ANNUAL

ENVIRONMENTAL MANAGEMENT

REPORT

DURALIE COAL MINE

TEXT VOLUME

DURALIE COAL PTY LTD

4 SEPTEMBER 2009

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ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

INTRODUCTION

This Annual Environmental Management Report (AEMR) covers the environmental protection, pollution control and rehabilitation activities at the Duralie Coal Mine up until 4 September 2009. Where applicable, comparisons of performance against the plans outlined in the Environmental Impact Statement, Statement of Environmental Effects and regulatory requirements are made. Environmental activities planned for the next 12 months are also discussed.

SCOPE

This section outlines information in relation to the development, management and operation of the Duralie Coal Project by Duralie Coal Pty Ltd (DCPL) and Leighton Mining (LM). DCPL is the mine owner and LM is the contract miner.

Background to Development

The Duralie Coal Mine is located approximately 80km north of Newcastle in New South Wales. It lies between the villages of Stroud Road and Wards River. Refer Figures 1 and 2 (Plans & Appendix (P&A) Volume).

Coal was first discovered in the Gloucester Basin in 1855 and some limited, small scale mining by hand followed.

In 1970-71 an extensive drilling programme identified coal in the Duralie area. Extensive development planning and environmental investigations took place between 1981 and 1984. Additional exploration and feasibility studies were carried out in 1993.

Development Consent for the mine was granted by the NSW Minister for Urban Affairs and Planning on 21 August 1997 and Mining Lease Number 1427 was issued by the NSW Minister for Mineral Resources on 6 April 1998.

In October 1998 a Statement of Environmental Effects (SEE) was produced to consider proposed alterations to the Duralie Mine. These proposed alterations were approved by the NSW Minister for Urban Affairs and Planning on 5 February 1999.

Construction commenced in June 2002 with mining production commencing in March 2003 and the first coal railed to the Stratford Mine for processing in the same month.

Duralie Mine consists of an open-cut, truck and excavator mine producing run of mine (ROM) coal which is processed at the Stratford Coal Mine Coal Handling and Processing Plant (CHPP).

Coal Products and Markets

The Duralie mine produces two ROM products which are processed and blended with other ROM coals at the Stratford CHPP. From the blending of ROM coals a 10.5% ash "Gloucester Coking Coal" is produced. Approximately 85% coal of the "Gloucester Coking Coal" product is sourced from the Weismantel seam mined at Duralie. The remainder of the product coal generated from Duralie Mine is sold as thermal coal.

Gloucester coking coal is predominantly sold to the Japanese market with some domestic sales, whilst thermal coal is currently supplied to export energy coal markets.

Typical coal product qualities are shown in Table 1 below.

Table 1 - Typical Coal Qualities of Stratford Coal Products

Parameter	Gloucester Coking Coal	Mid Ash High Sulphur Thermal Coal	High Ash Thermal Coal
Total Moisture	8.0%	6.0%	6.0%
Inherent Moisture (ad)	1.3%	1.2%	1.2%
Ash (ar)	10.5%	20%	24%
Volatile Matter	32.2%	29.0%	23.0%
Total Sulphur	1.3%	2.5%	1.0%
Fixed Carbon (ar)	48.3%	45%	47%
CSN	8	Not applicable	Not applicable
Fluidity	>10,00ddpm	Not applicable	Not applicable
Gross Calorific Value	Not applicable	>6,200kcals/kg	>6,200kcals/kg
HGI	Not applicable	52	62
Size	0 to 50mm	0 to 50mm	0 to 50mm

Site Personnel Responsible for Mining, Rehabilitation and Environment

Site personnel responsible for mining, rehabilitation and environmental issues at the end of the reporting period were:

Gloucester Coal Manager Mining: Mr Todd Hutchings

Mine Manager: Mr Jon Meldon

Mining Superintendent: Mr Barry Short

Environmental Manager: Mr John Trotter

Corporate Environmental Policy

DCPL's Environmental Policy states that:

"Duralie Coal Pty Ltd aims to maximise the recovery of economic coal reserves to supply domestic and export markets with coking and energy coals while protecting the environment for future generations.

We will maintain high standards of environmental management throughout our mining and processing operations in order to meet statutory obligations and community expectations.

Our guiding principles are:

- Environmental management is the responsibility of everyone on site.
- We encourage open communications.
- We will actively minimise disturbance and impact on the surrounding environment caused by our operations.
- We will meet current and anticipated environmental standards by utilising the best practical technologies for water quality protection and waste management.
- We will implement appropriate standards of rehabilitation to ensure minimal visual impact and the achievement of a stable final landform, along with the preservation of fauna, flora and downstream water quality.
- We will monitor and regularly assess our environmental performance and keep the local community informed through a consultative committee".

APPROVAL STATUS

Status of Leases, Licences, Permits and Approvals

The Duralie Mine has the following approvals:

- Mining Lease No. 1427 dated 6 April 1998 issued by the Minister for Minerals Resources. The lease was issued for a period of 21 years.
- Development Consent issued by the Minister for Urban Affairs and Planning dated 5 February 1999. The consent is limited to a period of 21 years from the date of a grant of a Mining Lease in respect of the Development.
- Department of Land & Water Conservation (DLWC) permit issued under the Rivers and Foreshores Improvement Act 1948 dated 4 June 2002 for the construction of a culvert crossing from protected land in or near the protected water known as: tributary of Karuah River (Permit Number 701).
- Department of Land & Water Conservation (DLWC) permit issued under the Rivers and

Foreshores Improvement Act 1948 dated 4 June 2002 for the construction of the rail siding and culvert crossing across Coal Shaft Creek (Permit Number 704).

- Environment Protection Licence (EPL) No. 11701 issued by the Environment Protection Authority on 4 September 2002.
- Interim Mining Operations Plan (IMOP) (for period up until 31 December 2002 - Construction) approved by the Department of Mineral Resources (DMR) on 13 September 2002.
- DLWC Bore Licence for the Duralie Open Cut (20BL168404) dated 23 September 2002.
- DLWC Bore Licence for monitoring bores (20BL168539) dated 31 October 2002.
- DIPNR licence - 20SL060324 – relating to diversion of Coal Shaft Creek. This licence was replaced by Approval Number 20WA202053 under the Karuah River Water Sharing Plan.
- Mining Operations Plan (MOP) approved by the DMR on 28 February 2003.
- Modification to Development Consent 24 September 2003 (relating to Coal Shaft Creek).
- Site Water Management Plan approved by the DIPNR on 25 September 2003.
- Modification to existing DIPNR licence 20SL060324, dated 2 October 2003.
- Irrigation Management Plan approved by the DIPNR on 22 December 2003.
- DIPRN Bore Licence 20BL168539 had three bores added on 2 February 2004.
- Variation to Environment Protection Licence 11701 effective 9 February 2004.
- MOP Amendment approved by the DMR on 18 October 2004 (relating to an irrigation area access road).
- An attachment to the MOP by way of DCPL correspondence to the Department of Primary Industries – Mineral Resources (DPI-Minerals) dated 29 April 2005 (relating to exploration drilling within the mining lease) – approval given via email received 2 May 2005.
- Modified Irrigation Management Plan approved by the DIPNR on 23 August 2005.
- Variation to Environment Protection Licence 11701 effective 13 December 2005.
- Variation to Environment Protection Licence 11701 effective 3 March 2006.
- Approval by DPI – Minerals on 19 July 2006 for exploration drilling within an area described with the "Twin Houses Review of Environmental Factors - May 2006".
- Development Consent issued by the Minister for Planning dated 30 July 2006. This consent modifies the Development Consent granted by the Minister for Urban Affairs and

Planning on 5 February 1999. The new Consent permitted the mining of the "Duralie Extended" area.

- Altered MOP plans following the approval of the "Duralie Extended" area were submitted to DPI – Minerals (refer Plans and Appendix (P&A) volume).

- Environmental Management Strategy and Blast Monitoring Program approved by the Department of Planning (DoP) on 4 April 2007.

- Air Quality and Noise Monitoring Programs approved by DoP on 24 May 2007.

- Approval by Great Lakes Council dated 24 May 2007 to erect a telecommunications tower on the Duralie Coal Mine site.

- Alterations to the MOP (eastern highwall realignment, drainage realignment) were submitted to DPI-Minerals in correspondence dated 21 June 2007 and approved via correspondence dated 30 July 2007.

- Rehabilitation Management Plan approved by DoP on 31 October 2007

- Revised Noise Monitoring Program approved by DoP on 27 November 2007.

- Revised Environmental Monitoring Program and Site Water Management Plan approved by DoP on 2 June 2008.

- Alterations to the MOP (additional eastern highwall realignment, north eastern diversion channel) were submitted to the DPI-Minerals in correspondence dated 27 May 2008 and approved via correspondence dated 18 August 2008.

- Alterations to the MOP (proposed diversion drain for proposed Auxiliary Dam No. 1) were submitted to the DPI-Minerals in correspondence dated 31 July 2008 and approved via correspondence dated 18 August 2008.

- Modification to Development Consent to allow construction of three auxiliary water storage dams by DoP on 3 December 2008.

- Revised Erosion and Sediment Control Plan (Auxiliary Dams Addendum); revised Site Water Balance; revised Surface Water Management and Monitoring Program; revised Aboriginal Cultural Heritage Management Plan; and revised Irrigation Management Plan by DoP on 15 December 2008.

Review of Performance

A brief review of environmental performance in relation to the Department of Environment, Climate Change and Water – Environment Protection Authority (DECCW-EPA) issued Environment Protection Licence (EPL) and Development Consent Conditions is summarised below. This performance is further discussed in the sections on environmental management activities and environmental monitoring.

DECCW-EPA Environment Protection Licence

- Records of environmental monitoring activities have been kept.

- A record of pollution complaints has been maintained including the date and time of the complaint, method of complaint lodgement, personal details of the complainant (name and telephone number), the nature of the complaint, action taken and any follow-up contact with the complainant.

- A copy of this AEMR has been forwarded to DECCW-EPA as well as other agencies as listed in the Development Consent. These agencies are Department of Primary Industry – Minerals (DPI-Minerals), Great Lakes Council (GLC), community representatives on the Community Consultative Committee (CCC), Department of Planning (DoP), Department of Water and Energy (DWE), Department of Environment, Climate Change and Water - National Parks and Wildlife Service (DECCW-NPWS), Department of Primary Industries - Agriculture (DPI-Ag) and the Department of Health (DoH). In addition copies of the report have been made available to Stroud and Forster Libraries and the document has been placed on the Gloucester Coal website (www.gloucestercoal.com.au).

- Two reportable incidents involving blasting occurred during the reporting period (a blast over pressure above 120 dB(L) and/or ground vibration over 10mm/s) – refer Section "Vibration and Airblast". .

- Dust suppression measures are in place. Dust monitoring to date (dust deposition gauges and high volume (PM_{10}) air samplers) shows that current dust suppression systems have been effective and dust levels were below EPA limits.

- Quarterly noise compliance monitoring was undertaken in October 2008, January 2009, April 2009 and July 2009. The surveys determined that monitored mine operational noise at the time of the surveys complied with EPL noise level criteria at all monitored locations.

- On four occasions during the reporting period sediment dams spilled. Spilling dams had an average suspended solids concentration of 90 mg/l.

Development Consent Conditions

Development Consent conditions which were met during this reporting period include those related to operation of a meteorological station, operation of dust deposition gauges and high volume (PM10) air samplers, six monthly reporting of environmental monitoring, operation of a telephone complaints line, operation of a consultative committee, biological monitoring, blast monitoring, protection of an Aboriginal site ("Honey Tree"), monitoring of topsoil for Aboriginal artefacts, operation of a "blasting hotline" and employment of an environmental officer.

Amendments to Approvals/Licences over the Reporting Period

Refer *Status of Leases, Licences, Permits and Approvals*.

Dams Safety Committee

The Main Water Dam is prescribed under the Dams Safety Act 1978.

Between August 2004 and June 2008 the Dams Safety Committee (DSC) was provided with a monthly figure showing pit workings in relation to the dam. In addition, other information requested by the DSC, in the form of a monthly report, was supplied to the Committee between September 2007 and June 2008. The Committee no longer requires a monthly report and currently receives a quarterly pit layout figure.

A Dam Safety Emergency Plan (DSEP) for the Mine Water Dam was prepared and a copy supplied to the DSC in May 2006. This document was updated in January 2009.

Routine visual inspections of the Main Water Dam are undertaken three (3) times per week. Monthly monitoring of piezometers terminating beneath the dam's clay core and within the clay core is also undertaken and water levels interpreted. Monuments located along the dam's crest were surveyed for any indication of movement during the reporting period.

A Mine Water Dam Operations and Maintenance Manual was prepared for, and approved by, the DSC during the reporting period.

The proposed Auxiliary Dam 1 was prescribed by the DSC in October 2008. This dam was constructed during the reporting period and provides supplementary storage to the Main Water Dam.

A draft Dam Safety Emergency Plan (DSEP) for Auxiliary Dam 1 was prepared and provided to the DSC during the reporting period.

COMMUNITY LIAISON

Employment Status and Demography

As at 4 September 2009, the employment status at the mine site was as follows:

Duralie Coal Pty Ltd		7
Leightons Mining Pty Ltd	Staff	14
	Wages	63
	Casual	14
Interail Australia Pty Ltd		8
Trevor Harris Contracting Pty Ltd		2
Trellis Contracting Pty Ltd		1

TOTAL	**109**

In addition to direct permanent employment at the mine, on the basis of a conservative employment multiplier of one mine site job generating one job within the general community, up to 109 (full time equivalent) jobs are expected to have been provided in supporting services. On the basis of a review of employees' living location, 68% of mine employees resided within the greater local area (defined as being bounded by Stroud, Gloucester and Dungog).

Social/Economic Contributions and Achievements

Under the 30 July 2006 Development Consent Modification, Duralie Coal is required to pay Great Lakes Council (GLC) the following:

- A community infrastructure contribution of $78290.26 each year commencing on 30 April 2007 until the cessation of coal mining on the site. The contribution is to be indexed according to the CPI at the time of each payment.

- A contribution of $32620.94 each year for the maintenance of the Bucketts Way commencing on 30 April 2007 until the cessation of coal mining on site. The contribution is to be indexed according to the CPI at the time of each payment.

- A contribution of $10000 each year towards a structural inspection of road bridges located along the Bucketts Way (between its intersection with Clarence Town Road and the mine access road) commencing on 30 April 2007 until the cessation of coal mining on the site. The contribution is to be indexed according to the CPI at the time of each payment."

Under the 1998 Development Consent, Duralie Coal is required to pay $2,000 per annum to the Community Environmental Monitoring and Consultative Committee (CEMCC) for the duration of coal extraction. This contribution is indexed according to the Consumer Price Index (CPI) at the time of payment. The CEMCC elected to add the unspent portion of the annual committee payment to the annual community infrastructure contribution. During the reporting period the third allocation of Duralie Coal's community contributions was in the process of being allocated to deserving local projects.

Significant economic benefits have flowed or are flowing into the local region from expenditure incurred at the Duralie Mine, both during the construction and initial operation phases. Duralie expenditure also served to "soften" the impact of the wind down of coal production at the nearby Stratford Operation in terms of local and regional employment. Wherever possible and practical, DCPL prefers to utilise the services of local providers.

Liaison and Complaint Resolution

Liaison with the local community is channelled through the Community Environmental Monitoring and Consultative Committee (CEMCC) which was formed in accordance with Development Consent Condition 24 and whose title was altered to the Community

Consultative Committee (CCC) under the 2006 Development Consent Modification. The CCC met on four occasions during the reporting period – November 2008, February 2009, May 2009 and August 2009.

In accordance with Development Consent Condition 26, DCPL was required to establish and maintain a complaints handling and response procedure. Under the system, complaints received during normal office hours are directed to the environmental officer. Outside normal office hours the answering service advises a mine employee – with the environmental officer being called first - of the complaint by telephone.

A dedicated complaints telephone number is in place 24 hours per day. This number is 1300 788 131. The number is advertised within the Sensis *White Pages Directory*, a local telephone directory (*Pink Pages*) and in the local newspapers *(Gloucester Advocate and Dungog Chronicle)* on a six monthly basis.

Duralie staff, when notified of a complaint, determine an appropriate response on the basis of the nature of the complaint. This may involve a site visit/inspection, liaison with personnel on site by telephone or other appropriate action. All complaints are responded to within 24 hours of receipt.

All complaints received and responses taken in relation to each complaint are recorded in a Complaints Register. The Complaints Register is tabled at each Community Consultative Committee meeting for the period covered since the last Committee meeting. Twenty four (24) complaints were received by Duralie Coal during the reporting period.

Community Consultative Committee

The Community Consultative Committee (CCC) for the Duralie Coal Mine is comprised of:

- Four (4) local community representatives (NSW Farmers Association, Johnsons Creek Conservation Committee, Wards River Progress Association and a vineyard proprietor being represented);
- Two (2) local government representatives (Great Lakes Council); and
- Two (2) DCPL representatives.

The Mayor of Great Lakes Council is the CCC Chairperson and DCPL provide the CCC Secretary.

The CCC in accordance with Development Consent is charged with:

- Reviewing DCPL's performance with respect to environmental management and community relations;
- Undertaking regular inspections of mine operations;
- Reviewing community concerns or complaints about mine operations and DCPL's complaints handling procedures;
- Providing DCPL with advice on improved environmental management and community relations, including the provision of information to the community and the identification of community initiatives to which DCPL could contribute;
- Providing the Department of Planning with advice regarding the conditions of

Development Consent; and

- Providing advice to the general community on the performance of the Duralie Coal Mine with respect to environmental management and community relations.

The CCC meets quarterly. During the AEMR reporting period the CCC met on 6 November 2008, 5 February 2009, 7 May 2009 and 6 August 2009.

Issues discussed during the last four (4) CCC meetings included:

- Proposals to extend area approved for coal mining ("Part 3A" and "Section 75W" of NSW Environmental Planning & Assessment Act)
- Irrigation
- Community contributions
- Mine water storage
- Quiet haul trucks
- Complaints
- Auxiliary water storage dams
- Noise measurement
- Soil and water testing
- Trial discharge
- Purported Aboriginal men's and women's sites
- Exploration Licence for Glen Road area
- Train noise
- Committee member reappointment
- Site facilities upgrade

SUMMARY OF OPERATIONS

RESOURCE UTILISATION

Current Exploration

DCPL has conducted exploration activities within and immediately adjacent to Mining Lease 1427 which commenced in July 2008 after a period of activity in the Stratford area. This exploration has focused on delineating the Weismantel and Clareval seams in the North West Duralie area. A total of thirty four (34) drill holes consisting of slim core and non cored open holes with depths of 40 to 200m were drilled. Cored samples have been gathered for coal quality analysis, geotechnical analysis and geochemical assessment of overburden. Samples from open drill holes have been tested for indicative qualities prior to core drilling. Some limited costeaning (or trenching) for the coal outcrop has occurred.

In the period DCPL has continued exploration within ML1427 and in the adjacent Authorisation A315 in the area known as Duralie North West. All the activity has focused on intersecting the Clareval Seam at depth to determine potential limits of open cut mining. Core and non core samples have been recovered to assist investigations into coal quality, geotechnical and gas content. One to two drilling rigs have been in attendance in the period

Reserve/Resource Status

On the basis of the current mine plan, coal reserves for the Duralie Mine (2006 Modification) at the end of the reporting period have been estimated at 2.0 million tonnes.

Estimated Mine Life

Completion of mining at the Duralie Mine is estimated for end of 2010**.**

Recovery / Dilution

Mining losses and dilutions are expected to be minimal due to relatively simple geological structure, the thickness of the seam (10-12m normal thickness) and the bulk nature of the mining operation. The long term trend of coal losses of less than 2% and dilutions of less than 5% is expected to continue.

OPEN CUT MINING

Duralie is an open cut operation with a current operating stripping ratio (volume of overburden per tonne of coal) of 4:1. All mining operations are by truck and hydraulic excavator or shovel.

The Duralie Mine is located approximately 20km south of the Stratford Mine facilities. The workings extract coal from the Weismantel seam at the base of the Gloucester Coal Measures. The deposit forms a synclinal structure with the open cut area located at the southernmost crop line within the main axis of the Gloucester Basin. The open cut area forms a reversed "J" shape with mining commencing in the north east part of the pit progressing southward toward the "nose" of the axis then to the north west in a narrow trench. The operation now is now situated on the west limb of the syncline with seams dipping at about 50 degrees west.

Two types of waste have been identified within the deposit. They are categorised as potentially acid forming (PAF) or non-acid forming (NAF). Identification is undertaken by the site geologist. In the early stages of the mining operation PAF waste was placed within compacted clay cells within the out of pit waste dump. The purpose of the clay cells is to limit the potential for oxygen and water to reach the PAF material such that an acidic leachate is not produced (it should be noted that oxidation of pyrite to sulphate is required in order to produce acid). Once sufficient in pit void was available, PAF wastes were deposited below a reduced level (RL) of 40 metres. This level was deemed to be of a sufficient depth to ensure a recovering water table would submerge all the deposited PAF material and hence largely prevent oxygen reaching that material. Agricultural lime is spread across placed PAF materials to reduce the risk of acid formation prior to clay encapsulation or submersion.

The deposition of the Weismantel seam has been influenced by the proximity of marine environments resulting in a typically high sulphur content over the first half a metre of the

seam. Additionally, moderately high inherent sulphur exists throughout the remainder of the seam.

Mining commenced in March 2003 using one hydraulic excavator (and another on standby) with three Cat 789 rear dump trucks and ancillary gear. Dips within the deposit vary from a shallow 5 degrees to an almost vertical profile. Consequently, a method of horizontal 3m to 4m benches is used as the primary extraction method. An average of 5m of free dig material is generally experienced at Duralie after which all waste material generally requires blasting. The truck fleet currently comprises eight Cat 789 trucks.

ROM Production History and Forecast

Actual ROM production for the reporting period is listed in Table 2 below by month.

Table 2 - Monthly ROM Coal Production

MONTH	ROM PRODUCTION* (tonnes)
September 2008	115,760
October 2008	169,168
November 2008	134,785
December 2008	109,907
January 2009	87,727
February 2009	117,224
March 2009	168,837
April 2009	116,540
May 2009	159,534
June 2009	144,202
July 2009	113,622
August 2009	158,345

* train weight received at Stratford Mine site

Total ROM production (September 2008 - August 2009) was 1.60 million tonnes.

Total waste mined (September 2008 - August 2009) was 6.66 million bench cubic metres (bcm).

ROM production forecast for next reporting period is for similar volumes.

Mining Equipment and Method

The mining equipment currently in use at Duralie is listed in Table 3 provided on the following page.

Table 3 - Current Mining Equipment

Item	Description	Number
Hydraulic Excavator - Backhoe	250 tonne (Liebherr 9250)	1
Hydraulic Excavator - Backhoe	200 tonne (Liebherr 994)	1
Hydraulic Excavator - Backhoe	160 tonne (Komatsu PC 1600)	1
Rear Dump Truck	190 tonne (Cat 789)	7
Water truck	Komatsu 785	1
Track Dozer	D10	3
Grader	Cat 16H	1
Excavator	30 or 20 tonne	2
Front End Loader	Cat 980 (intermittent use)	1
Drill	Reedrill SK50,	1

The mining sequence is summarised below:

- Fauna/flora assessment (as required) is undertaken.
- A sedimentation control plan is prepared for the area to be disturbed (or an existing plan utilised).
- Sedimentation controls are implemented (as required).
- Tree clearing is limited to the minimum required for ongoing operations and undertaken ahead of the advancing face or dump. The distance is generally limited to 100m.
- Topsoil is removed in accordance with a topsoil stripping plan.
- Overburden removal is undertaken by a hydraulic excavator in backhoe configuration. Generally, the first one to five metres of clay overburden is ripped and/or free-dug. Deeper overburden requires blasting prior to excavation.
- Overburden waste material is deposited within/above a void section of the mining excavation.

Spontaneous Combustion Incidence

There were no incidents of spontaneous combustion during the reporting period.

COAL HANDLING AND BENEFICIATION

ROM Coal Processing On Site

ROM coal is processed through a rotary breaker to produce a coal fraction less than 140 mm.

The essential elements of the coal processing plant on site and their design capacities are as follows:

ROM conveyor handling rate	1400 tph
Train load out rate	2400 tph

Saleable Coal Production

Product coal utilising Duralie ROM coal is produced at the Stratford Mine site. Blending of Duralie ROM coal with other ROM coals and rewashed reject material occurred during processing to produce a saleable product coal. Saleable coal production for the period September 2008 to August 2009 was 1.71 million tonnes comprising 0.43 million tonnes of coking coal and 1.28 million tonnes of thermal coal.

