percentile) rainfall years for the City of Lithgow (provided by the Bureau of Meteorology).

- Annual 10th percentile (dry year) = 612.7mm.
- Annual 50th percentile (average year) = 858.6mm.
- Annual 90th percentile (wet year) = 1117.7mm.

Rainfall is reasonably well distributed throughout the year, although there is a peak in summer and early autumn, with the lowest rainfall months being in winter and spring.

The average annual runoff likely to report to each storage or settlement structure for average, wet and dry years has been calculated by GSS Environmental. As detailed records of water accumulation in quarry site water storages have not been maintained, a number of assumptions were used in the calculation of annual runoff.

1. Only catchments D1, D2, D3, D4, M2, M5, M6 and C2 have been considered as these are the only catchments from which surface water is actively captured for potential operational use. The remaining catchments identified on **Figures 2a** and **2b** either divert clean water, or only temporarily hold dirty water within smaller sediment basins prior to discharge, and therefore do not contribute to the water balance of the Austen Quarry (at this time).
2. With the exception of sub-catchment C2, the clean and relatively undisturbed catchments have been assumed to have a runoff coefficient of 0.2. Anecdotal evidence provided by Austen Quarry personnel has indicated that the estimated volume of water available for capture in sub-catchment C2, assuming the co-efficient of 0.2, is still too high. As a result a co-efficient of 0.1 has been assumed for sub-catchment C2.
3. A runoff coefficient of 0.4 has been assumed for highly disturbed catchments with little to no vegetation.
4. Within those sections of sub-catchments defined as dirty, but where a significant cover of vegetation remains or has been established, a runoff coefficient of 0.2 has