Actual coal production to date by month is shown in Table 4 provided on the next page.

Table 4 - Product Coal Produced by Month for Duralie and Statford Mines

MONTH	MONTHLY PRODUCT COAL (tonnes)		
	Coking Coal	Thermal Coal	Total Product Coal
September 2008	31,091	116,560	147,651
October 2008	48,371	102,957	151,328
November 2008	49,368	109,538	158,906
December 2008	36,179	87,666	123,845
January 2009	14,499	91,755	106,254
February 2009	16,424	129,444	145,868
March 2009	37,962	136,186	174,148
April 2009	14,891	102,942	117,833
May 2009	36,368	116,354	152,722
June 2009	85,079	59,123	144,202
July 2009	25,008	114,191	139,199
August 2009	34,300	112,934	147,234

Coal Stockpile Capacity (ROM)

Duralie ROM coal stockpile capacity	15,000 tonnes
Stratford ROM coal stockpile capacity	100,000 tonnes

Product Transport

All ROM coal is transported from site to Stratford Coal Mine by rail. Railing to the Stratford site in restricted to between 7am and 10pm.

1.71 million tonnes of ROM coal was transported from the Duralie Mine in the reporting period.

852 train movements (Duralie-Stratford-Duralie circuit) occurred during the reporting period. There was a maximum daily movement of 4 trains.

MINE DEVELOPMENT

Mining of coal commenced in March 2003 after a construction period of approximately eight months. Coal mining initially involved extraction of coal from the south-eastern corner of Box Cut 1. Box Cut 1 initially lay between Coal Shaft Creek (to the west) and the Main Northern Railway Line (to the east). During the reporting period, mining of coal was ongoing within the "Strip 7", "Strip 8" and "Strip 9" areas. Waste was removed from "Strip 7", "Strip 8", "Strip 9" and "Strip 10" areas.

During the reporting period waste rock produced was used to progress the in pit waste dump.

Surface facilities at the mine and current mine development as at 4 September 2009 are indicated within Figures 7-10 provided in the Plans and Appendix (P&A) volume.

ENVIRONMENTAL MANAGEMENT

MANAGEMENT AND MONITORING PLANS, PROGRAMS AND PROTOCOLS

The following documents were prepared and approved by the DoP during the current reporting period:

- Revised Aboriginal Cultural Heritage Management Plan
- Erosion and Sedimentation Control Plan (Auxiliary Dams Addendum)
- Revised Irrigation Management Plan
- Revised Site Water Management Plan

METEOROLOGICAL MONITORING

A meteorological station (i.e. weather station) is operated at the mine site as required by the Development Consent. The location of the station is shown on Figure 3 (P&A).

Rainfall

Table 5 provided below summarises the rainfall record obtained from the site Weather Station rain gauge.

Table 5 - Duralie Mine - Monthly Rainfall Records

MONTH	YEAR				STROUD DISTRICT AVERAGE[3] 1889-2008
	2009 (To Date)		2008		
	Monthly Total (mm)	No. of Rain Days/Month[2]	Monthly Total (mm)	No. of Rain Days/Month[2]	
January	28.0	10	156.0	15	116.0
February	267.0	9	188.1	21	125.1
March	129.0	12	53.4	7	145.4
April	139.0	13	315.4	17	101.6
May	97.0	17	25.0	4	91.0
June	81.2	12	77.2	14	99.4
July	38.6	9	40.8	7	74.8
August	2.4	2	32.8	7	65.8
September			108.0	9	63.1
October			54.2	9	77.6
November			98.6	9	82.7
December			56.4	10	102.5
TOTAL FOR YEAR	**782.2**	**84**	**1205.9**	**129**	**1145.0**

Notes:
1. No. of Rain Days/Month - the number of days in the month on which rain fell.
2. When tipping bucket rain gauge data used, a "rain day" by definition requires a minimum recording of >0.25mm comprising dew, heavy fog or light rain (or a combination thereof).
3. Average based on Stroud Post Office records until mine site weather station commissioned in 2002.

The 2008 rainfall total for the period monitored (September to December) was 317.2 mm.

Rainfall for 2009 to date (782.2 mm) was less than the January – August average of 818.7 mm.

The three driest months for the reporting period were (in order): August 2009, January 2009 and July 2009.
The wettest months for the reporting period were (in order): February 2009, April 2009 and March 2009.

Evaporation

Table 6 on the following page shows minimum, average and maximum evaporation rates for the reporting period. The graphical representation of the daily minimum, average and maximum evaporation rates recorded for each month during this period is provided in the Plans and Appendix volume.

Table 6 - Monthly Minimum, Average and Maximum Evaporation Rates

MONTH	MINIMUM EVAPORATION RATE (mm/day)	AVERAGE EVAPORATION RATE (mm/day)	MAXIMUM EVAPORATION RATE (mm/day)
September 2008	0.7	4.0	12.3
October 2008	1.2	4.6	8.2
November 2008	2.0	5.2	10.9
December 2008	1.6	6.3	11.3
January 2009	1.7	6.9	10.5
February 2009	0.9	5.6	10.9
March 2009	2.0	4.4	6.8
April 2009	0.8	2.7	7.1
May 2009	0.7	2.3	6.0
June 2009	0.6	1.9	5.9
July 2009	0.5	2.8	7.2
August 2009	1.9	3.3	8.0

Wind Speed and Direction

Table 7 below indicates the monthly minimum, average and maximum wind speeds for the

period September 2008 to August 2009, inclusive. The graphical representation of the daily minimum, average and maximum wind speeds recorded for each month during this period is provided in the Plans and Appendix volume.

Table 7 - Monthly Minimum, Average and Maximum Wind Speeds

MONTH	MINIMUM WIND SPEED RECORDED (k/hr)	AVERAGE WIND SPEED (k/hr)	MAXIMUM WIND SPEED RECORDED (k/hr)
September 2008	0.0	5.6	47.0
October 2008	0.0	8.9	48.2
November 2008	0.0	10.3	58.1
December 2008	0.0	9.6	51.3
January 2009	0.0	10.0	59.2
February 2009	0.0	8.9	41.0
March 2009	0.0	7.7	46.3
April 2009	0.0	6.8	40.6
May 2009	0.0	5.9	51.9
June 2009	0.0	6.1	45.0
July 2009	0.0	7.9	59.0
August 2009	0.0	6.0	52.2

Table 8 provided below summarises the dominant wind directions for each month from September 2008 to August 2009, inclusive. Monthly wind roses are provided in the Plans and Appendix volume.

Table 8 - Dominant Wind Directions by Month

MONTH	DOMINANT WIND DIRECTIONS
September 2008	N*
October 2008	N
November 2008	N
December 2008	N
January 2009	N
February 2009	N
March 2009	N, NNW
April 2009	N
May 2009	N, ESE, NNE
June 2009	N*
July 2009	N, W
August 2009	N*

* limited data due to sensor fault or cable problem.

Temperature

Table 9 provided on the following page summarises monthly air temperatures.

Table 9 - Monthly Minimum, Average and Maximum Air Temperatures

MONTH	MINIMUM AIR TEMP RECORDED (deg C)	AVERAGE AIR TEMP (deg C)	MAXIMUM AIR TEMP RECORDED (deg C)
September 2008	2.0	15.5	33.0
October 2008	7.4	18.0	35.5
November 2008	8.6	19.2	34.9
December 2008	9.3	21.6	34.7
January 2009	11.0	23.8	40.8
February 2009	13.2	22.7	39.5
March 2009	10.8	20.4	32.4
April 2009	6.1	17.3	27.4
May 2009	4.2	14.0	22.2
June 2009	0.7	11.7	20.5
July 2009	1.5	10.8	24.5
August 2009	1.1	13.7	29.6

The graphical representation of the daily minimum, average and maximum atmospheric temperatures recorded for each month is provided in the Plans and Appendix volume.

WATER MANAGEMENT

The main principles of the water management system on-site are to:

- Minimise the generation of mine related water;
- Minimise storage requirements by maximising re-use of mine related water;
- Remove potential impacts on downstream water resources by provision of secure containment on site and disposal by irrigation re-use;
- Implement a fail-safe system, whereby under extreme events in excess of design capacity, mine related waters would spill to the mine pit and not to the clean water catchments; and
- Not allow sediment laden water having an elevated suspended solids concentration to be discharged off site.

Water Supply and Demand

The main water supply storage on-site for use in dust suppression is the Main Water Dam

(MWD) (monitoring point SW3) located to the northwest of the Industrial Area. The MWD and Auxiliary Dam 1 (AD1) are the principal permanent mine water storages on-site. Water from these dams comprises pit produced water (runoff to/rainfall/seepage to), water from specific sediment dams and surface water runoff from the Industrial area.

The principal water losses in the water system are:

- Water applied to land by means of irrigation.
- Water used for dust suppression.
- Evaporation from the Main Water Dam and Auxiliary Dam 1.
- Water retained in ROM coal and railed to Stratford.

Mine related water stored volume increased by 208 ML during the reporting period.

The Main Water Dam's current storage capacity is 1405 ML whilst Auxiliary Dam 1 can contain 462 ML.

At the completion of the reporting period the Main Water Dam contained 1290 ML whilst Auxiliary Dam 1 held 71 ML.

It is estimated that 348 ML of water was pumped from the mine workings during the twelve month period ending 30 June 2009. This water has its origins in groundwater inflows, seepage through out of pit/in pit waste material, runoff and incident rainfall. It is not possible to distinguish between the different origins of this water which is pumped from in-pit sumps. Given the almost average (in historical terms) rainfall during the twelve month period, it is considered that the majority of this water was derived from surface runoff and rainfall seepage through waste material. DIPNR (now DWE) Bore Licence 20BL168404 allows for up to 300 ML of groundwater to be extracted from "works" in any 12 month period. It is therefore considered that groundwater extracted from mine workings did not exceed the 300 ML annual limit.

Surface Water Management

Surface water management is divided into the management of clean and mine related water as outlined below. Mine related water comprises both mine water and sediment laden/turbid water. Section 3.2.4 covers management of runoff from the overburden dump and sediment and erosion control.

Clean Water Management

The main objective of clean water management is the segregation of clean from mine related water by the construction of diversion drains around disturbed areas, thereby minimising the quantity of mine related water generated.

Surface water controls aim to prevent clean runoff water from entering the open mining pit and overburden dumping areas where practical. The main structures are:

- An extensive diversion drain located around the MWD – to the west of all mining

activities ("Western Diversion Drain"). This drain intercepts runoff from the catchment above the MWD and delivers that water to Coal Shaft Creek. The drain was completed in early 2003;

- Diversion of Coal Shaft Creek. The diversion channel (built in stages) is required until the creek can be re-established at the conclusion of mining;
- Flood control embankments to prevent inundation of mining areas;
- A culvert under the Main Coal Haul Road which allows Coal Shaft Creek to flow through the site; and
- Various runoff control drains/bunds about disturbed areas designed to divert clean water runoff around those areas.

The main elements of the clean water diversion system are shown in Figures 7-10 (P&A Volume).

Mine Related Water Management

Mine related water management refers to the control, collection and re-use of water which may have become contaminated by mining operations and associated activities or which by its nature is considered to be undesirable for release to the environment. Mine related water comprises mine water and sediment laden/turbid water. Mine water is water that has come into contact with mining activities. Sediment laden/turbid water has come into contact with disturbed areas but predominantly not core mining areas.

Mine waters are typically characterised by higher salinity and on occasion lower pH. Sediment laden waters are characterised by elevated suspended solids and elevated turbidity.

The main objectives of the mine related water control facilities are:

- On site storage to prevent escape to Coal Shaft Creek and Mammy Johnsons River; and
- Management of the stored quantity of mine related water by irrigation.

The principal sources of mine related water are:

(a) Mine Water

- Rainfall within mining pits mixing with particulate matter and relatively saline groundwater;
- Groundwater seeping into mining pits;
- Rainfall induced runoff and seepage from active sections of the overburden dump; and

- Rainfall induced runoff from the Industrial Area.

(b) Sediment Laden Water

- Rainfall induced runoff from haul roads;
- Rainfall induced runoff from areas stripped of topsoil (typically exposing clays);
- Rainfall induced runoff from areas yet to adequately vegetate within sediment dam catchments; and
- Direct rainfall falling on sediment laden water storages.

Mine related water uses and losses are:

- Evaporation and seepage losses from water storages;
- Haul road dust suppression;
- Railed coal dust suppression;
- Water retained in product coal railed to the Stratford Mine; and
- Stored water applied to land via irrigation (evapotranspiration).

The mine related water storages on site are:

- Main Water Dam (MWD)
- Auxiliary Dam 1 (AD1)
- Sediment Dam VC1 (waste dump)
- Sediment Dams SD1 – SD5 (access road)
- Sediment Dams RS1 and RS6 (rail siding dams)

The locations of mine and sediment laden water storage areas are shown in Figure 7 (P&A Volume).

Surface Water Monitoring

DCPL monitors surface water quality on and surrounding the mine site by sampling from a series of selected locations. These locations comprise both streams and water storage structures. A meteorological monitoring station (i.e. weather station) provides site rainfall data. The locations of these monitoring sites are shown on Figures 2 and 8 (P&A volume).

Surface water monitoring is conducted in accordance with the Duralie Coal Mine "Surface and Groundwater Monitoring Plan (Section 2)" dated May 2002 (and updated March 2004) and the Environment Protection Authority (EPA) Environment Protection Licence (EPL)

11701.

Surface water is sampled and analysed on both a monthly and/or event basis. An "event" occurs when at least 20 millimetres of rainfall is received at the mine site within a 24 hour period. Note also that a second monitored "event" must be greater than 21 days beyond the first "event" to by definition constitute an "event". It should also be noted that monitoring is also undertaken when a sediment dam is spilling.

Collected waters are analysed for a suite of physical and chemical parameters. Results are compared with the Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines for Fresh and Marine Water Quality (2000) (Aquatic Ecosystems Table 3.4.1 referencing slightly to moderately disturbed systems) and EPA requirements. Use of the Aquatic Ecosystems criteria is considered of most relevance given that irrigation utilising water from Mammy Johnson River does not occur (or is infrequent) above Stroud Road, water from that section of the river would not normally be used for human consumption, aquaculture is not a high profile activity within the River and livestock are considered to only occasionally drink from the river.

Groundwater Management

Groundwater is monitored in order to determine whether the mine is having an observable impact on groundwater resources in the area.

DCPL monitors groundwater quality on and surrounding the mine site by sampling from a series of selected locations (bores). The location of these bores is shown in Figure 8 (P&A volume).

Groundwater monitoring is conducted in accordance with the Duralie Coal Mine "Surface and Groundwater Monitoring Plan (Section 3)" dated May 2002 (revised March 2004) and the Environment Protection Authority Environment Protection Licence 11701.

Collected waters are analysed for a suite of physical and chemical parameters. Results are evaluated for observable trending (refer "Review of Water Monitoring Results" below).

Sediment and Erosion Control

The control of sediment generation and erosion is primarily controlled by:

- Timely progressive rehabilitation and vegetation establishment on disturbed areas (e.g. completed sections of the overburden dump) to minimise the area exposed to erosion;
- The direction of runoff from disturbed areas into sediment dams; and
- The placement of silt fences, silt rolls (gravel filled), straw bales, geotextile fabric and/or rock in order to either trap or restrict the generation of silt or to dissipate flow energy.

All elements of sediment control are regularly monitored and maintained. Sediment dams are cleaned out when the storage volume is substantially reduced by sediment deposition (i.e. when 30% of storage volume is lost to sediment build up) and inspected after major rainfall

events.

Sloping areas under rehabilitation are stabilised by structural controls such as bench drains and contour banks (if required) to break up the effective slope length exposed to erosion. Final slopes will generally not exceed 14 degrees which will aid in the control of erosion and sediment generation.

Review of Water Monitoring Results

Local Streams

Reference should be made to accompanying data tables provided in the P&A volume:

- *SW1 – Karuah River*
- *SW2 – Coal Shaft Creek*
- *SW2 Rail Culvert – Coal Shaft Creek*
- *SW2 Upstream – Coal Shaft Creek*
- *SW6 – Former RS3/4 Culvert*
- *GB1 – Mammy Johnsons River*
- *Site 9 – Karuah River*
- *Site 11 – Mammy Johnsons River*
- *Site 12 – Mammy Johnsons River*
- *Site 15 - Mammy Johnsons River*
- *Site 19 – Karuah River*

Comments on analysed parameters during the reporting period are as follows:

- pH at all sites was generally within the ANZECC guidelines. Most sites had occasions when samples were slightly more alkaline (Sites SW1, SW2, SW2 RC, SW2 Upstream, SW6, GB1, 9, 11, 15 & 19).
- Electrical conductivity (EC) across all sites ranged about the ANZECC nominated band. EC above the ANZECC range is attributed to lower stream flows and groundwater influence under drier weather (especially obvious during periods of drought). EC was generally higher within Mammy Johnsons River than in the Karuah River. Also EC was generally higher within Coal Shaft Creek when compared to Mammy Johnsons River.
- Turbidity readings were generally low at all sampling locations, with the exception of when flows were high after rainfall events.
- Total suspended particulate (TSS) results in terms of average concentrations were generally similar within Mammy Johnsons and Karuah Rivers. The drainage alignment on the Mining Lease demonstrated the highest TSS results (Site SW6). There is no stated ANZECC guideline for TSS. Elevated TSS results typically were recorded during high flow events and, on occasion, possibly reflected cattle activity.
- Sulphate concentrations recorded at all sites were generally low (no stated ANZECC guideline). The highest sulphate concentration recorded (158 mg/l) was for a sample collected at Site SW6 on 5 September 2008.

- Manganese concentrations recorded were generally low and within the ANZECC guideline. However, concentrations above the ANZECC guideline were recorded in samples taken from Site SW2 Upstream (five sampling occasions in November and December 2008) and Site 11 (February 2009). The highest result was a concentration of 2.92 mg/l recorded for a sample collected from Site SW2 Upstream (Coal Shaft Creek) on 19 November 2008.
- Filtered iron concentrations at all sites were quite low (no stated ANZECC guideline). Highest concentration recorded (1.94 mg/l) was for a sample collected at Site 19 on 16 February 2009.
- Zinc concentrations at all sites were also generally low. However, zinc results were quite commonly in excess of the ANZECC guideline which is extremely low. Highest concentration recorded (0.36 mg/l) was for a sample collected at Site SW1 (Karuah River) on 13 December 2008.
- Aluminium concentrations at all sites were generally low. Again, the ANZECC guideline for this metal is quite low. As such, the ANZECC guideline was exceeded on a regular basis across multiple sites. The highest reading recorded was from Site SW6 on 21 May 2009 (13 mg/l).
- For calcium, magnesium and chloride concentrations there are no stated ANZECC guidelines. Calcium and magnesium concentrations were not high at any site (maximum 71 mg/l and 69 mg/l respectively at Site SW2 Upstream (Coal Shaft Creek) on 31 August 2009 and 24 November 2008 respectively). Chloride concentrations were reasonably variable across the monitored sites (between 4 and 424 mg/l – maximum chloride concentration occurring at Site SW2 Upstream (Coal Shaft Creek) on 24 November 2008). Elevation in chloride concentration is routinely observed under low stream flows.

Additional analysis for selected sites was undertaken in this reporting period. The following statements refer to this additional monitoring where ANZECC Guidelines – in terms of limits - for Fresh & Marine Water Quality 2000 (Aquatic Ecosystems) under slightly to moderately disturbed systems are nominated:

- Analytes which do not exceed ANZECC guidelines at any sampled site:
    - Arsenic, boron, mercury, nickel, selenium, silver, ammonia.
- Analytes which do exceed ANZECC guidelines at sampled sites:
    - Cadmium – exceedances recorded at sites GB1, Site 9 and Site 12. Greatest exceedance occurred at Site 12 for a sample taken on 20 April 2009 (0.004 mg/l).
    - Copper –exceedances recorded at sites SW2, SW2 RC, GB1, Site 9, Site 11, Site 12, Site 15 and Site 19. Greatest exceedance was for a sample taken at Site 11 on 28 January 2009 (0.02 mg/l).
    - Lead – the only exceedance recorded was for a sample collected at GB1 on 11 February 2009 (0.006 mg/l)

Generally, analytical results for routine (excluding the additional referred to above) monitoring displayed a similar structure to the previous reporting period.

The expectation stated within the EIS for increased sediment loads into Coal Shaft Creek and Mammy Johnsons River under mine construction, decreasing as the creek diversion was established was previously observed.

Biological Monitoring

As part of Duralie Coal's environmental monitoring program, Invertebrate Identification Australasia was commissioned to conduct biological monitoring of the streams near the mine. An environmental assessment of the aquatic ecosystems of Mammy Johnsons River and the Karuah River above the junction with Mammy Johnsons River was made prior to the commencement of mining operations.

Biological monitoring has been conducted during approximately March and September each year since the start of mining operations.

Monitoring conducted during this reporting period was conducted during September 2008 and March 2009. These surveys both involved sampling from eight sites. Note that two additional monitoring sites were utilised beyond previous surveys to provide background data to support possible mining extension approval. The September survey identified a total of 70 species in 49 families. The results for the March survey were 73 species in 51 families.

The September 2008 report found that *"the results of the current survey indicate that there has been a substantial improvement in ecosystem condition compared to previous years and show no evidence of any adverse effects on the aquatic macroinvertebrate community. Therefore, there are no adverse effects on the aquatic ecosystem as a result of the mine's operations."*

The March 2009 report stated that "t*he results of the current survey indicate that there has been a sustained improvement in ecosystem condition compared to previous years and shows no evidence of any adverse effects on the aquatic macroinvertebrate community. Therefore, there appears to no adverse effects on the aquatic ecosystem as a result of the mine's operations."*

Copies of the reports are provided in the Plans & Appendices Volume.

Mammy Johnsons River Sediments

Sediment sampling and analysis was undertaken in 2002, 2005 and 2008.

The 2008 results are provided in the Plans & Appendices Volume.

Mine Water

Mine water, in a practical sense, comprises water that is generated within the mine workings, waste rock emplacements (prior to an acceptable standard of rehabilitation being achieved), storage areas for such water and runoff from areas where coal is handled. Mine water is generally characterised by elevated EC, elevated sulphate concentrations and low turbidity/TSS.

The three principal mine water storage areas are the Main Water Dam (sampling location SW3 major), Main Pit (sampling location SW4) and Auxiliary Dam 1. Monitoring for SW3 (major) during the reporting period indicated, on average, a moderate EC (<2000 uS/cm), neutral pH (7.5) and low miscellaneous metals concentration. Similar monitoring for SW4 on average indicated an EC of approximately 3500 uS/cm, neutral pH (7.0) and elevated sulphate, calcium and chloride concentrations. Sulphate has its origin in sulphides present within the pit rock and coal, calcium from liming of wastes and chloride from the former marine environment.

No localised areas of lower pH water were observed within the pit during the reporting period.

On the basis of mine water quality behaviour to date, a significant change in water quality throughout the mine life is not anticipated.

Groundwater Monitoring

Monitoring of groundwater re-commenced in October 2002 in accordance with the "Surface and Groundwater Monitoring Plan". It should be noted that five (5) deep groundwater bores had been monitored for several years prior to commencement of mine construction.

The construction and early mining groundwater bore network was expanded to ten (10) bores – made up of a compliment of deep and shallow bores to obtain samples from different aquifers. During 2004 the monitoring network was expanded by a further three (3) bores for the purpose of sampling groundwater within the proposed ("Type 2") mine water irrigation area (identified as "SI" bores). During the last reporting period an additional piezometer (designation "DB7W) located between northern future mine workings and Mammy Johnsons River was installed.

Reference should be made to accompanying data tables for each monitoring well provided within the P&A volume.

Comments on analysed parameters for monitoring conducted during the reporting period are as follows:

- Depth to groundwater was comparable with recent historical data for all monitored wells. However, bores DB2W and DB4W have lower standing water levels which indicate that the groundwater level in areas about these bores is yet to return to pre-mining levels (refer to Groundwater Depressurisation below). Bore DB6W shows a rising of the water table about the bore during the reporting period;
- pH is comparable with historical data with fluctuations apparent. pH in the reporting period varied from 5.5 (DB4W in May 2009) to 9.6 (DB2W in August 2009);
- Electrical conductivity generally showed a high degree of variability across many of the wells as has historically been the case. This would appear to reflect the cycle of dry and wet conditions. Shallow wells intercept generally low conductivity aquifers;
- Calcium and magnesium concentrations across all wells tended to fluctuate within reasonably tight ranges.
- Sulphate concentrations varied across wells. Well SI2W exhibited the widest range of any well spanning over 500 mg/l;
- Aluminium concentrations are quite low (often being close to the limit of analytical

detection) in all the deeper wells but comparatively higher in the shallower wells. The highest concentration recorded was 68 mg/l (DB3W in March 2009);

- Dissolved iron concentrations showed no common trend with rises and falls across wells generally. Concentrations showed a wide range from a low of <0.05 mg/l (several wells) to a high of 99 mg/l (DB5W in November 2008);
- Manganese concentrations across all wells were not high with the highest being 7 mg/l within BH4BWin November 2008; and
- Zinc concentrations were essentially low and not inconsistent with available historical data.

As a general remark, it would appear from the data comparison that groundwater quality is varying in a random manner, such that some parameters are increasing, some decreasing and some remaining static when compared with historical information. This is considered to be the most common expectation of a natural groundwater system.

On the basis of the above, no mine operational activities are believed to have influenced groundwater quality.

It should be noted that the EIS described groundwater in the vicinity of the coal measures as being characterised by the following parameters/ranges:

- pH – 6.3 to 6.6
- Electrical conductivity – 1600 to 4000 uS/cm

For this reporting period, the groundwater pH range for bores likely to be influenced by the coal measures was between 4.4 and 9.6. This is a wider range than observed before.

Similarly, the electrical conductivity range for the same bores was 1100 to 6300 uS/cm.

Groundwater Depressurisation

Depth to water information from piezometer monitoring shows that bore water levels are generally consistent between bores and with EIS predicted drawdown levels. The four bores to the west of the open cut pit (SI1W, SI2W, SI3W & DB6W) are all above or close to maximum predicted levels. Three bores to the east and south of the open cut pit exhibit water levels higher than the maximum predicted drawdown levels (DB1W, DB2W & DB4W). One bore south of the open cut (DB5W) has a monitored water level of RL 44-45m which is inconsistent with the maximum predicted drawdown level of approximately RL 60m. This bore recorded similar baseline (pre-mine) water levels – also well below predicted maximum levels within the EIS study, indicating that EIS predictions may be inaccurate in this area, likely due to a lack of groundwater data at the time.

Three graphs showing depth to water data by like groups of piezometers (in terms of location relative to the mining area) are provided in the Plans & Appendicies Volume. The three graphs represent piezometers located between the mining excavation and Mammy Johnsons River, a single piezometer sited hydraulically upgrade of the mining excavation and the three piezometers located within the western ("Type II") irrigation area. The data has been plotted in terms of actual depth to water measurement (top of casing to top of aquifer) minus the minimum depth to water reading recorded for that piezometer. These plots show relative movement of the aquifer over time and comparisons can be made with pre-mining conditions.

The first graph ("Pit-River Groundwater Bore RL Change") shows that the maximum drawdown (expected to be largely induced by mining activity) of any piezometer in this grouping seven (7) metres – within bore DB2W. Note drawdown has since recovered to be of the order of four (4) metres.

The second graph ("DB6W Bore RL Change") shows a maximum drawdown of less than two (2) metres in the period since the commencement of mining.

The third graph ("Western Irrigation Area Bore RL Change") indicates that depth to top of aquifer has varied by up to four (4) metres within these piezometers since irrigation commenced. Depth to water result for bores SI2W and SI3Wl exhibited unexpected behaviour during the reporting period (though quite different from each other) but both returned to a more expected depth to water level in August 2009 monitoring. It is uncertain whether, in fact, the unexpected water level change is actually a data recording error. Note that these piezometers would be expected to show depth to water fluctuations without irrigation simply as a consequence of rainfall episodes.

Reporting

Six-monthly water monitoring data for the period commencing September 2008 was placed on the GCL website in April 2009. Data for the second six month period (commencing March 2009) is provided within this report and which will also be publicly available by being placed on the GCL website.

Water monitoring data is also provided quarterly to the CCC.

Irrigation

The Duralie Coal Mine operates under a continual stored water surplus. There is only minimal requirement for process water on site – e.g. for dust suppression and fire fighting. Development consent precludes the disposal of mine water to the local creek/river system. As a consequence, mine water accumulates on site if not actively drawn down.

Irrigation, as proposed within the Duralie EIS, is used to draw down stored water. Irrigation currently consists substantially of a network of fixed sprays within the catchment of the Main Water Dam (Type I area), three (3) travelling irrigators operating to the west of the Main Water Dam (Type II area) and three (3) travelling irrigators operating to the north of the current mining area (Type III area).

The application of mine water is subject to a management plan (Irrigation Management Plan).

In order to ensure irrigation of mine water does not have an unacceptable adverse impact upon the environment (particularly soils, vegetation, off site water quality etc) appropriate monitoring is undertaken. The monitoring includes (or in the past has included) evaluation of irrigation source water quality, soil moisture levels, runoff water quality from areas under irrigation, soil macroinvertebrates, plant species diversity and pasture biomass.

Routine determination of soil moisture levels to rank irrigation priorities is undertaken within

Type II and Type III irrigation areas utilising "Gbug" sensor/loggers.

During the reporting period (September 2008 to August 2009) approximate irrigation volumes for Type II/III areas were:

Type II areas – 3234 hours (compare with 2727 hours last reporting period) of travelling irrigator operation corresponding to an on ground application of 206 ML.
Type III areas – 3603 hours (compare with 2625 hours last reporting period) of travelling irrigator operation corresponding to an on ground application of 230 ML.

Therefore 436 ML of mine water was irrigated within Type II/III areas utilising travelling irrigators during the reporting period (compared with 341 ML the previous reporting period).

Soil sampling from the Type II areas has been undertaken in August each year since 2005 and tested for analytes of interest, namely bicarbonate alkalinity, chloride, sulphate, calcium, sodium and magnesium concentrations in order to determine whether there was any significant salt accumulation within irrigated topsoils. Sampling sites were chosen along the three (3) irrigation "runs" most irrigated within the Type II area during the first year of irrigation (2005). Upon choosing sampling locations it was proposed that ongoing sampling and analysis be undertaken from those same locations over time in order to determine trend behaviour. Note that Run 8 was discontinued from the sampling program during this reporting period due to the construction and use of Auxiliary Dam 1 and was replaced by Run 22.

Initial topsoil samples from all Type III runs were collected in January 2006. Samples were again collected in August each year (commencing 2006) for the three runs most irrigated for the period up to August 2006.

It should be noted that there is naturally occurring variation in elemental composition between locations and even about an actual location. This situation is clearly indicated by analytical results from the non-irrigated sampling site ("Reference" site).

Comparisons by run for the 2008/2009 period (relative to the reference (non irrigated) site) were:

Run 10: Increased concentrations: sulphate, chloride, calcium, sodium
Decreased concentrations: bicarbonate alkalinity

Run 16: Increased concentrations: sulphate, chloride, calcium, magnesium, sodium
Decreased concentrations: bicarbonate alkalinity

Run 31: Increased concentrations: sulphate, chloride, calcium, sodium
Decreased concentrations: bicarbonate alkalinity

Run 32: Increased concentrations: chloride, sodium
Decreased concentrations: sulphate, magnesium, bicarbonate alkalinity

Run 35: Increased concentrations: chloride, calcium, sodium
Decreased concentrations: sulphate, magnesium, bicarbonate alkalinity

Analytical results are provided in the Plans and Appendix Volume.

Photographic recording of vegetation with Type II and III irrigation areas was undertaken in December 2008 and July 2009.

Water quality for the Main Water Dam ("SW3") in terms of a comprehensive metals suite was undertaken on several occasions during the reporting period. Analytical results are provided in the Plans and Appendix Volume (Surface Water Monitoring section).

Re-establishment of Coal Shaft Creek

A re-established creek channel corridor bulk earthworks specification was prepared in January 2007.

Inpit waste placement about the southern end of the mining excavation is occurring in such a manner as to facilitate the ultimate construction of the re-established Coal Shaft Creek through this area.

Site Water Balance

A review of site water parameters with reference to the 12 month period ending 30 June 2009 determined the following (for comparison purposes average per annum values for the period 2003 to 30 June 2009 are provided in parentheses):

Inflows (Megalitres per annum)

Pump from open cut pit to Mine Water Dam (MWD)	348 (382)
Pump from sediment dams	41 (53)
MWD rainfall-runoff	412 (334)
MWD upstream seepage	169 (145)
Western area irrigation "first flush" collection	107 (146)
Total Inflow	1077 (1060)

Outflows (Megalitres per annum)

Irrigation	510 (428)
Evaporation	274 (193)
Haul Road/Drill use (dust suppression)	93 (67)
Total Outflow	877 (688)
Site Net Gain (Megalitresper annum)	200 (372)

It is expected that an extensive mine water balance assessment as part of a greater Environmental Assessment will be undertaken as part of the proposed Part 3A (Environment Planning and Assessment Act) development application. It is anticipated that the Part 3A application will be lodged with the DoP late 2009.

Complaints

During the reporting period there was one water related complaint received.

EROSION AND SEDIMENT MANAGEMENT

The mine had the following dedicated erosion and sediment control structures in use during the reporting period (refer Figure 7 in P & A Volume):

Five (5) access road sediment dams – designated as SD1 to SD5
Two (2) rail siding sediment dams – designated as RS1 and RS6
One (1) waste dump sediment dam – designated as VC1

Sediment dam sizing is based on providing sufficient capacity to hold runoff from a 1 in 20 year, 1 hour duration rainfall event (for a given catchment). The quality of water collecting within sediment dam is managed (where practical) to minimise suspended sediment load. This is achieved by a combination of promoting stabilising groundcover within the dam's catchment and introduction of a flocking agent such as gypsum (as required).

Sediment dams are inspected following receipt of sufficient rain whereby such dams have the potential to spill.

In addition to dedicated sediment dams, clean water is directed around disturbed areas (where practical) using diversion drains/bunds or in the case of Coal Shaft Creek, a creek diversion (refer discussion under *Water Management*) in order to minimise sediment laden water.

Results of monitoring are provided with the table "Sediment Dams – Monitored During Rain Periods" (provided in the P&A Volume). Spills occurred from four (4) separate dams – SD2, SD3 and SD5 (each four occasions) and RS1 (one occasion). Note that for the purpose of this discussion spilling over consecutive days is considered to constitute "one occasion". Dam spills occurred during September 2008, February 2009, March 2009 and May 2009. In the 72 hours about these spill events the following quantity of rain was received – 75 mm (September); 128 mm (February), 116 mm (March) and 53 mm (May).

It should be noted that at all times pumping (where possible) of sediment dams in order to prevent or limit the amount of spilling water was undertaken. Prioritisation of pumping operations also took into account the likely quality of spilling water when a dam was considered vulnerable to spilling.

AIR

Dust Monitoring and Criteria

DCPL has an Air Quality Management Plan (AQMP) that establishes a dust management

strategy which:

- Identifies air quality criteria;
- Outlines proactive and responsive dust management and control measures;
- Establishes dust management protocols;
- Formulates an air quality monitoring programme;
- Establishes stakeholder consultation protocols; and
- Details reporting and review requirements.

The AQMP was produced in July 2002 (and augmented by an Air Quality Monitoring Plan approved by the DoP in May 2007) and provided to the EPA, Planning NSW, Great Lakes Council and members of the CEMCC.

In order to monitor air quality (dust) surrounding the mine site, DCPL utilises a network of six (6) static dust fallout gauges, two (2) high volume PM_{10} air samplers and a meteorological monitoring station (i.e. weather station). The locations of these monitoring sites are shown on Figure 3 (P&A volume).

Monthly dust fallout levels are measured so that dust deposition rates in g/m^2/month can be determined at or near three (3) residences along Johnsons Creek Road (east of the mine site) and within the village of Wards River. The EPA annual average limit for dust deposition is $2.5g/m^2$/month with a monthly maximum of $4g/m^2$/month.

The high volume air samplers (HVAS) (PM_{10}) are set up near company owned rural dwellings along Johnsons Creek Road ("Twin Houses" – located to the northeast of the mine and "High Noon" – located to the southeast of the mine). Sampling occurs for a 24 hour period every 6 days in accordance with AS 2724.3. The EPA goal for air quality is an annual average limit of $30ug/m^3$/day and a National Environmental Protection Measure (NEPM) 24-hour average limit of $50ug/m^3$/day.

Dust Control Procedures

Dust is controlled by methods which include:

- Minimising disturbed areas,
- Prompt reshaping, topsoiling and revegetation;
- Watering haul roads and other dust generating roads;
- Utilising water sprays on the drill;
- Water sprays on the ROM dump hopper and transfer point between the ROM and train loading bins; and
- Water sprays during train coal loading.

Review of Dust Monitoring Results

Dust Deposition Gauges

Graph 1 shows the dust deposition results for the six (6) dust deposition gauges (D1-D5, D7). Gauge D7 is located within the village of Wards River. The monthly results for deposited dust are tabulated below:

Table 10 – Dust Deposition Gauge Results

	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09
D1	0.8	0.4	1.3	0.9	2.0	0.5	2.8	0.5	0.3	0.4	0.4	3.6
D2	0.8	1.0	0.6	0.3	1.2	1.0	2.2	0.6	0.4	0.7	1.0	1.5
D3	0.5	0.6	0.9	1.0	1.0	0.5	2.3	0.4	0.5	1.0	0.4	3.3
D4	1.5	1.7	0.6	0.4	1.7	0.4	6.3	0.3	0.6	1.6	0.3	0.4
D5	0.6	0.3	0.4	0.8	1.0	0.8	6.7	0.7	1.6	2.0	4.3	0.7
D7	0.5	0.5	0.4	0.6	0.7	0.5	2.7	0.5	1.5	1.0	0.6	0.6
EPA limit	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Dust levels recorded had an average value of 1.2 g/m^2/month. On three (3) occasions during the reporting period a deposition gauge result exceeded 4 g/m^2/month and all elevated values were attributed to contamination from a combination of bird dung, insects and plant material. The results compare with the EPA upper limit of 4 g/m^2/month and the annual average limit of 2.5 g/m^2/month. Dust gauge results are provided within Graph 1 (P&A Volume).

Contamination of samples routinely occurred – primarily from insects and to a lesser extent algae or bird dung.

Graph 2 (P&A Volume) shows the running/cumulative monthly averages for dust deposition gauges. This figure shows that the average dust deposition level for all monitoring sites were significantly below the 2.5 g/m^2/month annual average limit as set by EPA.

High Volume (PM_{10}) Dust Samplers

Graph 3 (P&A Volume) shows the high volume air sampler (HVAS) (with heads restricting dust capture to particle size less than 10 micrometre – ie PM_{10}) monitoring results for the two HVAS in ug/m^3/day (24 hours) for the monitoring sites at "High Noon" and "Twin Houses" during the reporting period.

Analytical data indicated that both monitoring locations (in terms of monitored days) did not exceed the National Environmental Protection Measure (NEPM) of 50 ug/m^3/day during the reporting period with the exception of data recorded on 15 September 2008 ("Twin Houses" site) and 25 April 2009 (both monitoring sites). The elevated results for monitoring on both occasions were not attributed to mining activity.

For the 15 September 2008 monitoring event, on investigation the wind direction and deposited dust appearance was not consistent with the mine being the source of dust. Similarly, the elevated dust results produced on 25 April 2009 were not attributed to mining operations since no mining occurred on this public holiday.

The results during the reporting period by monitoring location were: "High Noon" 1-59 ug/m^3/day and "Twin Houses" <1-104 ug/m^3/day.

HVAS results are tabulated below.

Table 11 – High Volume Air Sampler Results

Date	High Noon	Twin Houses	Date	High Noon	Twin Houses
09-Sep-08	27	20	20-Mar-09	21	25
15-Sep-08	46	104	26-Mar-09	27	26
21-Sep-08	33	47	01-Apr-09	19	20
27-Sep-08	19	21	07-Apr-09	29	32
03-Oct-08	36	46	13-Apr-09	15	13
09-Oct-08	16	21	19-Apr-09	22	22
15-Oct-08	14	13	25-Apr-09	59	58
21-Oct-08	14	15	01-May-09	11	9
27-Oct-08	26	32	07-May-09	10	13
02-Nov-08	16	<1	13-May-09	10	15
08-Nov-08	23	23	19-May-09	17	16
14-Nov-08	30	27	25-May-09	8	11
20-Nov-08	9	9	31-May-09	9	10
26-Nov-08	13	13	06-Jun-09	1	6
02-Dec-08	23	22	12-Jun-09	4	10
08-Dec-08	8	9	18-Jun-09	5	5
14-Dec-08	16	21	24-Jun-09	3	5
20-Dec-08	4	2	30-Jun-09	5	6
26-Dec-08	11	10	06-Jul-09	5	17
01-Jan-09	25	24	12-Jul-09	3	4
07-Jan-09	24	25	18-Jul-09	2	3
13-Jan-09	10	9	24-Jul-09	4	5
19-Jan-09	31	39	30-Jul-09	4	11
25-Jan-09	17	15	05-Aug-09	5	10
31-Jan-09	18	15	11-Aug-09	11	7
06-Feb-09	28	22	17-Aug-09	23	28
12-Feb-09	10	9	23-Aug-09	14	8
18-Feb-09	11	10	29-Aug-09	38	38
24-Feb-09	21	18			
02-Mar-09	14	23			
08-Mar-09	15	17			
14-Mar-09	10	10			

Graph 4 (P&A Volume) shows the running/cumulative average for the two HVAS during the reporting period. The running average for the "High Noon" ranged between 9.0 and 16.6 ug/m^3/day whilst "Twin Houses" ranged between 9.7 and 18.6 ug/m^3/day (all results contributing to averages). Thus, annual averages for both sampling locations were below the 30 ug/m^3/day EPA recommended limit.

Reporting

Six-monthly air quality monitoring data for the period commencing September 2008 was placed on the GCL website in April 2009. Data for the second six month period (commencing March 2009) is provided within this report and which will also be publicly available by being placed on the GCL website.

Air quality data is also provided quarterly to the CCC.

Complaints

No complaints relating to air quality issues were received during the reporting period.

National Pollutant Inventory

The Duralie Coal Mine provided a National Pollutant Inventory (NPI) report to the NSW EPA for the twelve month period ending June 30, 2008. The presentation of Duralie Coal's emission data on the Federal Government's NPI website (www.npi.gov.au) is provided within Appendix II (Environmental Monitoring Data).

Duralie Coal's report for the twelve month period ending June 30, 2009 will be provided in the next AEMR.

Greenhouse Gas Emissions

With reference to the "National Greenhouse Accounts (NGA) Factors, January 2008" published by the Federal Department of Climate Change, this document categorises activity-specific emissions as "direct/scope 1" if they occur as a consequence of actions on a mine site and "indirect/scope 2 and scope 3" in they are occur as a consequence of actions beyond that mine site. "Scope 2 emissions" are considered to be "allocated to the organisation that owns or controls the plant or equipment where the electricity is consumed." In the case of DCPL, a power station, were it to burn coal to generate electricity for use at the Duralie Coal Mine, would be considered to produce "Scope 3 emissions".

Scope 1 Emissions

Diesel	18,026 tonnes CO2-e
Explosives	804 tonnes CO2-e
Fugitive Methane*	72,602 tonnes CO2-e

(* note that outcropping coal is mined at the Duralie Coal Mine and hence a proportion of methane contained within the coal seam would be reasonably expected to have vented prior to mining. Hence the estimate for fugitive methane is likely to be conservatively high. Note also that DCPL anticipate using site derived factors to estimate emissions in the next AEMR.)

Scope 2 Emissions

Electricity used at the Duralie Coal Mine – 1,609 tonnes CO2-e (carbon dioxide equivalent)

Therefore a total of 93,041 tonnes CO2-e made up of Scope 1 and 2 emissions was released to

the atmosphere during the reporting period.

DCPL is currently mining the Weismantel Seam. Under DCPL's pending Part 3A (Environmental Planning & Assessment Act, 1979) Application, it is proposed that both the Weismantel and the adjacent Clareval Seam be mined.

Molopo Australia Limited (ABN 79 003 152 154) have investigated coal bed methane resources within the Gloucester Basin. A media release to the Australian Stock Exchange (ASX) dated 2 June 2008 spoke of "Weismantel 3 (being) a single well production test in the southern part of the (Gloucester) Basin targeting the Weismantel and Clareval seams." A further release to the ASX dated 8 July 2008 described the possibility of coal bed methane extraction from within the Gloucester Basin in the order of "15 – 25 PJ/annum initial capacity production dependent on ongoing pilot program results."

Coal bed methane extraction within the vicinity of coal to be mined from the Duralie Coal Mine area has the potential to reduce fugitive methane releases for future open cut mining activity.

Energy Saving

The site's Electrical Energy Savings Action Plan (EESAP) was produced in 2006. It makes provision to benchmark the previous one (or two) years production (feed tonnes) and energy / demand consumption and greenhouse gas allocation.

The EESAP states that practical energy and demand initiatives will be evaluated and implemented where economically justifiable.

Principle uses of electrical energy at the Duralie Coal Mine are in the areas of:

- Water pumping, predominantly as part of irrigation activities;
- Operation of conveyor belts; and
- Lighting.

In accordance with the Plan, energy and maximum demand opportunities were identified. It was determined that the installation of 200 kilo volt amp reactive (kVAr - the unit of reactive power either capacitive or inductive) of power factor correction equipment (PFCE) would reduce the maximum demand at the Duralie Mine by 83kVA (10%). The estimated cost was $15,000 with a payback period of 20 months. PFCE was installed in early 2009.

Consideration of pumping water for irrigation outside peak tariff hours (with the incentive of lower energy costs) determined that this was not practical and hence altered irrigation practices did not result.

With conveyor belting, considerations such as belt material weight and roller type (mass, diameter, bearing quality) are to be assessed with a view to achieving lower electrical energy requirements. This project did not progress during the reporting period.

A lighting scoping study to identify the quantity and size of the total site light loading is yet to be conducted. The purpose of this study will be to evaluate opportunities to control area lighting in a more efficient manner such as areas currently illuminated at night where no person regularly attends.

NOISE

Noise Criteria and Control Procedures

A Noise Management Plan (NMP) was produced in December 2002 (and supplemented by a Noise Monitoring Plan approved by the DoP in May 2007) to develop procedures for the management of noise emissions during the construction and operation of the Duralie Coal Mine. The NMP was provided to Great Lakes Council, EPA, Planning NSW and members of CEMCC.

Under the 1999 Development Consent, DCPL was required to undertake six monthly noise monitoring surveys, as part of its Development Consent, which involve measuring and recording the $L_{eq\ (15minute)}$ noise level at locations specified by the EPA in order to assess compliance with noise limits imposed on the mine.

The 2006 Development Consent Modification required quarterly noise monitoring and nominated $L_{eq\ (15minute)}$ noise limits at a series of nearby privately owned properties. The Noise Monitoring Plan approved in 2007 provides a framework for this quarterly monitoring and addresses the requirements of the EPL with respect to noise monitoring. The locations as specified under DCPL's EPL are the southern mine freehold property boundary (adjacent to Johnsons Creek Road – designated as N1) or the alternative site AS1 (Off Johnsons Creek Road; Gibson owner and Kennedy tenant), the Doherty Property (Johnsons Creek Road – designated as N2) and the ex-Harrison Property (now owned by DCPL, Duralie Road – designated as N3) or an alternative site AS3 (Durallie Road; Jensen owner). An EPL variation seeking to alter monitoring at Site AS1 to an adjoining privately owned property following acquisition of the Gibson property by Gloucester Coal Limited was submitted to the EPA in the last reporting period.

Four (4) noise surveys were conducted during the reporting period. These surveys were conducted during October 2008, January 2009, April 2009 and July 2009.

Review of Noise Survey Results

The results of the October 2008, January 2009, April 2009 and July 2009 surveys are provided in Table 12. Noise monitoring locations are shown on Figure 4 which is located in the P & A Volume.

Table 12 – Contributed Mine Noise During Surveys

October 2008 Survey

Monitoring Location[1]	Mine Contribution $Leq_{0eq(15\ minute)}$ for Day 28/10/08	Mine Contribution $Leq_{0eq(15\ minute)}$ for Evening 27/10/08	Mine Contribution $Leq_{0eq(15\ minute)}$ for Night 28/10/08	Noise Limits (day/evening/night) $Leq_{0eq(15\ minute)}$	Excursion dB(A)
AAS1 Lyall	Nil	<35	<35, 37	35	2#
N2 Doherty	<35	Nil	<35, <35	35	0
AS3 Jensen	Nil	Nil	Nil, Nil	35	0

Note that since a moderate to strong temperature inversion was present the noise limit does not apply.

January 2009 Survey

Monitoring Location[1]	Mine Contribution $Leq_{0eq(15\ minute)}$ for Day 20/01/09	Mine Contribution $Leq_{0eq(15\ minute)}$ for Evening 20/01/09	Mine Contribution $Leq_{0eq(15\ minute)}$ for Night 20-21/01/09	Noise Limits (day/evening/night) $Leq_{0eq(15\ minute)}$	Excursion dB(A)
AAS1 Lyall	Nil	Nil	Nil, Nil	35	0
N2 Doherty	Nil	Nil	Nil, Nil	35	0
N3 Ex-Harrison	Nil	Nil	Nil, Nil	35	0

April 2009 Survey

Monitoring Location[1]	Mine Contribution $Leq_{0eq(15\ minute)}$ for Day 16/04/09	Mine Contribution $Leq_{0eq(15\ minute)}$ for Evening 15/04/09	Mine Contribution $Leq_{0eq(15\ minute)}$ for Night 15-16/04/09	Noise Limits (day/evening/night) $Leq_{0eq(15\ minute)}$	Excursion dB(A)
AAS1Lyall	Nil	<35	Nil, Nil	35	0
N2 Doherty	31	<35	<30, <30	35	0
AS3 Jensen	Nil	Nil	33, 34	35	0

July 2009 Survey

Monitoring Location[1]	Mine Contribution $Leq_{0eq(15\ minute)}$ for Day 29/07/09	Mine Contribution $Leq_{0eq(15\ minute)}$ for Evening 29/07/09	Mine Contribution $Leq_{0eq(15\ minute)}$ for Night 29-30/07/09	Noise Limits (day/evening/night) $Leq_{0eq(15\ minute)}$	Excursion dB(A)
AAS1 Lyall	Nil	39	39, 41	35	4,6#
N2 Doherty	35	33	Nil, Nil	35	0
AS3 Jensen	27	Nil	<20,<24	35	0

Note that since a strong temperature inversion was present the noise limit does not apply.

The four noise surveys conducted during the reporting period concluded that the Duralie Mine was compliant with the EPA noise level criteria at all monitored locations under the prevailing atmospheric conditions with the exception of site AAS1 during two surveys (October 2008 and July 2009). The mine contributed noise level recorded at the monitoring site AAS1 during the night component of the October 2008 survey (37 dB(A) $Leq_{(15minute)}$) together with the evening and night components (two readings) of the July 2009 survey (39, 39 and 41 dB(A) $Leq_{(15minute)}$ respectively) were deemed not to be an exceedance of the EPA noise level criteria due to the contribution of either moderate to strong or strong temperature inversions prevailing at the time.

Mobile Plant Noise Assessments

Key items of mobile plant – typically haul trucks – are regularly assessed for noise outputs. Availability of mobile plant for noise testing is subject to production requirements and servicing/maintenance/breakdowns.

Noise assessments of haul trucks occurred in December 2008 and July 2009. No significant deterioration of noise performance for any individual truck was detected.

Statement of Environmental Effects (SEE) Comparison

The 2006 SEE (Duralie Extended Modification) provided day, evening and night time mine operational noise audibility predictions for operational years 2006 and 2010.

When a comparison is made between monitoring locations and 2006 and 2010 Evening LAeq (15 minute) Intrusive Noise Contours provided in the 2006 SEE, reporting period monitoring results are consistent with predications made.

Complaints

Nineteen (19) noise related complaints were received by DCPL during the reporting period.

VIBRATION AND AIRBLAST

Blast Criteria and Control Procedures

Blasting is conducted in accordance with a Blasting/Vibration Management Plan (BVMP). Blasting limits are imposed by the site's EPL. The requirement to monitor blasts for ground vibration and overpressure is contained with the EPL, Development Consent conditions and the Mining Lease (ML 1427).

Permanent blast monitors are located on the Schultz property (Bucketts Way, south west of mine); Doherty property (Johnsons Creek Road, north east of mine) and the Holmes property (Duralie Road, north west of mine). Note that the Holmes property was acquired by Gloucester Coal Limited during the reporting period. The locations of these permanent blast monitoring locations are shown on Figure 5 (P&A volume).

Additional blast monitors are utilised primarily for the assessment of ground vibration at strategic locations such as nearby rail line culverts, dam walls, the train load out bin, electricity transmission power poles etc when it is considered that blasting operations are sufficiently close to such structures that there is the potential for damage to those structures as a result of blasting.

The EPL conditions state that overpressure caused by blasting at monitored locations may exceed 115 dB(L) for 5% of blasts during the reporting period but must not exceed 120 dB(L) at any time. Similarly, ground vibration at monitored locations caused by blasting may exceed a peak particle velocity of 5 mm/s for 5% of blasts during the reporting period but not exceed 10 mm/s.

With the introduction of the modification of the Development Consent a "blasting hotline" was established. This system allows the public to telephone a dedicated number (65 384 213) and be advised of intended blasts.

Dilapidation (structural) surveys of several privately owned dwellings located in the vicinity of the mine are routinely carried out by an independent structural engineer. In addition, surveys can be commissioned following an approach by a landowner concerned about dwelling damage which they consider may be related to mining activity.

Three such surveys were undertaken in August 2008. One of these surveys involved a dwelling previously inspected. The surveys did not find any structural damage caused by blasting. The next surveys are due to occur in approximately August 2010.

Review of Blast Monitoring Results

The airblast overpressure and ground vibration results for all blasts undertaken during the reporting period are shown in Table 13 below.

Table 13 - Blast Monitoring Results

Date	Holmes		Doherty		Schultz		Monitored Blasts	Blasts > 115dBL or 5mm/s	% Blasts > 115dBL or 5mm/s
	mm/s	dBL	mm/s	dBL	mm/s	dBL			
4-Sep-08	0.67	102.5	1.24	90.1	<0.22	<110.0	1	0	0.0%
9-Sep-08	0.52	102.0	1.25	81.3	<0.22	<110.0	2	0	0.0%
11-Sep-08	0.40	103.0	1.65	78.8	<0.22	<110.0	3	0	0.0%
17-Sep-08	0.62	105.9	1.92	81.3	<0.22	<110.0	4	0	0.0%
18-Sep-08	<0.22	<110.0	<0.22	<110.0	<0.22	<110.0	5	0	0.0%
22-Sep-08	0.65	102.0	1.36	86.2	<0.22	<110.0	6	0	0.0%
23-Sep-08	0.32	103.9	0.39	95.7	<0.22	<110.0	7	0	0.0%
25-Sep-08	0.45	104.3	1.29	86.2	<0.22	<110.0	8	0	0.0%
29-Sep-08	<0.22	<110.0	0.31	101.1	<0.22	<110.0	9	0	0.0%
30-Sep-08	0.62	102.0	1.09	95.3	<0.22	<110.0	10	0	0.0%
1-Oct-08	<0.22	<110.0	0.29	103.2	<0.22	<110.0	11	0	0.0%
3-Oct-08	<0.22	<110.0	0.29	94.8	<0.22	<110.0	12	0	0.0%
7-Oct-08	1.15	102.0	0.65	95.3	<0.22	<110.0	13	0	0.0%
9-Oct-08	<0.22	<110.0	<0.22	<110.0	<0.22	<110.0	14	0	0.0%
10-Oct-08	0.30	98.7	0.49	101.3	<0.22	<110.0	15	0	0.0%
14-Oct-08	0.30	106.8	0.55	94.8	<0.22	<110.0	16	0	0.0%
15-Oct-08	1.25	106.2	0.95	109.3	<0.22	<110.0	17	0	0.0%
17-Oct-08	<0.22	<110.0	<0.22	<110.0	<0.22	<110.0	18	0	0.0%
20-Oct-08	<0.22	<110.0	0.36	101.1	<0.22	<110.0	19	0	0.0%
27-Oct-08	0.50	100.2	0.79	93.9	<0.22	<110.0	20	0	0.0%
28-Oct-08	0.42	105.9	0.51	89.2	<0.22	<110.0	21	0	0.0%
31-Oct-08	0.55	122.4	0.96	97.9	<0.22	<110.0	22	1	4.5%
5-Nov-08	0.45	106.2	0.77	88.3	<0.22	<110.0	23	1	4.3%
11-Nov-08	0.25	104.3	0.56	97.5	<0.22	<110.0	24	1	4.2%
12-Nov-08	0.30	100.2	0.56	91.5	<0.22	<110.0	25	1	4.0%
17-Nov-08	0.40	103.0	0.77	94.4	<0.22	<110.0	26	1	3.8%
20-Nov-08	0.27	89.9	0.60	101.1	<0.22	<110.0	27	1	3.7%
24-Nov-08	0.27	100.2	0.55	99.4	<0.22	<110.0	28	1	3.6%
25-Nov-08	0.25	100.2	0.40	94.4	<0.22	<110.0	29	1	3.4%
28-Nov-08	0.62	114.0	0.96	94.4	<0.22	<110.0	30	1	3.3%
1-Dec-08	<0.22	<110.0	0.75	87.3	<0.22	<110.0	31	1	3.2%
2-Dec-08	1.57	102.5	1.16	106.0	<0.22	<110.0	32	1	3.1%
4-Dec-08	0.30	107.4	1.01	98.8	<0.22	<110.0	33	1	3.0%
8-Dec-08	0.27	101.4	0.44	101.9	<0.22	<110.0	34	1	2.9%
10-Dec-08	0.40	110.8	<0.22	<110.0	<0.22	<110.0	35	1	2.9%
12-Dec-08	pretrigger[1]	pretrigger[1]	0.84	90.1	<0.22	<110.0	36	1	2.8%
17-Dec-08	0.32	103.9	0.61	100.6	<0.22	<110.0	37	1	2.7%
19-Dec-08	<0.22	<110.0	<0.22	<110.0	0.49	78.8	38	1	2.6%
19-Dec-08	0.40	102.5	0.69	101.3	<0.22	<110.0	39	1	2.6%
22-Dec-08	<0.22	<110.0	<0.22	<110.0	<0.22	<110.0	40	1	2.5%
23-Dec-08	0.35	102.0	0.67	100.1	<0.22	<110.0	41	1	2.4%
24-Dec-08	0.25	105.9	0.33	102.5	<0.22	<110.0	42	1	2.4%
7-Jan-09	0.35	109.3	0.81	101.5	<0.22	<110.0	43	1	2.3%
9-Jan-09	0.45	109.3	0.57	91.5	<0.22	<110.0	44	1	2.3%
13-Jan-09	0.25	97.9	<0.22	<110.0	<0.22	<110.0	45	1	2.2%
14-Jan-09	0.82	99.5	0.69	102.5	<0.22	<110.0	46	1	2.2%
16-Jan-09	0.35	101.0	0.36	100.8	<0.22	<110.0	47	1	2.1%
20-Jan-09	0.47	105.1	0.69	94.4	<0.22	<110.0	48	1	2.1%

Date	Holmes		Doherty		Schultz		Monitored Blasts	Blasts > 115dBL or 5mm/s	% Blasts > 115dBL or 5mm/s
	mm/s	dBL	mm/s	dBL	mm/s	dBL			
21-Jan-09	1.67	97.0	1.47	102.7	<0.22	<110.0	49	1	2.0%
27-Jan-09	0.22	96.0	0.71	91.7	<0.22	<110.0	50	1	2.0%
29-Jan-09	0.42	104.3	0.84	99.9	<0.22	<110.0	51	1	2.0%
2-Feb-09	0.87	104.3	0.42	101.6	<0.22	<110.0	52	1	1.9%
6-Feb-09	0.22	98.7	0.64	94.8	<0.22	<110.0	53	1	1.9%
11-Feb-09	0.27	91.9	0.55	86.2	0.3	81.3	54	1	1.9%
13-Feb-09	0.60	103.5	1.49	91.5	<0.22	<110.0	55	1	1.8%
20-Feb-09	0.87	100.8	0.80	69.2	<0.22	<110.0	56	1	1.8%
27-Feb-09	0.77	105.5	0.22	109.2	<0.22	<110.0	57	1	1.8%
3-Mar-09	1.47	100.8	<0.22	<110.0	<0.22	<110.0	58	1	1.7%
5-Mar-09	1.05	106.8	<0.22	<110.0	<0.22	<110.0	59	1	1.7%
5-Mar-09	<0.22	<110.0	<0.22	<110.0	<0.22	<110.0	60	1	1.7%
11-Mar-09	1.00	102.5	<0.22	<110.0	<0.22	<110.0	61	1	1.6%
19-Mar-09	1.10	107.4	1.14	91.7	<0.22	<110.0	62	1	1.6%
20-Mar-09	<0.22	<110.0	<0.22	<110.0	<0.22	<110.0	63	1	1.6%
24-Mar-09	0.90	114.7	0.48	102.1	<0.22	<110.0	64	1	1.6%
27-Mar-09	0.95	114.0	0.01	112.6	<0.22	<110.0	65	1	1.5%
31-Mar-09	0.45	97.0	0.46	85.0	<0.22	<110.0	66	1	1.5%
2-Apr-09	0.67	103.5	0.98	81.4	<0.22	<110.0	67	1	1.5%
8-Apr-09	0.95	105.1	0.60	91.0	<0.22	<110.0	68	1	1.5%
17-Apr-09	0.45	107.7	0.81	101.2	<0.22	<110.0	69	1	1.4%
28-Apr-09	0.30	103.5	0.32	99.2	<0.22	<110.0	70	1	1.4%
30-Apr-09	0.57	100.8	0.78	101.4	<0.22	<110.0	71	1	1.4%
4-May-09	0.60	103.0	0.81	101.4	<0.22	<110.0	72	1	1.4%
7-May-09	1.12	104.7	1.94	91.7	<0.22	<110.0	73	1	1.4%
11-May-09	<0.22	<110.0	0.34	97.7	<0.22	<110.0	74	1	1.4%
15-May-09	0.30	96.0	0.44	88.5	<0.22	<110.0	75	1	1.3%
20-May-09	0.67	108.8	1.30	95.0	<0.22	<110.0	76	1	1.3%
28-May-09	0.32	106.8	0.65	95.4	<0.22	<110.0	77	1	1.3%
29-May-09	0.35	94.8	0.48	79.0	<0.22	<110.0	78	1	1.3%
4-Jun-09	0.59	107.7	1.01	81.4	<0.22	<110.0	79	1	1.3%
9-Jun-09	0.68	108.8	1.46	88.5	<0.22	<110.0	80	1	1.3%
12-Jun-09	0.74	114.7	1.02	88.5	<0.22	<110.0	81	1	1.2%
16-Jun-09	0.36	111.3	0.29	108.0	<0.22	<110.0	82	1	1.2%
19-Jun-09	<0.22	<110.0	<0.22	<110.0	<0.22	<110.0	83	1	1.2%
20-Jun-09	0.66	112.5	1.13	111.7	<0.22	<110.0	84	1	1.2%
26-Jun-09	0.70	95.8	0.84	98.0	<0.22	<110.0	85	1	1.2%
30-Jun-09	<0.22	<110.0	<0.22	<110.0	<0.22	<110.0	86	1	1.2%
2-Jul-09	0.10	112.7	0.60	102.1	<0.22	<110.0	87	1	1.1%
3-Jul-09	<0.22	<110.0	pretrigger[2]	pretrigger[2]	<0.22	<110.0	88	1	1.1%
7-Jul-09	0.35	105.4	0.28	103.2	<0.22	<110.0	89	1	1.1%
16-Jul-09	1.48	117.6	0.54	106.9	<0.22	<110.0	90	1	1.1%
17-Jul-09	0.68	93.3	1.03	83.4	<0.22	<110.0	91	2	2.2%
22-Jul-09	0.53	110.3	1.09	87.5	<0.22	<110.0	92	2	2.2%
23-Jul-09	0.58	89.8	0.95	86.3	<0.22	<110.0	93	2	2.2%
24-Jul-09	0.10	111.0	<0.22	<110.0	<0.22	<110.0	94	2	2.1%
28-Jul-09	0.75	106.1	0.85	96.3	<0.22	<110.0	95	2	2.1%
29-Jul-09	<0.22	<110.0	0.33	91.0	<0.22	<110.0	96	2	2.1%
31-Jul-09	0.48	108.9	0.61	90.2	<0.22	<110.0	97	2	2.1%
6-Aug-09	0.53	113.5	0.42	106.3	<0.22	<110.0	98	2	2.0%
12-Aug-09	0.50	107.0	0.24	107.7	<0.22	<110.0	99	2	2.0%
13-Aug-09	<0.22	<110.0	<0.22	<110.0	<0.22	<110.0	100	2	2.0%
14-Aug-09	0.63	108.7	0.52	109.7	<0.22	<110.0	101	2	2.0%
20-Aug-09	1.46	121.1	2.19	93.5	<0.22	<110.0	102	2	2.0%
21-Aug-09	0.28	114.2	<0.22	<110.0	<0.22	<110.0	103	3	2.9%
25-Aug-09	0.40	112.4	pretrigger[2]	pretrigger[2]	<0.22	<110.0	104	3	2.9%
26-Aug-09	<0.22	<110.0	0.37	95.9	<0.22	<110.0	105	3	2.9%

Review of Overpressure Results

During the reporting period (period ending 4 September 2009) there were two (2) blasts where overpressure exceeded 120 dBL.

Following a production blast on 31 October 2008 an overpressure reading of 122.4 dBL was recorded at the ex-Holmes monitor. An investigation conducted by Leighton Mining (mining contractor) with assistance from Orica Mining Services into the elevated overpressure result concluded that it was "conceivable that there was potential for magnification of the (overpressure) result due to the wind conditions on the day."

A production blast which occurred on 20 August 2009 caused the ex-Holmes monitor to record an overpressure level of 121.1 dBL. An investigation following this blast attributed the elevated result to insufficient energy confinement associated with the first holes detonated. In order to reduce the likelihood of a reoccurrence of this behaviour, Orica recommended a slight increase in stemming height for early holes detonated. It was estimated that for this particular blast, overpressure experienced at the privately owned dwelling nearest to the mine in this vector would have been less than 113.1 dBL.

In addition, there was one further blast where overpressure exceeded 115 dBL.

Review of Vibration Results

During the reporting period (period ending 4 September 2009) there were no blasts where ground vibration exceeded 5 mm/s.

Complaints

There were four blast related complaints received during the reporting period.

OTHER ENVIRONMENTAL COMPLAINTS

There was one complaint which would be categorised other than those categories already discussed. This related to notification of intention to burn off.

COMPLAINT SUMMARY

Complaints (by category) received by Duralie Coal Pty Ltd (Duralie Coal) over the last 6 reporting years are as follows:

	03/04	04/05	05/06	06/07	07/08	08/09
Noise	0	1	16	16	23	19
Blasting	1	0	0	0	0	4
Air Quality	0	0	0	2	0	0
Water	0	0	0	0	0	1
Lighting	0	0	0	0	0	0
Train Offsite	0	0	0	2	0	0
Speeding Vehicles	0	0	0	1	0	0
Notification	0	0	0	0	0	1
Total* (by Category)	**1**	**1**	**16**	**21**	**23**	**25**

* Note that a single complaint may involve multiple categories.

Comments

- Complaints received during the 2002/2003 reporting year should be seen in the context of mine start up in a non-mining setting.
- For both 2003/2004 and 2004/2005 reporting years only a single complaint was received.
- Reporting years 2005/2006 to 2008/2009 produced a comparable level of both noise complaints and total complaints. Noise complaints constituted the majority of complaints received.
- Duralie Coal's Environment Protection Authority (EPA) Environment Protection Licence (EPL) 11701 applies to the area over which the Department of Primary Industries – Minerals, Mining Lease 1427 is issued. A requirement of the EPL is to record pollution complaints and hence complaints relating to coal trains operating off the mining lease and speeding vehicles on public roads are not within the scope of the EPL complaint recording obligation of Duralie Coal.

NATIONAL POLLUTANT INVENTORY

National Pollutant Inventory (NPI) reporting for the 2007/2008 reporting year was submitted in September 2008 and the 2008/2009 submission will be made during September 2009.

The NPI report as listed on the Commonwealth Department of the Environment and Heritage website (http://www.npi.gov.au) ranks all reportable substances for the 2007/2008 reporting year as low (see Plans & Appendices Volume).

COAL WASHERY REJECTS / REJECT MANAGEMENT

Handling and Disposal Procedures

Rock greater than 140mm is removed from ROM coal using a rotary breaker at the Duralie Mine. The separated rock is conveyed to a bin from which it is loaded out and trucked to be buried on site as potentially acid forming (PAF) waste. All other reject fractions are generated at the Stratford Mine and deposited along with processing waste fractions produced from the washing of Bowens Road North and Stratford deposit coals.

Refer to the Stratford Coal Mine AEMR for details regarding the handling and disposal of reject material at the Stratford site.

Chemical Characterisation of Wastes

Waste rock has been previously analysed as part of the EIS.

Chemical characterisation of wastes during the reporting period has consisted of:

- geochemical (NAG – nett acid generating) testing of waste rock profiles.

Chemical characterisation of wastes was also supported by assessment of pit sump and other mine water pH's.

To date, there have been only isolated incidences of acid formation (within the "Strip 3" pit area – occurring approximately 2004). Acidic water has been treated by ground limestone addition.

OTHER WASTE MANAGEMENT AND RECYCLING

Sewerage Treatment and Disposal

Sewage treatment at the mine site involves a single system that manages all generated sewage. Sewage is processed using a Garden Master 7100 Elite Aerated Waste Water Treatment System. The system works on the combined principles of primary settlement and aerobic treatment. Treated effluent is discharged via a spray system into a grassed area located to the southwest of the Main Office.

These sewage treatment facility is registered with Great Lakes Council.

Fuel Containment

Fuel (diesel) storage at the mine site consists of a single 110,000 litre capacity above ground

bunded storage tank. The storage area is subject to Dangerous Goods Acknowledgement Number 35/036328 (Workcover NSW).

Oil and Grease Containment and Disposal

Bulk oil is stored within a bunded area.

Used engine oils (lubricating oils) and hydraulic oils are recovered during plant and vehicle servicing in the workshop and in the field.

Within the workshop area, separate bunded areas hold a 5,000 litre waste oil tank and bulk oils and greases (tanks and drums). A washpad is utilised to clean vehicles and plant either prior to leaving site or for general servicing/repair. Off the washpad is a concrete sump which serves to trap silt and from which oil is removed using a skimmer. Waste oil collected is removed from site by a commercial contractor for subsequent recycling off-site.

In addition, Interail – the train contractor at site – provides temporary storage for waste oil prior to periodic removal by the waste oil contractor who services the Duralie site. Waste oil is stored in 200 litre drums mounted upon a bunding device.

Contractors are generally required to manage and remove from site all waste oil generated during their operations.

Used Tyres

Tyres were buried within backfill during the reporting period. Disposal was undertaken in accordance with earlier received advice from the EPA in the following manner:

- Tyres are placed in discrete lots and buried with a minimum cover of 5 metres;
- Disposal sites are adequately recorded for future reference. The depth of disposal is also recorded;
- Tyres stockpiled for disposal are adequately protected from fires; and
- Tyres disposed of are not placed with any other combustible material.

Rubbish Disposal

All domestic rubbish (e.g. food scraps, paper etc) is deposited in industrial rubbish bins which are periodically emptied by a waste contractor for subsequent disposal.

Scrap metal produced by the Leighton Mining workshop is collected and transferred off site by a scrap metal merchant. The merchant collects the scrap metal whenever the bins become full.

Paper, cardboard and aluminium drink cans are collected for recycling.

All contractors are responsible for the collection and removal of their own rubbish.

HAZARDOUS AND EXPLOSIVES MATERIALS MANAGEMENT

Hazardous materials are stored and used in accordance with relevant material safety data sheets (MSDS). MSDS's are kept in a file inside the First Aid Room and are available from an online database.

Status of Dangerous Goods Approval

An "Acknowledgement of Notification of Dangerous Goods on Premises" (Acknowledgement Number 35/036328) with an expiry date of 2 October 2009 issued by Workcover NSW is held by HWE Mining Pty Ltd. This Acknowledgement addresses:

- Above-ground tanks (diesel)
- External magazine (detonators & boosters)
- Above-ground tank (oxidizing liquid)
- Roofless bulk storage (ammonium nitrate)

CULTURAL AND NATURAL HERITAGE CONSERVATION

Archaeological surveys conducted at the Duralie Mine site in the 1980's and 1990's did not identify any Aboriginal sites or items with the exception of one site. A tree, to be subsequently referred to as the "honey tree" was the subject of a site inspection involving various parties including representatives of NPWS in November 1998. The consensus at the time of inspection was that the "honey tree", an old ironbark, had had timber pieces inserted into the trunk in a spiral pattern to allow someone to scale the tree and access the crown – possibly to collect honey. It was not clear whether such timber insertion would have been performed by an Aboriginal person or early European settler. The "honey tree" was subsequently listed on the NPWS Aboriginal Heritage Information Management System (AHIMS) database.

The "honey tree" is located between the eastern extent of the mining excavation and the Main Northern Railway Line. The tree has been protected by erection of a painted post and rail fence about the tree. Signage on the fence directs persons not to enter the area.

The Duralie Mine has an Aboriginal Heritage Management Protocol (AHMP), the purpose of which is to address the requirements of development consent condition 41, namely:

(a) The Honey Scarred Tree as identified by NPWS shall not be disturbed; and
(b) In the event that artefacts are identified on the site during development through earthworks, construction or operation of the coal mine, the Applicant shall contact the NPWS and cease work in the relevant location pending investigation of its heritage value.

In accordance with the AHMP topsoil disturbance during earthworks, construction and operation of the mine has been monitored utilising officers of the Karuah Local Aboriginal Land Council (KLALC). During the reporting period KLALC officers did not report any Aboriginal artefacts.

During 2003/2004 and 2008/2009 former mine workings from mining activities conducted during the 1930's were uncovered. Items considered to have historical significance such as a steam boiler, timber pit props, rail and broken pieces of coal skip wheels were provided to the Stroud Historical Society.

MANAGEMENT OF NATIVE FAUNA and FLORA

DCPL endeavour to properly manage native fauna and flora which are either impacted or have the potential to be impacted by mining operations. In keeping with this philosophy a Vegetation Clearance Protocol (VCP) was prepared which provides details on flora and fauna management strategies. Under the VCP, pre-clearance surveys and habitat assessment are undertaken in areas of native vegetation prior to disturbance.

"Habitat" trees are those trees considered to have the potential to provide shelter for arboreal animals (eg via hollows etc). Upon felling of habitat trees, any fauna recovered during the felling operation are relocated to suitable alternative habitat.

Tree clearance to the northern approved disturbance limit occurred during the reporting period. Tree clearance consisted of commercial timber harvesting followed by removal of the remainder of the vegetation. Select removed timber was retained for use in creek reestablishment and to augment rehabilitation.

EMPLOYEE ENVIRONMENTAL AWARENESS TRAINING

The majority of operational employees at the Duralie Mine previously worked at the Stratford Mine. As such they were exposed to an Environmental Awareness Programme previously given to staff and employees of that site. This programme involved presentations on a series of environmental topics at "tool box talks".

Prior to the commencement of mining operations at the Duralie Mine site, plant operators were given a presentation by the Environmental Officer on issues of specific relevance to the Duralie site – with particular emphasis on water management and acid rock drainage.

Contractors and new employees working at site are also provided with information on environmental issues as part of induction training. This includes elements such as the reporting of oil or fuel spills, removal of wastes etc.

REHABILITATION

The primary objectives of the rehabilitation programme are:

- Production of a landform which is stable and consistent with the local surrounding landscape;
- Minimisation of erosion;
- Re-instatement of pre-mining land capability for the final land uses of grazing, woodland habitat and/or other appropriate land use;
- Tree and shrub establishment, mounding or bunding to provide visual amenity and to re-establish flora and fauna corridors and habitats; and
- To minimise the amount of disturbed land awaiting rehabilitation.

REHABILITATION PRINCIPLES

Rehabilitation of disturbed areas is undertaken concurrent with ongoing mining operations.

Disturbances associated with the construction of the mine infrastructure (e.g. rail siding and access road batters, office areas) have been rehabilitated using a variety of techniques including reshaping, topsoil placement, seeding/fertilising and hydramulching.

Rehabilitation of the out of pit overburden dump involves the contouring of the outer dump faces to an overall slope of 1 in 4 followed by drainage works (ie contour drains with grade 1% flattening to 0.6%).

A small proportion of the out of pit dump lies on a natural ground profile which falls away from the mining excavation. In order to limit the potential for infiltrating rain to accumulate salts and thence to charge a local waterway, a nominal 0.6m compacted clay layer was placed beneath the topsoil covering.

Topsoil, previously stripped from the site, is respread to a nominal thickness of 100mm and revegetated. Direct placement of freshly stripped topsoil on areas under rehabilitation is undertaken wherever possible.

The overburden dump is rehabilitated in progressive increments to the final landform so that contaminated water catchment areas are minimised.

Topsoil is removed from ahead of the advancing pit or overburden dump. All suitable and accessible topsoil material is removed. The topsoil is pushed into piles by dozers and loaded into trucks by excavator. The topsoil is either immediately respread onto recontoured areas or is stockpiled for later re-use.

To minimise degradation of topsoil quality during stockpiling the following measures are in place: stockpiling time is minimised whenever possible; topsoil stockpiles do not exceed 3m in height (average 1.5m) and stockpiles are reshaped, seeded with pasture grasses and fertilised to maintain biological activity. These measures help prevent erosion, soil loss and

limit dust generation.

Following drainage works and topsoil placement, site preparation involves chisel ploughing on level ground or ripping (300-400mm) on slopes.

Areas to be rehabilitated will comprise a combination of treed and pastured areas. Trees are planted to achieve maximum aesthetic and screening effects as well as providing windbreaks, woodlots, stock shelter and habitat enhancement. Local endemic native species (particularly trees identified in the EIS) will be used wherever possible based on trialling of various species in the initial rehabilitation areas. Pasture seed utilised will consist of a mix based on previous sowings, seasonal availability and external advice.

In terms of the site's topsoil balance, it is anticipated that sufficient topsoil resources will be available to complete rehabilitation. This expectation is based on topsoil to date being stripped to at least 100mm, deeper topsoil profiles lying in the Coal Shaft Creek area and a final void ultimately being produced. An estimation of stored topsoil on hand is provided below.

TOPSOIL STRIP VOLUMES AND TOPSOIL RESERVES

At the end of the reporting period an estimated 128,500 cubic metres of topsoil was held in various stockpiles.

On the basis of areas currently disturbed that will require rehabilitation in the future (estimate of 108 hectares), there is currently adequate reserves of topsoil to provide a nominal 120 mm cover. However, considering the eventual presence of a final void which will not require topsoiling, a proportion of stored topsoil could be dedicated to forming deeper profiles within a re-established Coal Shaft Creek with sufficient topsoil resources remaining to ensure an adequate topsoil cover of other areas.

REHABILITATION PROGRESS

Rehabilitation has been completed in areas such as the shoulders of the site access road, western (mine water dam) cleanwater diversion drain, rail siding embankments, dam embankments and the Coal Shaft Creek diversion.

Rehabilitation completed during the current reporting was restricted to topsoil stockpiles.

Table 14 summarises the main rehabilitation works undertaken in the reporting period.

Table 14 - Summary of Main Rehabilitation Works

Rehabilitation Type	Area (ha)	Sites Treated
Sown Pasture on Topsoiled Areas	0.2	Southern end of out-of-pit waste dump – drains.
Sown Pasture on Topsoil Stockpiles or former Stockpile Locations	2	Topsoil stockpiles from soil removed from Strips 8-11.

Completed rehabilitation is shown in figure 9 (P&A Volume).

Rehabilitation activities in the next 12 months will centre on:

- Progression of the out of pit emplacement area (south-western end).

The rehabilitation target for the next reporting period is thirty (30) hectares.

A comparison between the 2003 Mining Operations Plan (MOP)[1] rehabilitation estimates and actual achieved rehabilitation (prior to March 2009 or "Year 6" of operations) is as follows:

Total Rehabilitated Area (hectares)
MOP estimate - 56
Achieved - 47.7[2]

Rehabilitation on Slopes (hectares)
MOP estimate - 16
Achieved - 15.1

[1] 2003 MOP rehabilitation estimates should be considered in light of the 2006 mining area extension ("Duralie Extended" approval) which will increase the area requiring rehabilitation.
[2] note that "rehabilitation achieved" includes elements such as the Coal Shaft Creek diversion not fully provided for within the 2003 MOP estimate.

As at September 2009, vegetation establishment was as follows:

Table 15 - Summary of Revegetation Progress

AEMR Year Area Sown	Location	Status
2006	eastern waste emplacement	95% ground cover (pasture area) – kikuyu and Rhodes grass dominant. Scattered acacia to 2m in height.
2007	southern waste emplacement	60 - 70% ground cover, acacia and eucalypt species to 2m high; Rhodes, paspalum and couch grass species prominent.
2008	southern waste emplacement	80% ground cover, acacia to 2m in height, eucalypts to 1m, (western facing). Plateau area and eastern facing side 30% ground cover – predominantly Rhodes and paspalum grass species.
2009	Southern waste emplacement	Well established cover crop in drains.

LAND USE MANAGEMENT

Agricultural Report

Cropping

DCPL conducted a trial planting of sorghum ("BMR Pacific Forage Sorghum") commencing in late 2005 within the Type III irrigation area. The trial was undertaken on an eight (8) hectare plot. There were two (2) separate harvesting events during the 2005/2006 season with the first realising 100 bales and the second 140 bales (a total of 240 bales). The sorghum growth rate was estimated at 160kg/ha/day.

Following the success of the initial trial planting, a second planting was undertaken in the 2006/2007 season. The area sown was increased to 23.5 hectares. A different sorghum variety was sown ("Better Graze Forage Sorghum"). Two harvesting events ("cuts") occurred with the first cut returning 400 bales and the second 200 bales (a total of 600 bales). The sorghum growth rate for this crop has been estimated at 130kg/ha/day.

The area under cropping for the 2007/2008 season increased to a total 26.4 hectares. "BMR Pacific Forage Sorghum" was sown. 451 bales of silage was obtained. Only a single cut was undertaken due to persistent wet weather conditions and weed infestation.

The 2008/2009 sorghum cropped was not successful. An initial winter crop (oats) was planted in 2009. It produced 130 large bales from a first cut. The possibility existed for a second cut beyond this reporting period.

The presence of the sorghum crop within the Type III irrigation area has been shown to accelerate the water loss by soils in this area when compared to non-cropped areas. This situation supports additional irrigation beyond pre-cropping rates.

The bailed sorghum has found a ready market with local graziers for cattle feed, particularly at times when local farmers are affected by limited local rainfall. Bailed oats was provided to the agricultural contractor.

Grazing

There is currently an estimated 120 cows and calves grazing within the mining lease area on either a lease or agistment basis involving two (2) separate lessees or agisters.

Landscaping and Visual Screening

DCPL produced a Landscaping and Revegetation Management Plan (LRMP) as required under Development Consent condition 31. This document has the purpose of stating a basic philosophy for landscaping and revegetation works together with specific works to be undertaken.

The overall visual impacts of the Duralie Mine are generally considered low. However, some local impacts are deemed to be moderate and these impacts have and will be ameliorated by undertaking a selection of relevant measures stated in the LRMP and detailed below:

- Minimising (where possible) disturbance to native vegetation, especially where such vegetation is providing visual screening;
- Retention specifically of ridge Open Forest and regrowth forest (where possible);
- Retention of all riparian vegetation along Mammy Johnsons River and those out of pit sections of Coal Shaft Creek;
- Planting of trees to provide screening for the Doherty dwelling;
- Ensuring out of pit emplacement design produces a landform which integrates with the adjoining natural landform;
- Painting of substantial fabricated infrastructure with a colour ("Rivergum") that assists it to blend in with the adjoining landscape;
- Maintenance of infrastructure to retain the ability of such infrastructure to blend into the surrounding landscape over the life of the project; and
- Placement, configuration and direction of lighting to reduce offsite nuisance effects of stray light.

Weed Control

Weed spraying to control wild cotton, wild tobacco, thistles, blackberry and acacia in various areas such as along the site access road, on the Mine Water Dam outer embankment, within the Type II & III irrigation areas, adjacent to the Mine Water Dam diversion drain, Tombstone area and other areas within the mining lease has been undertaken in previous reporting periods. There was only a minor requirement for weed spraying during the current reporting

period.

In addition, agricultural cropping areas were eradicated of weeds by herbicide application prior to sowing.

Feral Animal Control

Feral animals have not been a significant problem on site to date and hence no control practices have been required.

Bush Fire Management

DCPL does not have a formal Bushfire Management Plan specific to the site in place. However, the following bushfire management related activities/works include:

- Improved access to sections of the DCPL landholdings has been created with the construction of the mine;
- LM can make available an off road water cart for bushfire fighting purposes where suitable access for this machinery is available;
- DCPL routinely (as required) undertakes hazard reduction burns, in consultation with neighbouring property owners/occupiers and the local Bushfire Brigade. No such burns were required during the reporting period; and
- Fuel loads on cleared pastures area on the mine site which are removed from mining operations and adequately fenced are reduced by cattle agistment and/or periodic slashing.

An annual report on fire management related activities which the mine undertook during the calendar year 2008 was provided to the Rural Fire Service based in Tuncurry in January 2009.

Landuse Objective/Current Use

DCPL has prepared a Land Management Plan (LMP) which describes the existing vegetation within the Duralie Mine site and details procedures for the management and control of vegetation, pests and weeds in order to minimise land degradation.

The LMP has been written in accordance with the Duralie Mine's Development Consent condition 38 (ii), (iii) and (iv) *viz*:

> *The Applicant shall prior to commencement of construction works:*
>
> *(ii) Prepare, implement and regularly update (at its own expense), to the satisfaction and approval of the Director-General in consultation with DLWC and NSW Agriculture, a Land Management Plan for all its land holdings to*

provide for proper land management including, but not limited to:

(a) pastures management, including fertiliser regimes;

(b) livestock management and controls;

(c) revegetation design to maximise evapotranspiration in the short term;

(d) rehabilitation of degraded farmland;

(e) eradication of vermin and noxious weeds as required by the Rural Lands Protection Authority, the Prickly Pear Authority and other relevant authorities.

(iii) The land management plan shall be revised as necessary and incorporated with the irrigation management plan when the irrigation management plan is prepared under condition 7; and

(iv) Details of approved plans shall be made available to the GLC and CEMCC.

Prior to mining, the project area was used for cattle grazing. It is anticipated that the rehabilitated site will largely be returned to its former landuse.

Areas not required for mining in the short term are used for cattle agistment (where suitable fencing is available in order to prevent cattle from accessing active mining areas). Remnant vegetation and areas of natural regeneration, outside of areas to be affected by mining and associated activities are not disturbed. Fencing in future will be erected (where possible) to protect areas of natural regeneration from cattle grazing pressure or erosion.

Final Void Treatment

Under current mining approvals, a final void will be produced at the northern limit of the mining lease area. This will follow completion of surface mining.

At the end of the reporting period, DCPL was awaiting correspondence from the Department of Planning regarding final void planning in light of a pending Part 3A (Environmental Planning & Assessment Act, 1979) application by DCPL to extend mining at the Duralie Coal Mine beyond 2011.

COAL TRANSPORTATION

A run of mine (ROM) Coal Transportation Management Plan (CTMP) was prepared in accordance with Development Consent condition 15(iii). The CTMP details procedures for the monitoring of potential environmental impacts resulting from the storage and subsequent transportation of ROM coal by rail to the Stratford Coal Mine for processing.

QUALITY IMPROVEMENT AND TARGET INITIATIVES

ENVIRONMENTAL MANAGEMENT

The following environmental targets have been set for the next 12 months:

- Minimise noise related complaints reported to the mine; and
- Progress rehabilitation works.

REHABILITATION

The following rehabilitation target has been set for the next 12 months:

- Complete rehabilitation to the revegetation stage for thirty one (31) hectares on the out of pit waste dump by the end of May 2009.

LIST OF PLANS (Appendix Volume)

LIST OF APPENDICES (Appendix Volume)

I. Amended or New Approval and Licence Conditions issued during the Reporting Period

II. Environmental Monitoring Data

III. Weather Data (EPA only)

IV. Annual Rehabilitation Report Form (DPI-Minerals only)

ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

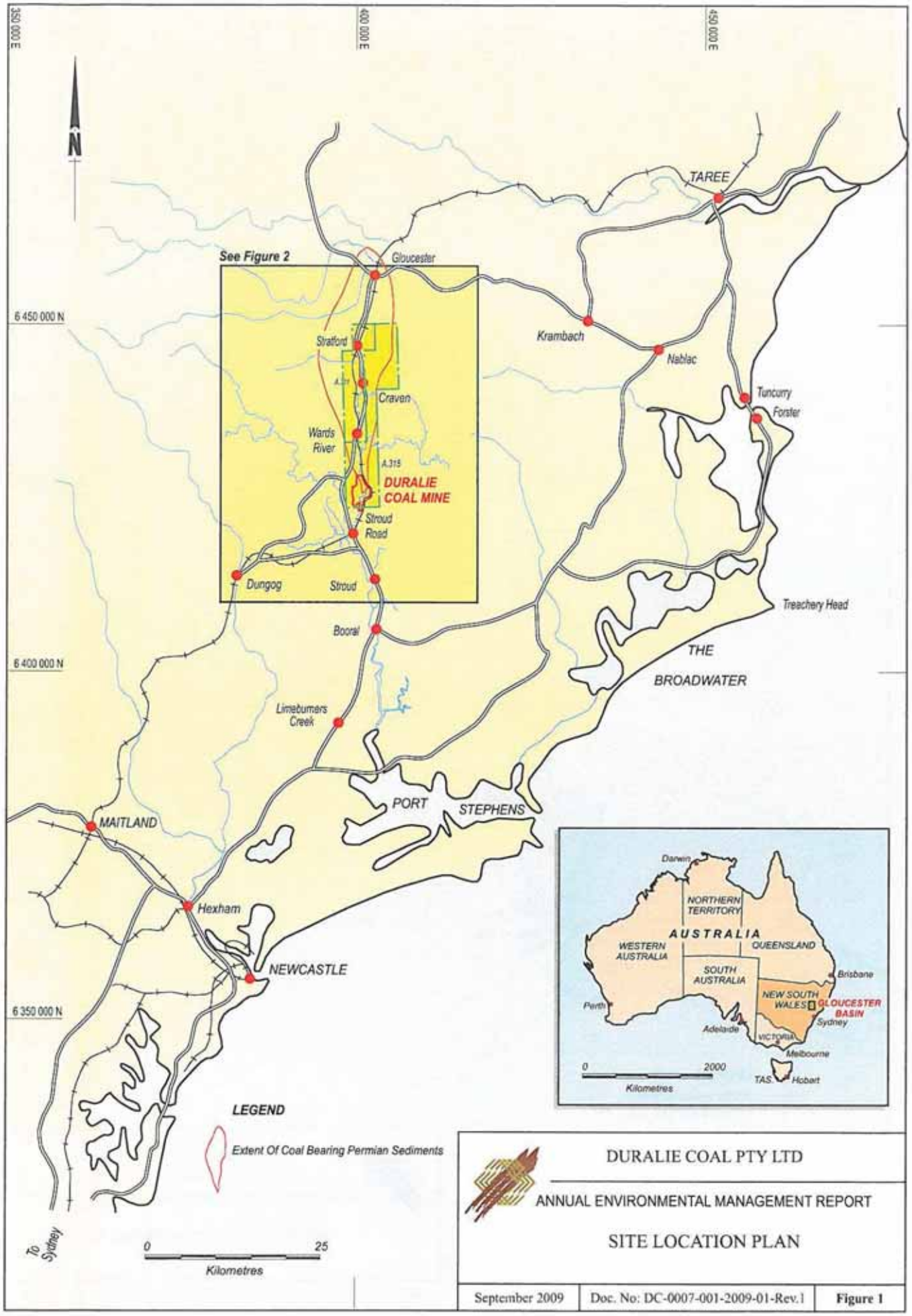
DURALIE COAL MINE

PLANS AND APPENDICES VOLUME

DURALIE COAL PTY LTD

4 SEPTEMBER 2009

PLANS

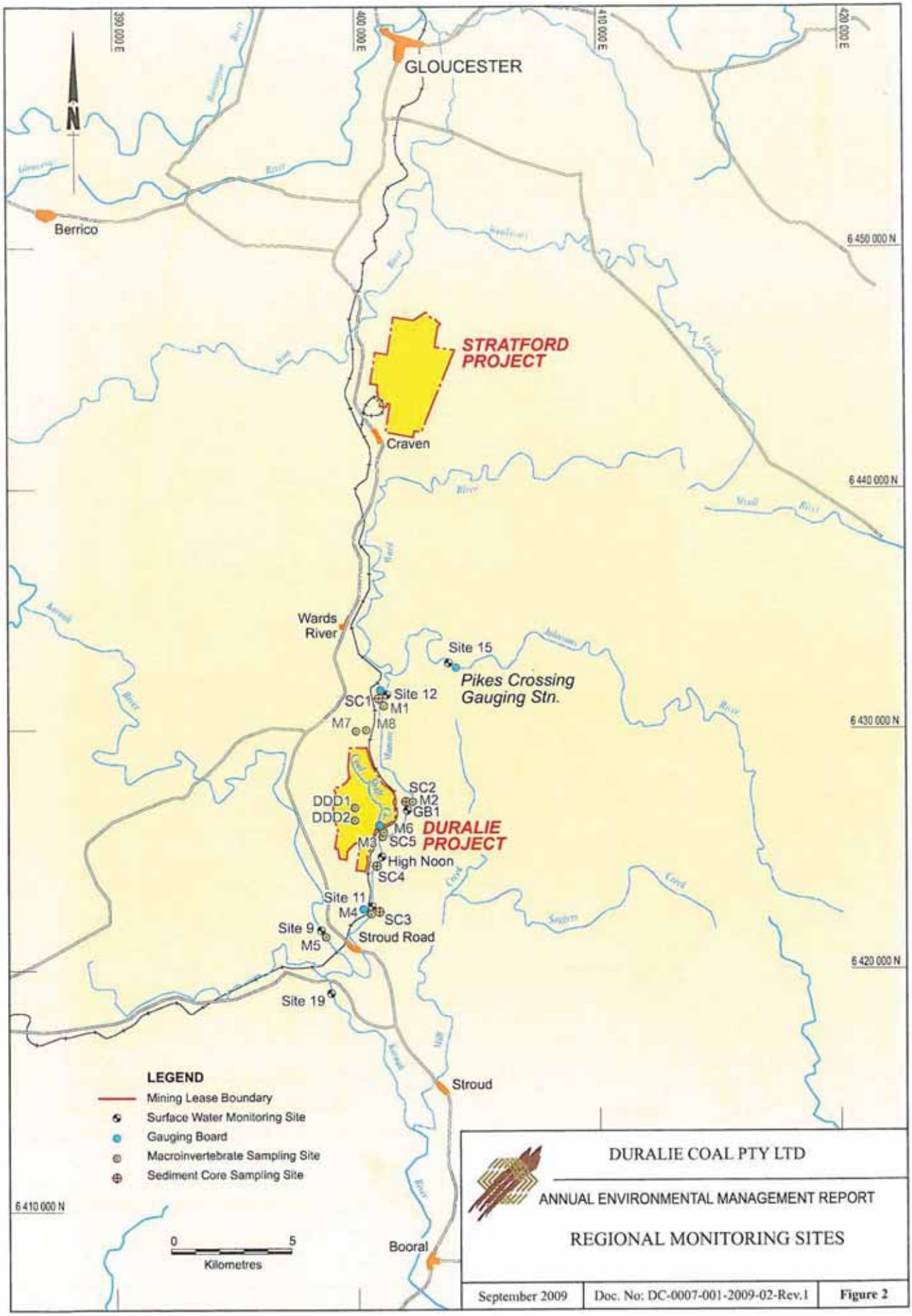


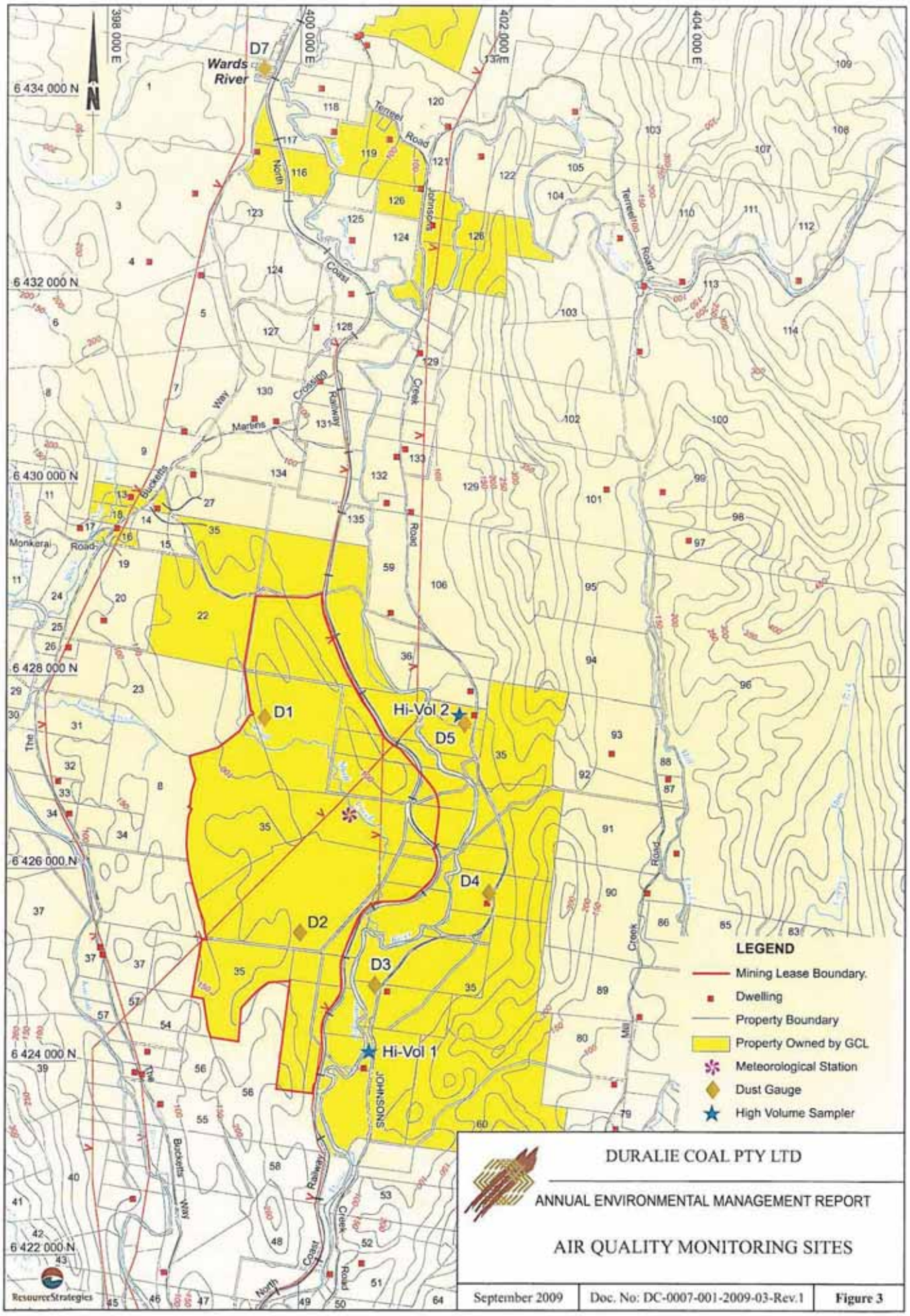
DURALIE COAL PTY LTD

ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

SITE LOCATION PLAN

September 2009	Doc. No: DC-0007-001-2009-01-Rev.1	Figure 1


390 000 E
400 000 E
410 000 E
420 000 E
6 450 000 N
6 440 000 N
6 430 000 N
6 420 000 N
6 410 000 N
N
GLOUCESTER
Berrico
STRATFORD PROJECT
Craven
Wards River
Site 15
Pikes Crossing Gauging Stn.
Site 12
SC1
M1
M7
M8
SC2
M2
GB1
DDD1
DDD2
M6
SC5
DURALIE PROJECT
M3
High Noon
SC4
Site 11
M4
SC3
Site 9
M5
Stroud Road
Site 19
Stroud
Booral
LEGEND
Mining Lease Boundary
Surface Water Monitoring Site
Gauging Board
Macroinvertebrate Sampling Site
Sediment Core Sampling Site
0
5
Kilometres
DURALIE COAL PTY LTD
ANNUAL ENVIRONMENTAL MANAGEMENT REPORT
REGIONAL MONITORING SITES
September 2009
Doc. No: DC-0007-001-2009-02-Rev.1
Figure 2

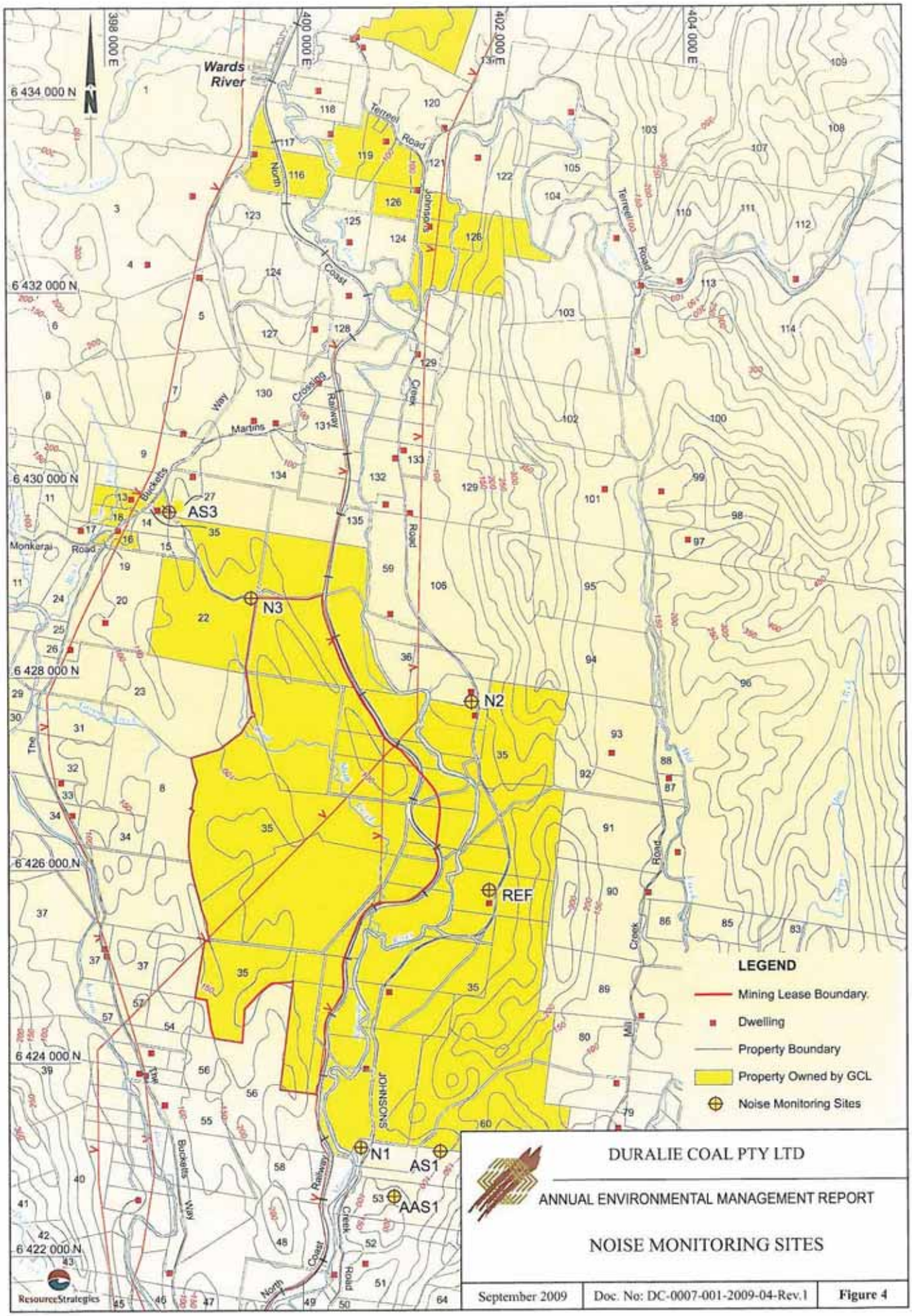


DURALIE COAL PTY LTD

ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

AIR QUALITY MONITORING SITES

September 2009	Doc. No: DC-0007-001-2009-03-Rev.1	Figure 3

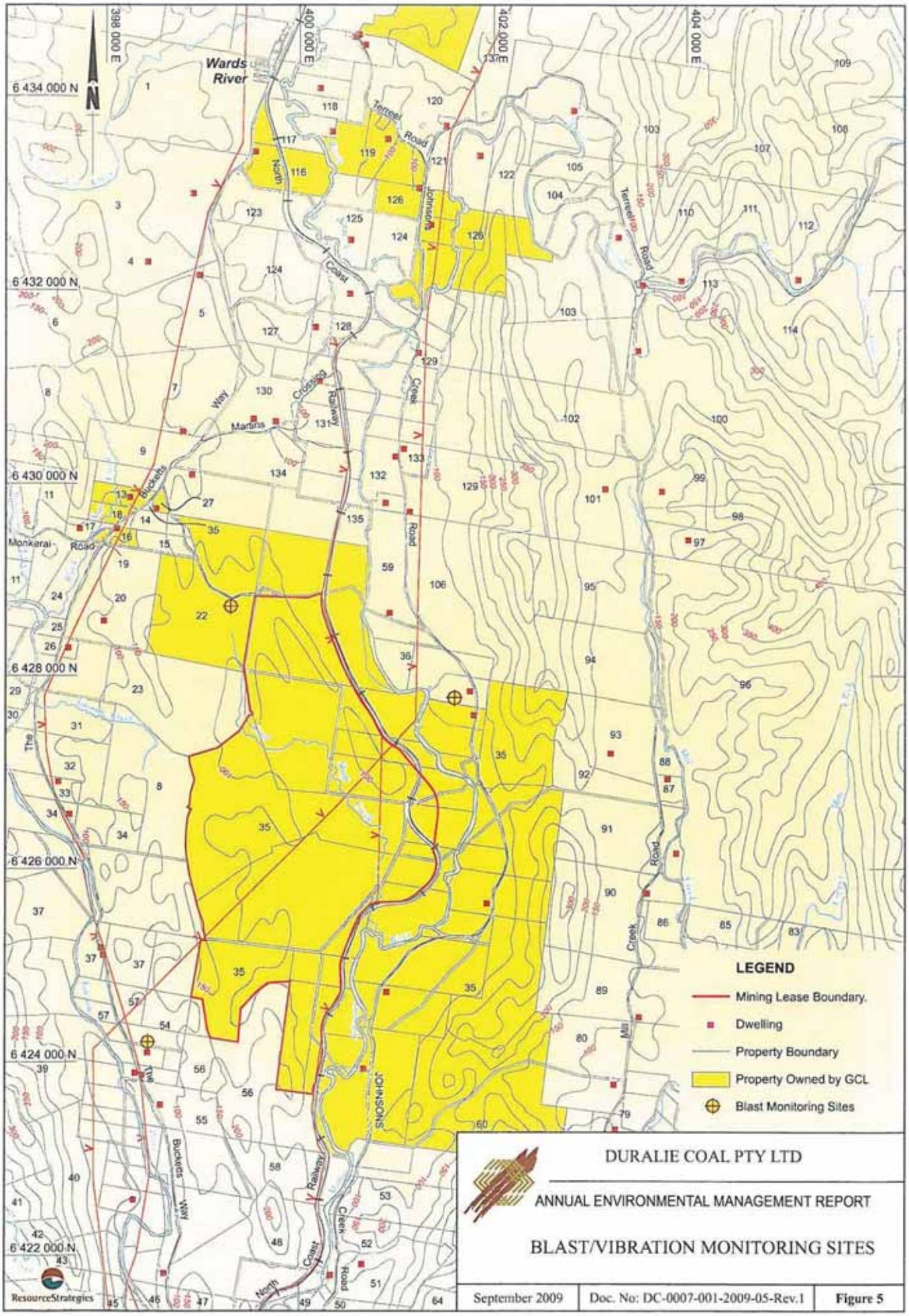


DURALIE COAL PTY LTD

ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

NOISE MONITORING SITES

September 2009	Doc. No: DC-0007-001-2009-04-Rev.1	Figure 4



DURALIE COAL PTY LTD

ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

BLAST/VIBRATION MONITORING SITES

September 2009	Doc. No: DC-0007-001-2009-05-Rev.1	Figure 5

1. SEJON NO 4 PTY LTD
3. KV & PM HOWARD
4. BV & PO HOWARD
5. GR & GR WEISMANTEL
6. SR & J HOGEVEEN
7. ED & LM HOLMES
8. CW & JI EDWARDS
9. PWM MOYLAN
11. PWM & BD & GO & MJ MOYLAN & SCM NEWTON
13. GLOUCESTER COAL LTD
14. T JENSEN
15. S WHITE
16. GLOUCESTER COAL LTD
17. MJ & CA MAHONY
18. GLOUCESTER COAL LTD
19. BL BEAVIS
20. MS JUTTNER
22. GLOUCESTER COAL LTD
23. PG & KA MADDEN
24. BMG & P. MOYLAN & S.NEWTON
25. GLOUCESTER RURAL LANDS PROTECTION BOARD
26. M MADDEN
27. GLOUCESTER COAL LTD
28. GREAT LAKES COUNCIL
30. JR GORTON
31. DJ WIELGOSINSKI
32. DH & SW OWENS
33. MA BRAGG
34. JI EDWARDS
35. GLOUCESTER COAL LTD
36. RS DOHERTY
37. DJ MCANDREW
39. AJ & AL DANIEL
40. RDK & NL WILLIAMS
41. ED SANDERS
42. HR & DA MOOREHOUSE
43. JV BRERETON
44. CS PARKER
45. IG WILSON
46. JS & KL BRATFIELD
47. DE ALLEN
48. MC JONES
49. DC CARROLL
50. PG & LJ BILLETT
51. RJ & SJ WOODLEY
52. SM, JAM, M & SC TRIGG, M JAMES AND BJ HOLLAND
53. SJ & JE LYALL
54. VR & EK SCHULTZ
55. IK & MJ SCHULTZ
56. EK & VR SCHULTZ
57. G SCHULTZ
58. TI & FHS WOOD
59. HATTAM PL
60. JS & KA GIBSON
61. MH & EV ELFICK
* 62. BJ & MC GAY
* 63. AW RAINE & T HILLEARD
* 64. KB & JN FARNHAM
65. CA BOWDEN
* 66. S & AF VASDA
* 70. TE RUMEEL
* 71. HJ GILLARD
* 72. B CLAYTON
* 73. SW & SR GRAY
* 74. Crown Land
* 75. AM MOKEEFF
* 76. P TRENCHEV
* 77. ROAD
* 78. RN & TE RUMBEL
* 79. GJ THOMPSON
* 80. BR & GJ & KG & KJ & WJ THOMPSON
81. I MELLAR
* 82. MA HOCKINGS & CH
* WILLCOX
83. LS MILLER
* 84. NE HITCHCOCK & EE COLDHAM
85. DG HUTCHISON
86. P & ME KENNEY
87. CN & SD STEPHENSON
88. TRJ & B HOPE
89. WJ THOMPSON
90. TR WATERER
91. B GILBERT
92. M & R GUBERINA
93. L & KM YOUNG
94. L & RK PAUL
95. DM LOWREY
96. GORTON TIMBER CO. LIMITED
97. TJ LORD
98. DP PICKLES
99. PJ AYLIEFE & LA SMYTH
100. DUZMEN PTY LTD
101. RJ GORTON
102. AT GORTON
103. VS & RM EDWARDS
104. PG SPENCER
105. RS MUDFORD
106. RS & R MUDFORD
107. DJ ROBERTSON
108. WA & JA THOMSON
109. HUNTER WATER CORPORATION
110. AG TERSTEEG
111. GW LEWIS & AJ MOORE
112. TJ SOMERVILLE & CD MARTIN
113. RJ BATHGATE & ML LEVEY
114. SHULGIN INVESTMENTS OTY LTD
116. GLOUCESTER COAL LTD
117. AE & CA HOWE
118. SW DAVIS
119. GLOUCESTER COAL LTD
120. WR KERSLAKE
121. KR MUDFORD
122. RS MUDFORD
123. K MacFARLANE
124. RJ WEISMANTEL AND COMPANY PL
125. KM & DB HOLLOWAY
126. GLOUCESTER COAL LTD
127. AR ROBSON
128. HL & MR HAMANN & PIXALU PL
129. WL RELTON
130. AJ & RM BAILEY
131. AJ FISHER-WEBSTER
132. J WEISMANTEL
133. MA & JM GUIDICE
134. T & K & V ZULUMOVSKI
135. DR & BM HARE SCOTT
136. D & M RASBURN
137. PACIFIC PROPERTY INVESTMENTS LTD

* Landholdings not shown on Figs 3,4 and 5 as they are under the Title Block and Legend

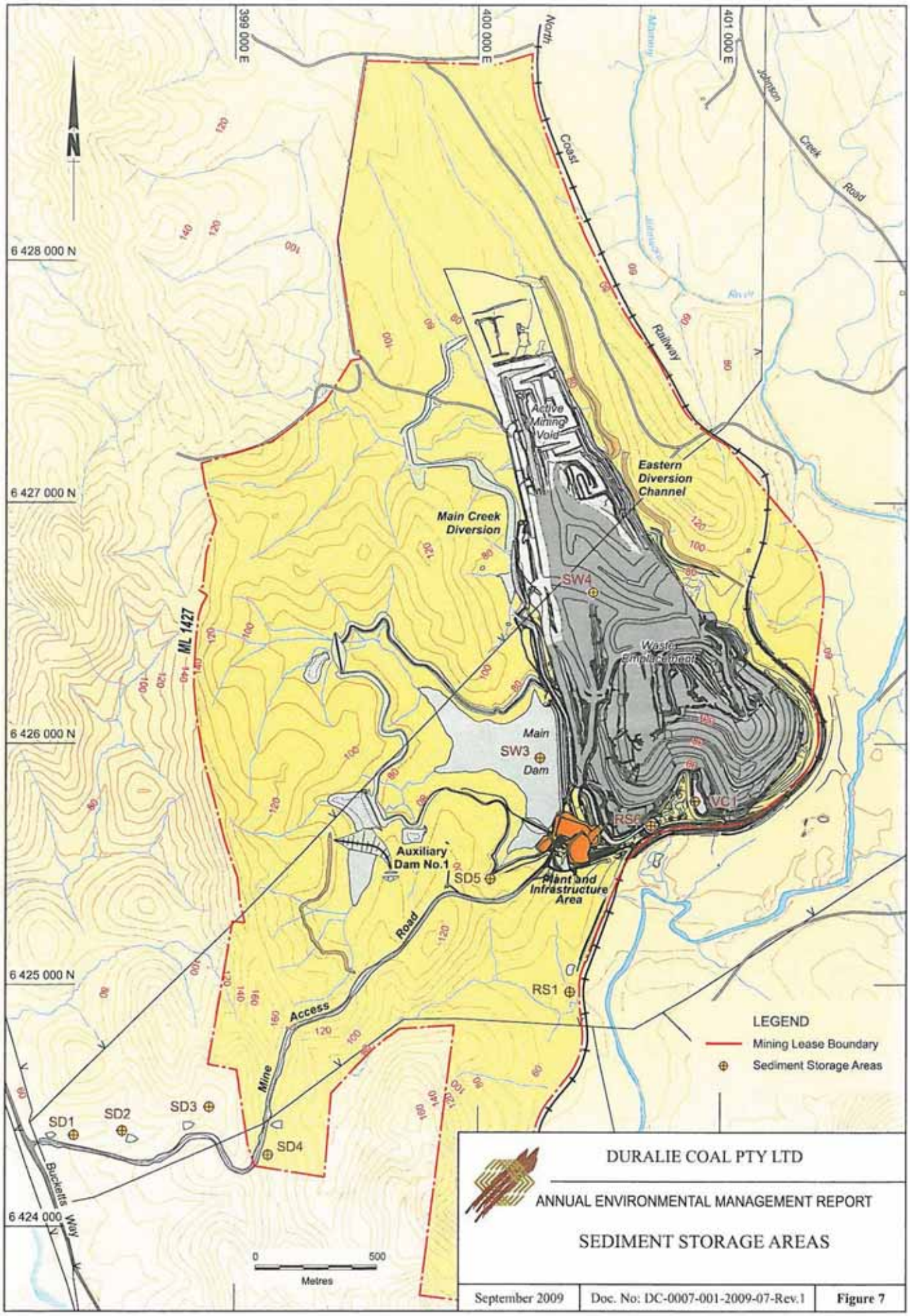
DURALIE COAL PTY LTD

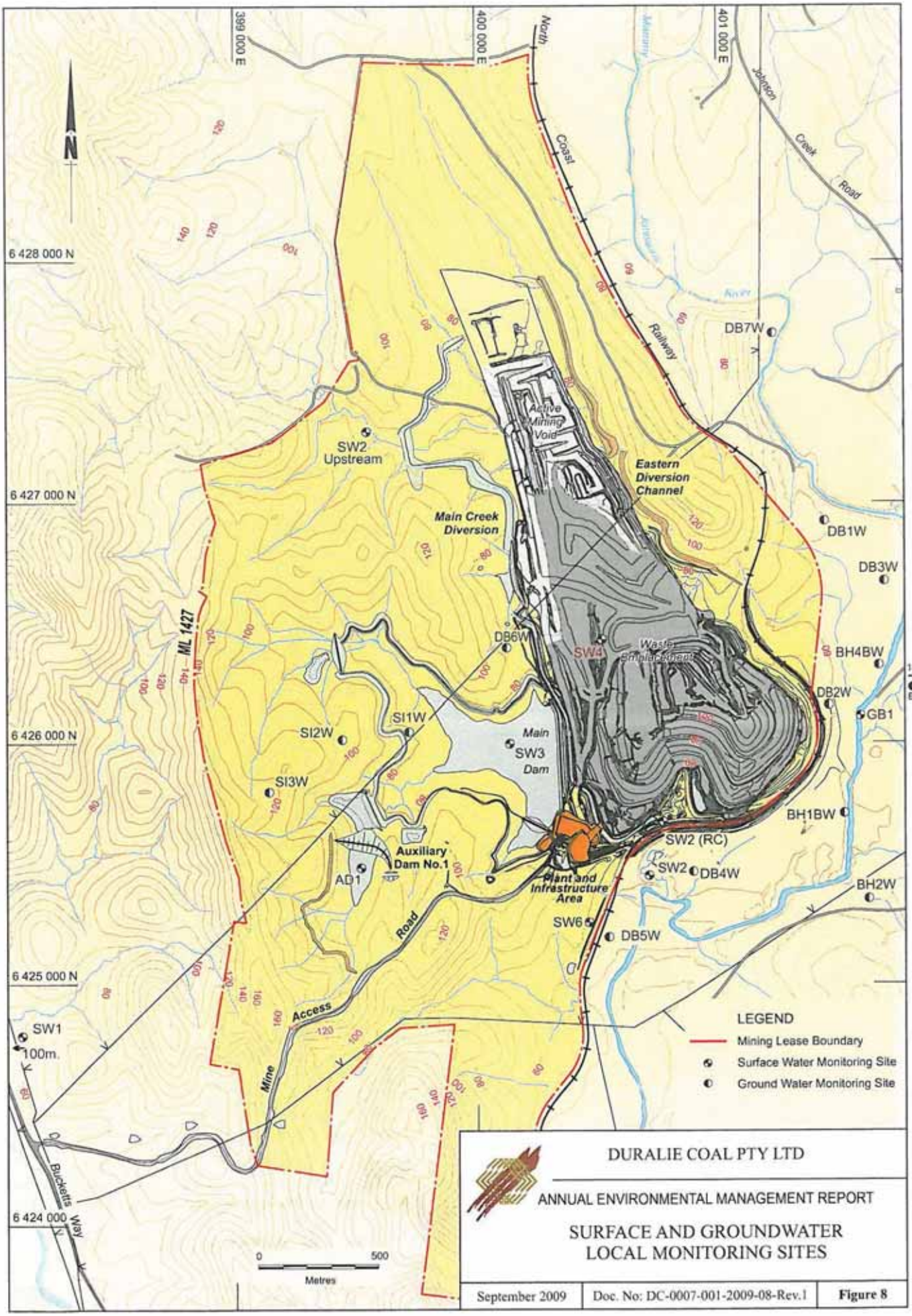
ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

LAND OWNERS

ResourceStrategies

September 2009	Doc. No: DC-0007-001-2009-06-Rev.1	Figure 6


399 000 E
400 000 E
401 000 E
6 428 000 N
6 427 000 N
6 426 000 N
6 425 000 N
6 424 000
North Coast Railway
Johnson Creek Road
Active Mining Void
Eastern Diversion Channel
Main Creek Diversion
SW4
Waste Emplacement
ML 1427
Main Dam
SW3
VC1
RS6
Auxiliary Dam No.1
SD5
Plant and Infrastructure Area
Access Road
Mine
RS1
SD1
SD2
SD3
SD4
Bucketts Way
0
500
Metres
LEGEND
Mining Lease Boundary
Sediment Storage Areas
DURALIE COAL PTY LTD
ANNUAL ENVIRONMENTAL MANAGEMENT REPORT
SEDIMENT STORAGE AREAS
September 2009
Doc. No: DC-0007-001-2009-07-Rev.1
Figure 7



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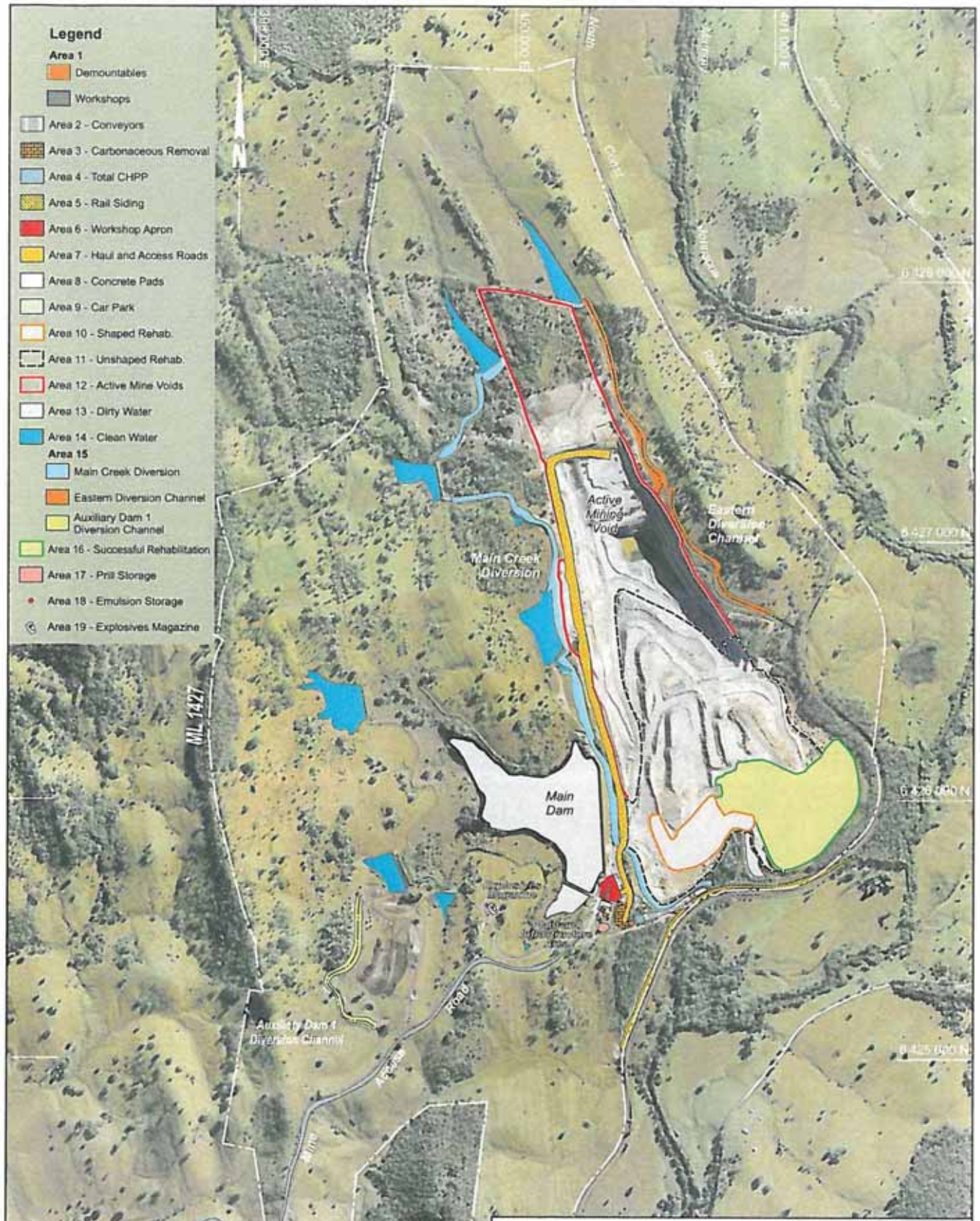
ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

SURFACE AND GROUNDWATER LOCAL MONITORING SITES

September 2009	Doc. No: DC-0007-001-2009-08-Rev.1	Figure 8



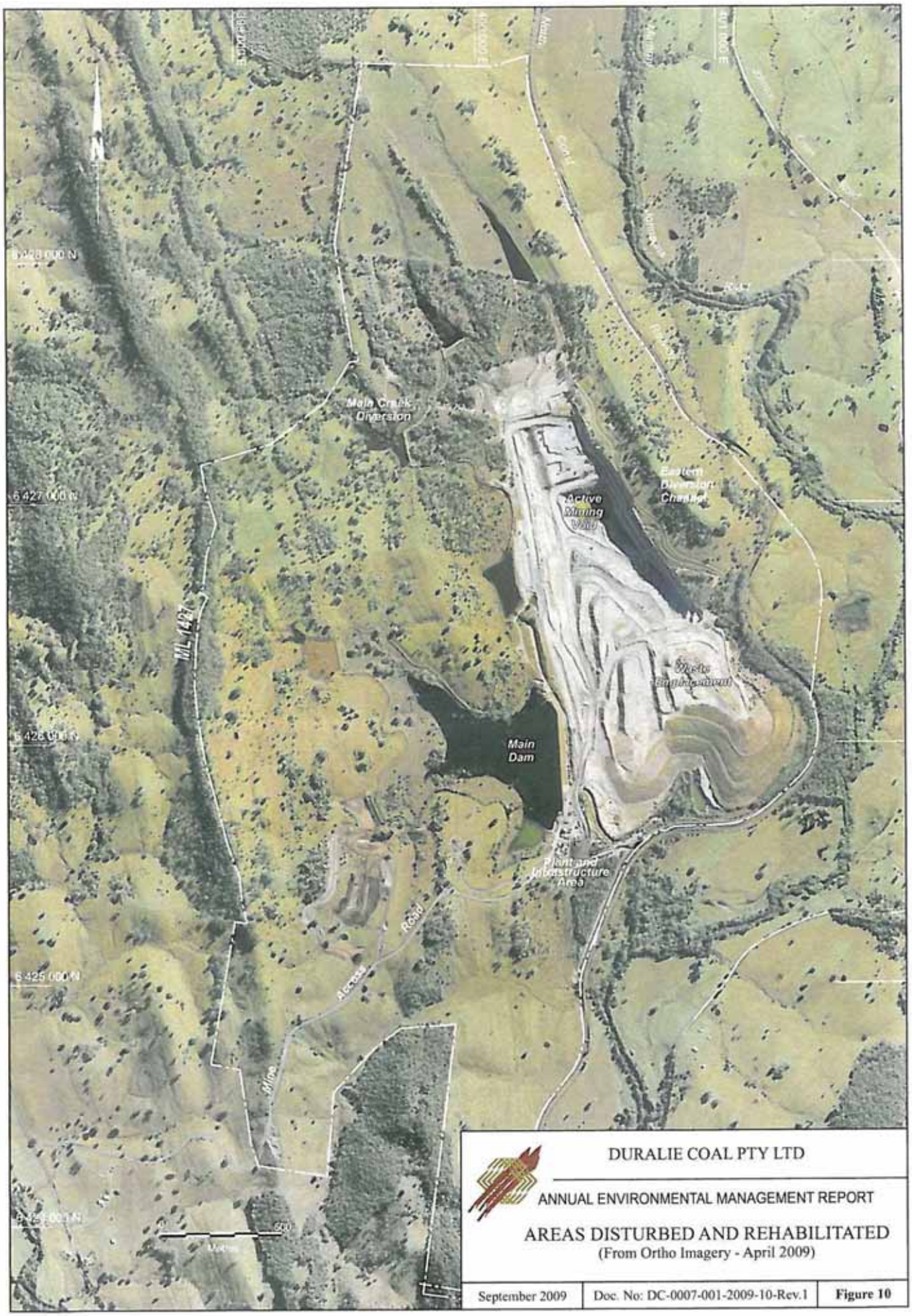
DURALIE COAL PTY LTD

ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

CATEGORISED AREAS DISTURBED AND REHABILITATED

(From Ortho Imagery - April 2009)

September 2009	Doc. No: DC-0007-001-2009-09-Rev.1	Figure 9

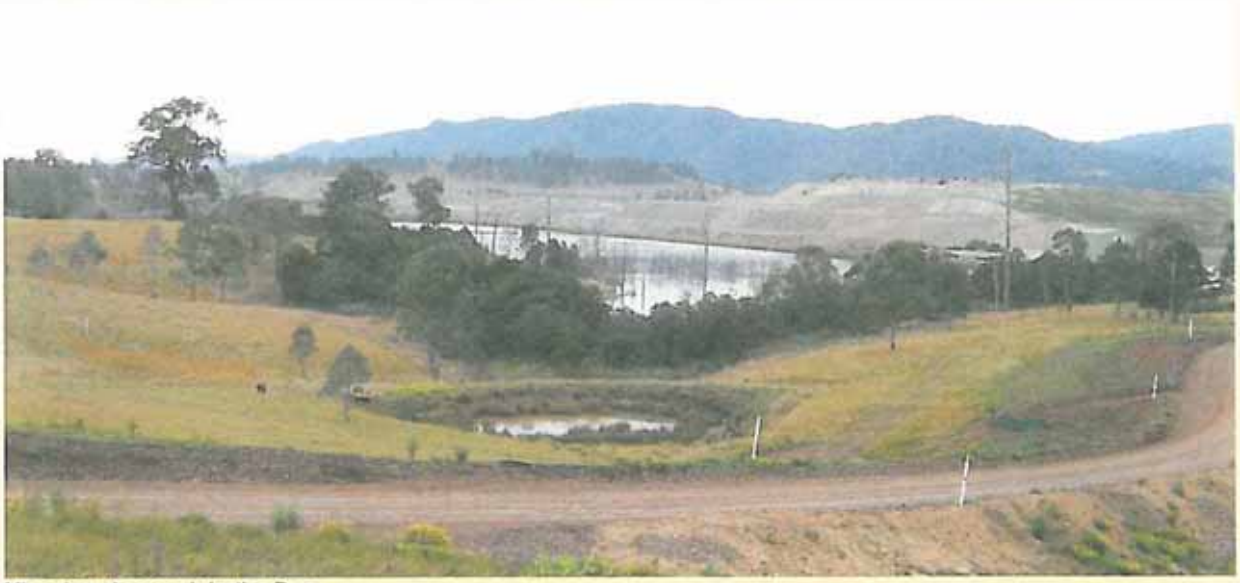


DURALIE COAL PTY LTD

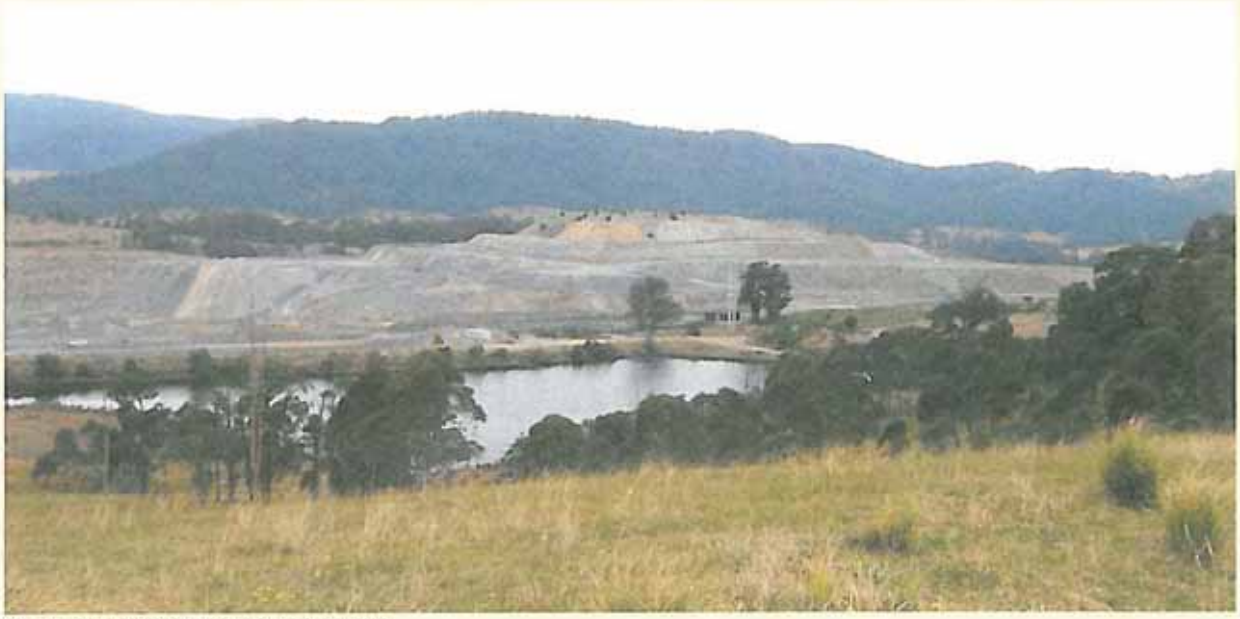
ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

AREAS DISTURBED AND REHABILITATED
(From Ortho Imagery - April 2009)

September 2009	Doc. No: DC-0007-001-2009-10-Rev.1	Figure 10



Mine viewed across Irrigation Dam.



Waste Emplacement from Weather Station.

DURALIE COAL PTY LTD

ANNUAL ENVIRONMENTAL MANAGEMENT REPORT

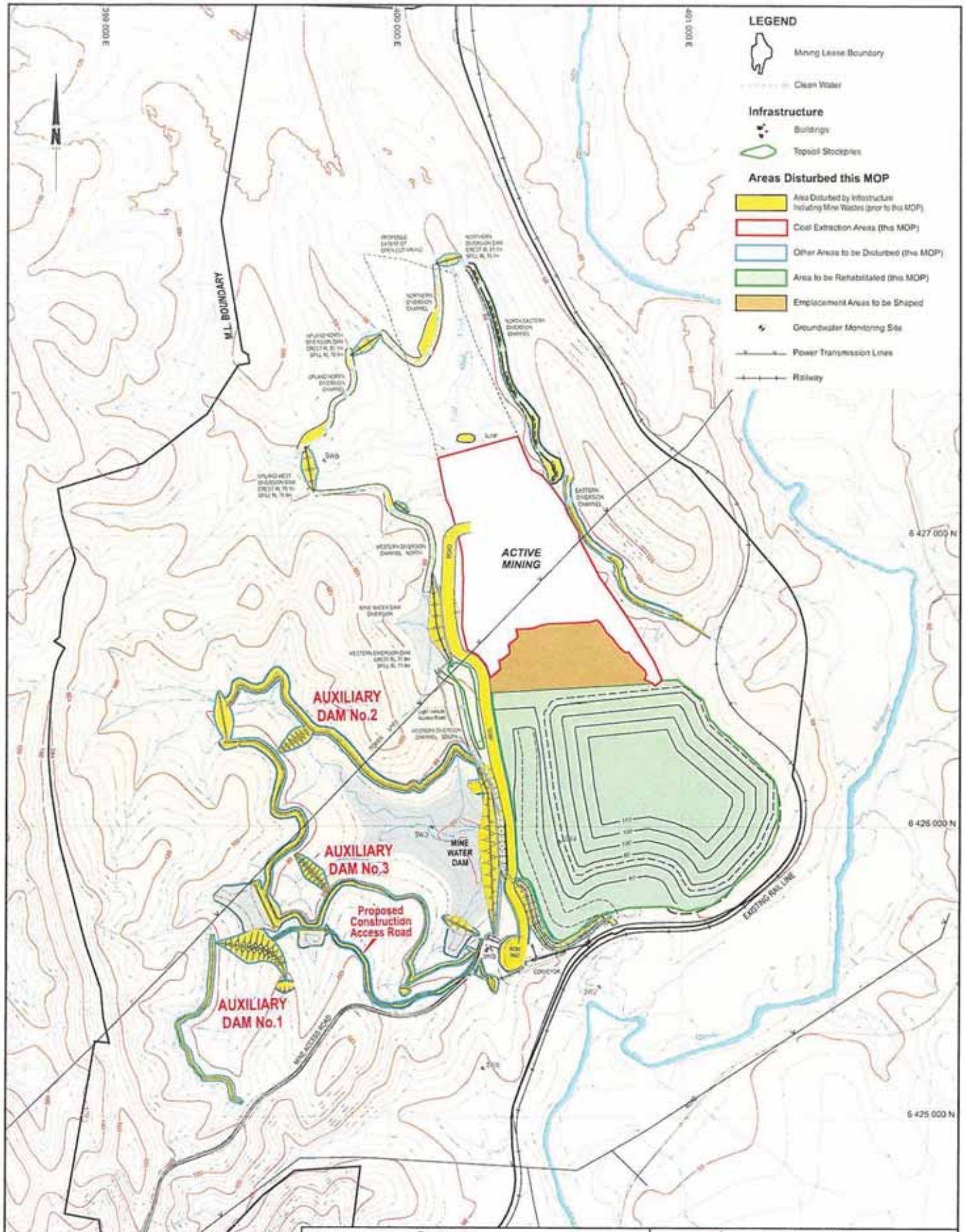
PHOTOGRAPHS

September 2009	Doc. No: DC-0007-001-2009-011-Rev.1	**Figure 11**

APPENDIX I

AMENDED OR NEW APPROVAL AND LICENCE CONDITIONS ISSUED DURING THE REPORTING PERIOD

MINING OPERATIONS PLAN AMENDMENTS



Name of mine: Duralie
Mining Title Leases: ML1427
MOP Commencement date: 01/03/2003 MOP Completion date (nominal): 01/03/2017
Name of leaseholder: Duralie Coal Pty Ltd
Name of mine operator if different: HWE Mining Pty Limited
Reporting Officer: Mark Sheldon
Title: General Manager Stratford and Duralie Operations
Signature: Date: 10/12/2008

DURALIE COAL

Water Management MOP Amendment
Auxiliary Dams Construction Access Road Added

December 2008	Doc No. DC-0029-01-Rev 4	Plan 1

APPENDIX II

ENVIRONMENTAL MONITORING DATA

BIOLOGICAL MONITORING

INVERTEBRATE IDENTIFICATION AUSTRALASIA
• Identifications • Surveys • Environmental Interpretations

Duralie Coal Project
-
Biological Monitoring of the Streams Adjacent to the Duralie Coal Mine
Study 1, Survey 14, September 2008.

INVERTEBRATE IDENTIFICATION AUSTRALASIA
51 Panorama Parade, Panania, NSW 2213, Phone (02) 6771 1458 Mobile 0412 372 388
Email: meridolum@ozemail.com.au or pserov@iprimus.com.au

Table of Contents

Executive Summary

Duralie Coal Pty Ltd commenced the establishment of an open cut coalmine in 2002, adjacent to the Mammy Johnsons River, and upstream from the township of Stroud Road. As part of Duralie Coal's environmental monitoring program, Invertebrate Identification Australasia was commissioned to conduct biological monitoring of the streams near the mine including portions of the Mammy Johnsons and Karuah Rivers. This report is the 14th environmental assessment of the aquatic ecosystems associated with the Duralie Mine and is the 13th since the mine became operational.

A total of eight sites (including two new additional sites) were sampled on the 16th September 2008 for aquatic macroinvertebrates and water quality using rapid assessment techniques. Two new sites have been added to this and future surveys in order to monitor the ecosystems within Coal Shaft Creek and a small tributary stream that enters the Mammy Johnsons River between Sites M1 and M2. A total of 70 species were recorded representing 49 families. In addition, five biological indices were calculated to determine the condition of the streams in and adjacent to the study area.

Over the last six months, 17 significant rainfall events have occurred. These events have resulted in increased river flows leading to a change in the community composition from a low flow dependent community to one that prefers high flow conditions resulting in higher observed values for the environmental indices compared with those of the previous September survey. Available data indicates that all sites have very healthy macroinvertebrate communities due to the higher river flows and increased water quality conditions.

The results of the current survey indicate that there has been a substantial improvement in ecosystem condition compared to previous years and show no evidence of any adverse effects on the aquatic macroinvertebrate community. Therefore, there are no adverse effects on the aquatic ecosystem as a result of the mine's operations.

The environmental monitoring of the water quality and the aquatic ecosystem within the Diversion Drain Dam (Site DDD2) above the mine water storage dam (west of the mining operation) is continuing. This monitoring program was established to assess any impacts of potential saline run-off from the irrigation of saline mine water onto the ridges and slopes surrounding the mining area on water quality and/or the local macroinvertebrate community. Results from the 11th survey of the dam indicate that the electrical conductivity is still very low, and there is a diverse aquatic community established and continuing to develop consisting increasingly of disturbance sensitive taxa. Macrophytes are well established and add to the diversity of habitats present in the dam and will, over time, increase the diversity and community complexity.

Introduction

Duralie Coal Pty Ltd commenced an open cut coalmine operation in 2002, adjacent to the Mammy Johnsons River, upstream of the township of Stroud Road. As part of Duralie Coal's environmental monitoring program, Invertebrate Identification Australasia was commissioned to conduct biological monitoring of the streams near the mine. Eight sites (two new) were sampled on the 16th September 2008 for aquatic macroinvertebrates and water quality using rapid assessment techniques. This is the 14th environmental assessment of the aquatic ecosystems of Mammy Johnsons River and the Karuah River above the junction with Mammy Johnsons River. Two new sites have been added in order to monitor the ecosystems within Coal Shaft Creek and a small tributary stream that enters Mammy Johnsons River between Sites M1 and M2.

This report also includes the 11th water quality and aquatic ecosystem survey of the Mine's Water Diversion Drain Dam No. 2 (Site DDD2). This monitoring program has been established to monitor for any changes to the diversion drain dam water quality and/or the local macroinvertebrate community as a result of potential saline run-off from irrigation onto the ridges and slopes surrounding the mining area.

Aquatic macroinvertebrate communities have been used as a reliable and cost effective environmental indicator of stream condition for more than 30 years across Australia. These communities have long been recognised as being ideally suited for the assessment of river health and condition as they are diverse, occupy every niche within a water body including the riverbed, water column and surface, are one of the major contributors to the processing of energy through a river system and respond directly to physico-chemical changes within the aquatic environment. The composition of this community consists of a range of predators, grazers, shredders and filter feeders and reliably reflects both natural and threatening processes operating within a catchment. The ubiquitous distribution and specific habitat requirements of each component at both the species and community levels, enables the use of their diversity as an indicator of ecological disturbance within a catchment.

Study Area and Sampling Sites

General Description

The Duralie Coal Mine is situated approximately 10 km northeast of the township of Stroud Road on the western side of Mammy Johnsons River on the New South Wales lower North Coast. The Mammy Johnsons River is a tributary of the Karuah River. The Mammy Johnsons and the Karuah Rivers are the two major watercourses to be potentially affected by operations from the Duralie mine.

Eight sites were sampled on the 16th September 2008 for aquatic macroinvertebrates and water quality using rapid assessment techniques (Figure 1, Table 1). Four sites are located along the Mammy Johnsons and Karuah Rivers, with two sites located above the mine (Sites M1 and M2) and two below the mining area (Sites M3 and M4). One site is located on the Karuah River (Site M5) at Stroud Road, upstream of the junction with Mammy Johnsons River. Site M3 was relocated approximately 50m downstream from the original site in order to incorporate a larger, stony riffle section, a habitat that was previously absent from Site M3. One site is located on the Diversion Drain Dam 2 (Site DDD2). For the current and future surveys two new sites have been added; these are the bottom pool of Coal Shaft Creek (Site SW2) and a small tributary of the Mammy Johnsons River (Site SW7), which has its confluence with the river between Sites M1 and M2.

Mammy Johnsons River

For a more complete description of Sites M1-M4 see Survey 13. During the current survey the pools and riffles were quite turbid due to several rainfall events prior to the current survey; in

addition no green filamentous algae was found at any of the sites. There appears to be little silt deposition, as there has been extensive scouring due to a number of recent high water events.

Site code	Site name and description	Grid Reference
M1	Mammy Johnsons River (MJR) above mine area, near gauging station.	400607N, 6430921E
M2	MJR - downstream of Site M1, above the mine area	401262N, 6427007E
M3	MJR - downstream of Site M2 and below mine area	401463N, 5425640E
M4	MJR - downstream of Site M3 below mine area, 30m W. of Johnsons Ck Rd	400388N, 6422495E
M5	Karuah River at Stroud Road on ***Stroud Rd/Dungog Road	401462N, 6425639E
DDD2	Diversion Drain Dam 2 above Mine Water Storage Dam in mining area.	387750N, 6424400E
SW2	Coal Shaft Creek at last pool before it enters the MJR above Site M3.	400762N, 6425309E
SW7	Small tributary stream that joins with MJR between Sites M1 & M2.	399832N, 6429906E

Table 1. Sampling sites.

Karuah River

For a more complete description of Site M5 see Survey 13. The water appeared turbid consistent with the Mammy Johnsons River for the current survey. No green filamentous algae was observed in the Karuah River, and the cobbles and boulders in the riffles had been obviously scoured clean of any algae, silt or detritus.

Diversion Drain Dam No.2

For a more complete description of Site DDD2 see Survey 13. The development of the foreshore riparian zone and macrophyte beds are continuing along with the natural colonisation of the near shore zone by sedges and floating macrophytes. There had been limited recent irrigation of the hillsides (personal communication John Trotter) due to the high rainfall levels and this has resulted in very low conductivity levels within the dam.

New Survey Sites (Sites SW2 and SW7)

Two new sites have been added to this and future surveys in order to monitor the ecosystems within Coal Shaft Creek (Site SW2) and an unnamed small tributary stream (Site SW7 – sampled within the Zulumovski property) that enters Mammy Johnsons River between Sites M1 and M2 (see Figure 1). Both survey streams are tributaries of the Mammy Johnsons River.

The purpose of monitoring the northern unnamed stream is to provide background data in light of a pending Part 3A (Environmental Planning & Assessment Act, 1979) application to extend existing approved mining operations to the north. The sampling location is downstream of proposed areas to be impacted by mining. The purpose of monitoring the lower Coal Shaft Creek sampling is to assess this area prior to a potential release of stored water from the mine.

Coal Shaft Creek (Site SW2) is a small ephemeral stream, which, within the Mining Lease, is partially diverted about the mining operation and discharges into the Mammy Johnsons River approximately 50-100m upstream of survey Site M3. The diverted section of stream has limited vegetation but has a dense native riparian zone in the lower reaches adjoining Mammy Johnsons River. This dense vegetation provides substantial shading and terrestrial habitat for terrestrial and aquatic invertebrates. The stream, below the diversion, contains permanent water in large pools which are possibly fed by groundwater seepage. The stream in the lower

reaches does respond quickly to rainfall events and also continues to have a low flow for extended periods after rain. The substrate within the lower pools is bedrock lined with deep fine sediments and detrital material. The sediments are anoxic at depth due to the build up of allochthonous (leaves and twigs). The pool at the time of the survey was quite turbid due to recent rainfall events.

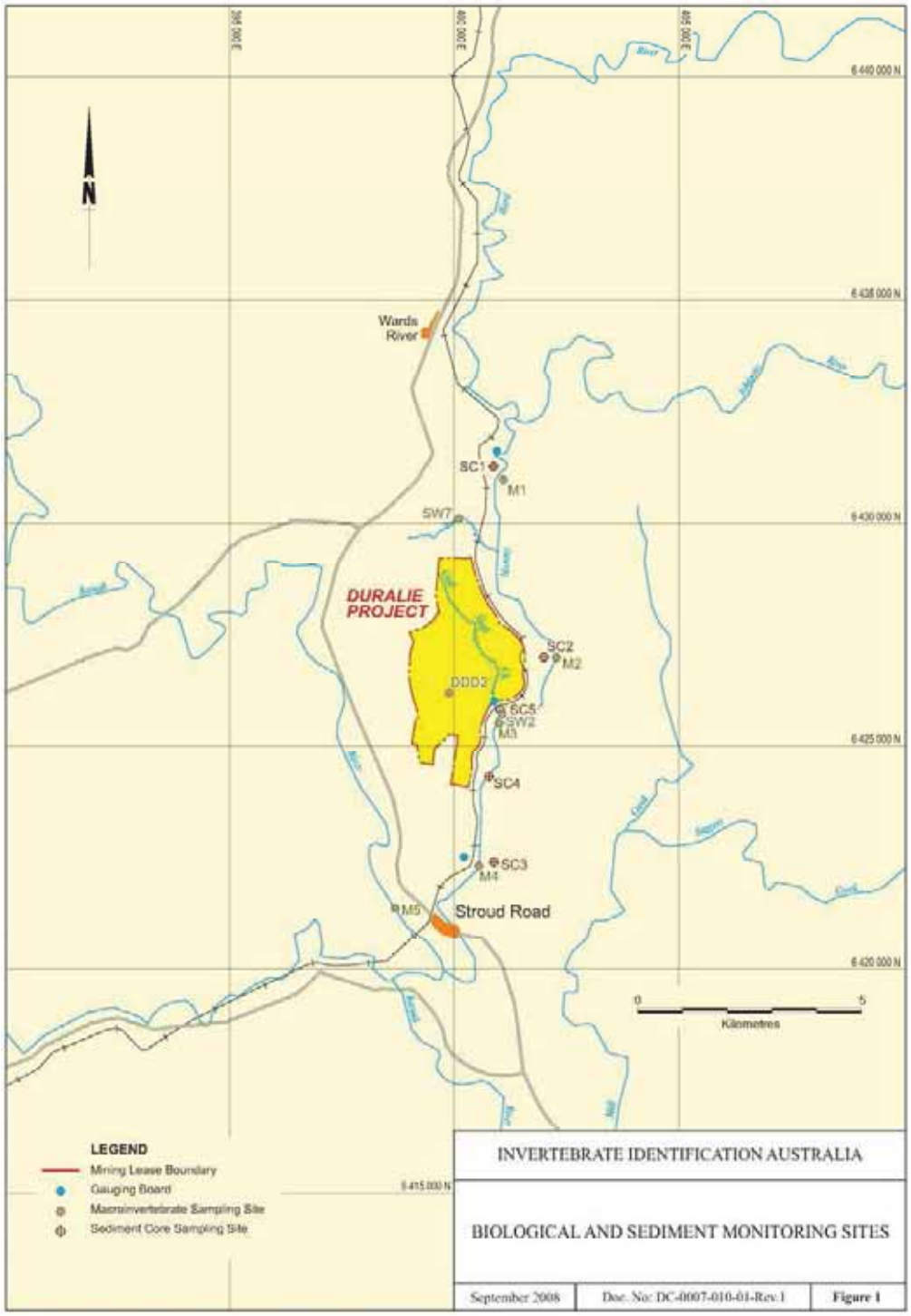


Figure 1. Map showing the locations of Sites M1 to M5 and Sites SW2 and SW7.

Site SW7 is a small drainage line/stream composed of a steep upper section and chain of ponds above and within the floodplain. It drains into the Mammy Johnsons River between survey Sites M1 and M2. The upper half of the stream is an ephemeral steep water course that

only flows during rainfall while the lower half appears to be predominantly groundwater fed with some permanent pools. Several springs/seepage zones were evident during this initial survey. The sample site is located in one of the deeper, permanent pools. The stream is within a grazing property that is mainly cleared except for native vegetation that has been retained within a narrow riparian zone. The substrate is sand and clay in the upper section with the lower chain of ponds consisting of a sand substrate with a layer of coarse allochthonous matter i.e. leaves from the surrounding paperbark trees. The stream was relatively clear although the water was quite tea coloured from the leaching of tannins from the surrounding riparian vegetation.

September Site Images

The following twelve photographs (Photos 1-11, 13) are of Sites M1 - M5 and DDD2 taken during the current survey and illustrate the prevailing conditions of the two rivers and dam as well as the extent of the riparian zone observed at each site. Photos 12 and 14 are of Site DDD2 taken during the September 2007 survey (Survey 12) to show the different states of development of the macrophyte community within the is site. Note the water levels are as high or higher in the river when compared to the previous survey and consistent between surveys in the case of the dam.

1.  **2**. 

Site M1, viewed downstream (1); viewed upstream (2) (September, 2008).

3.  **4**. 

Site M2, viewed downstream (3); viewed upstream (4) (September, 2008).

5.  **6**. 

Site M3, viewed downstream (5); viewed upstream (6) (September, 2008).

7.  8. 

Site M4, viewed downstream (7); viewed upstream (8) (September, 2008).

9.  10. 

Site M5, viewed downstream (9); viewed upstream (10) (September, 2008).

11.  12. 

Site DDD2, (11) viewed to the east, taken September, 2008; (12) taken September, 2007.

13.  14. 

Site DDD2, (13) viewed to the east, taken September, 2008; (14) taken September, 2007.

Methodology

Macroinvertebrate Sampling

Each site was sampled using two standardised methods outlined in the River Bioassessment Manual (Anonymous, 1994) and the NSW AUSRIVAS (Australian River Assessment

System) sampling and processing manual (Turak et al., 2004). For a more detailed outline of the methods used see Survey 13.

Identification

All samples were sorted under a stereomicroscope and stored in 70% alcohol. Specimens were identified to genus where possible, (except for Chironomidae, Oligochaeta and Platyhelminthes which are identified to family/subfamily), using a combination of current taxonomic works and keys and comparison with voucher specimens in the reference collections of Invertebrate Identification. Identification references included Williams (1981) and the taxonomic identification series produced by the Murray Darling Freshwater Research Centre.

Data analysis

SIGNAL. . SIGNAL is an acronym for 'Stream Invertebrate Grade Number - Average Level', and is a biotic index of pollution tolerance or sensitivity of stream invertebrates and was originally developed for use in the lower Blue Mountains (Chessman, 1995). Chessman *et al*., (1997) released a modified version; SIGNAL HU97, developed for the Hunter Valley, which is to the south, and its aquatic communities are more comparable to those found within the study area. See Table 2 for a breakdown of the SIGNAL values and water quality status.

SIGNAL -HU97B	Probable water quality status
>7	Excellent
6-7	Good
5-6	Fair
4-5	Poor
<4	Very poor

Table 2. Interpretation of water quality status using SIGNAL -HU97B scores (Chessman *et al*., 1997).

EPT Richness. The EPT (Ephemeroptera, Plecoptera and Trichoptera) score is based on the observation that the majority of these taxa are particularly pollution sensitive (Lenat, 1988, see Table 3). For further details sees Survey 13.

EPT genus richness	Probable condition of macroinvertebrate community
>6	Healthy
5-6	Slightly impaired
3-4	Moderately impaired
1-2	Severely impaired
0	Grossly impaired

Table 3. Interpretation of the EPT genus richness scores (Besley *et al*., 1996; Besley & Growns, 1998).

Number of Families. All macroinvertebrate families are separated and counted. The number of families present generally decreases with decreasing water quality and is used as a comparative measure of community change over time.

Functional Feeding Groups. Ratio of shredder taxa to total number of taxa. As with Numbers of Families the higher the ratio of shredders the better the water quality and is used as a comparative measure of community change over time.

Silt Tolerant Species

The Environmental Management Plan of the Duralie Mine states that the aquatic fauna assemblages need to be assessed for silt tolerant fauna, as the presence of such fauna can provide an indication of the degree of heavy sediment pollution. The main indicator families are the Dugesiidae, Lymnaeidae, Ancylidae, Planorbidae, Psephenidae, Chironomidae, Caenidae, Pyralidae and Ecnomidae.

The silt tolerant taxa values are best examined against the total number of taxa sampled from each site i.e. the silt tolerant ratio, as the variation of values is significantly reduced compared with examining the number of taxa alone. This index is used as a comparative measure of community changes over time.

Physico-Chemical Data

Physical and chemical parameters were measured at each site *in situ* and included temperature, dissolved oxygen, conductivity and pH. The results are presented in Table 5.

Results

Macroinvertebrate Data

The results are presented in Table 4. A total of 70 genera representing 49 families were recorded during the current survey. Sites M5, M1 and M4 recorded the highest diversity with 43, 37 and 35 genera, respectively. The values are significantly higher across all sites except for Site DDD2 which recorded the lowest diversity of all sites. However, it was slightly lower but comparable with previous surveys. Site SW2 recorded the lowest overall diversity amongst the stream and river sites with 28 genera. These results are within the range of variation observed from Survey's 1-13, except for Site M5, which recorded its highest value with 43 genera. The only other time over 40 genera has been recorded for Site M5 was September 2004 (see Survey 6) where 42 genera were observed.

Survey 14	M1	M2	M3	M4	M5	DDD2	SW2	SW7
SIGNAL - HU97B	6.3	6.1	5.9	5.9	5.9	4.0	5.1	5.6
No of Families	30	24	22	28	30	20	23	23
No of Genera	37	33	30	35	43	23	28	29
EPT	18	13	13	12	15	1	9	7
EPT ratio	0.49	0.39	0.43	0.34	0.35	0.04	0.32	0.24
Shredder Ratio	0.70	0.55	0.57	0.51	0.53	0.22	0.39	0.45
Silt Tolerant Taxa	6	3	4	4	6	2	5	4
Silt Tolerant Taxa Ratio	0.16	0.09	0.13	0.11	0.14	0.09	0.18	0.14

Table 4. Summary Table of numbers of genera, families and indices. A full list of the taxa found is presented in Appendix 1.

The variation in the number of genera observed at each site since September, 2002 is presented in Table 5 and Figure 2. The biodiversity values (= number of observed genera) recorded for the current survey shows an overall increase for all sites, except Site DDD2, compared with the February, 2008 survey. The normal pattern of diversity recorded along the river commences with Site M1 having a high diversity followed by a drop down to Sites M2 and M3 followed by a steady increase downstream to Sites M4 and M5. This pattern is once again demonstrated in this survey (Table 5) although the values for each river site are

generally higher than many previous surveys. These values have remained relatively consistent since Survey 3 in 2003. The two new sites recorded comparatively low but similar biodiversity counts with 28 genera observed at SW2, and 29 at SW7.

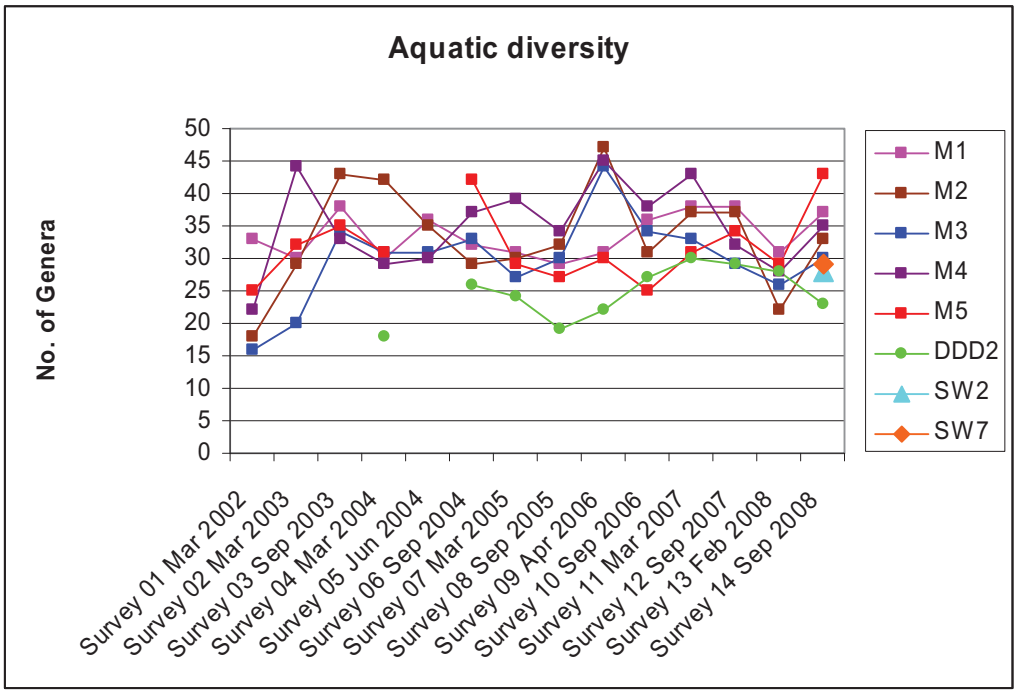


Figure 2. The observed variation in the number of genera recorded for all sites since September, 2002.

No of Genera	M1	M2	M3	M4	M5	DDD2	SW2	SW7
Survey 01 03/09/2002	33	18	16	22	25			
Survey 02 28/03/2003	30	29	20	44	32			
Survey 03 25/09/2003	38	43	34	33	35			
Survey 04 19/03/2004	30	42	31	29	31	18		
Survey 05 03/06/2004	36	35	31	30				
Survey 06 21/09/2004	32	29	33	37	42	26		
Survey 07 10/03/2005	31	30	27	39	29	24		
Survey 08 15/09/2005	29	32	30	34	27	19		
Survey 09 07/04/2006	31	47	44	45	30	22		
Survey 10 19/09/2006	36	31	34	38	25	27		
Survey 11 07/03/2007	38	37	33	43	31	30		
Survey 12 12/09/2007	38	37	29	32	34	29		
Survey 13 29/02/2008	31	22	26	28	29	28		
Survey 14 16/09/2008	37	33	30	35	43	23	28	29

Table 5. The observed variation in the number of genera and families recorded for all sites since September 2002.

The condition indice (SIGNAL) values differed from the biodiversity values by showing a small decrease in values at all sites relative to the previous survey, except for Site M1, which recorded a small increase. However, these values are still higher than most of the earlier values and there is still a trend for an overall increase in stream ecosystem condition. Figure 3 illustrates a gradual increase in condition of the river by the graphed trend lines for Site M3 and M4. The SIGNAL values for this survey ranged from 5.9 to 6.3 for the river Sites M4 and

M1, respectively. The SIGNAL value for Site M1 of 6.3 is the highest SIGNAL value recorded from all surveys. Sites M3-M5 had identical values of 5.9. The lowest overall value observed was 4.0 for Site DDD2, which is the second lowest value recorded for this site since sampling began. A significant feature of these results is the consistently moderate values recorded along the surveyed length of the Mammy Johnsons River and its comparative similarity to the Karuah River site. These values indicate that Sites M1 to M5, SW2 and SW7 were in fair to good condition while Site DDD2 is in very poor condition. Even though the SIGNAL values appear to suggest a lower condition rating compared with the other indices, the high species diversity and relatively number of EPT taxa compared with the silt tolerant taxa indicates that all the sites, with the exception of Site DDD2, are in good to excellent condition.

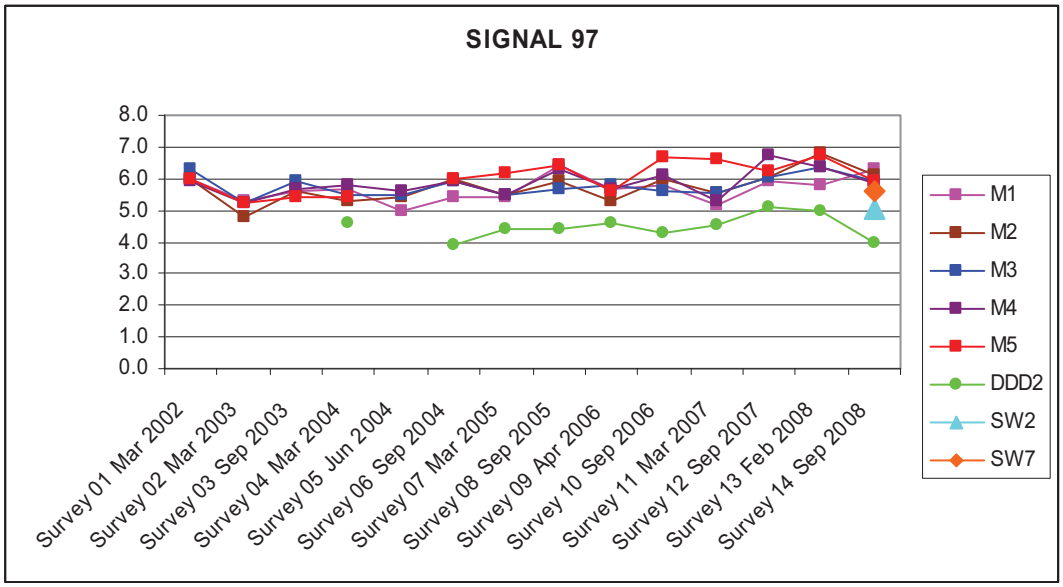


Figure 3. The observed variation in the SIGNAL-97 values for all sites since September 2002.

The variation in SIGNAL values along the river and the diversion drain dam since September, 2002 is presented in Table 6. Each survey, so far, has shown the same pattern with little overall variation along the river and a similar pattern over time at all sites. The current survey results exhibit moderate values for all sites with the exception of Site M1 (when compared with previous surveys). However, they are most similar to the previous spring surveys from 2007. This signifies that the community composition has remained very stable over time. The variations of SIGNAL values and low silt tolerant taxa values along the Mammy Johnsons River catchment reflects the slightly different geomorphology and flow rates although this year the values were quite similar between the two river systems. The overall results of the current survey show a comparable river condition compared with the September 2007 survey (Survey 12) but a decrease from the February 2008 survey. The SIGNAL index is also calculated for the dam site (Site DDD2), although it is not really appropriate for this particular site (a standing water system) as it was originally developed for flowing river systems. Nonetheless, it is still useful in mapping the changes in the community structure of the dam over time. The results indicate a significant drop in the level of condition compared to those observed in all previous surveys, except for the survey in September 2004. Although there has been a drop in condition in most river sites the values are still within the normal range and there has also been an increase in biodiversity. However the results from Site DDD2 show a drop in both biodiversity and condition that may be indicative of a change in water quality that will need to be further monitored to determine if this is a sampling anomoly or an actual decline in ecosystem condition.

The EPT index values (see Figure 4) demonstrate a continued significant increase in numbers of EPT taxa across all sites compared with all surveys since March 2007. This trend is different from previous annual patterns in that instead of showing an increase/decrease in spring/autumn numbers there is a continuous increase in taxa. This pattern is similar to the March 2004-March 2005 surveys. These results suggest that the pronounced increase in values has occurred as a result of aseasonal climatic trends.

SIGNAL - HU97B	M1	M2	M3	M4	M5	DDD2	SW2	SW7
Survey 01 03/09/2002	6.0	6.0	6.3	5.9	6.0			
Survey 02 28/03/2003	5.3	4.8	5.2	5.2	5.2			
Survey 03 25/09/2003	5.6	5.6	5.9	5.7	5.4			
Survey 04 19/03/2004	5.7	5.3	5.5	5.8	5.4	4.6		
Survey 05 03/06/2004	5.0	5.4	5.5	5.6				
Survey 06 21/09/2004	5.4	6.0	5.9	5.9	6.0	3.9		
Survey 07 10/03/2005	5.4	5.5	5.5	5.5	6.2	4.4		
Survey 08 15/09/2005	6.4	5.9	5.7	6.3	6.4	4.4		
Survey 09 07/04/2006	5.7	5.3	5.8	5.7	5.6	4.6		
Survey 10 19/09/2006	5.8	6.0	5.6	6.1	6.7	4.3		
Survey 11 07/03/2007	5.2	5.5	5.5	5.3	6.6	4.5		
Survey 12 12/09/2007	5.9	6.1	6.0	6.7	6.2	5.1		
Survey 13 29/02/2008	5.8	6.8	6.4	6.4	6.7	5.0		
Survey 14 16/09/2008	6.3	6.1	5.9	5.9	5.9	4.0	5.1	5.6

Table 6. The observed variation in the SIGNAL-HU97 values for all sites since September, 2002.

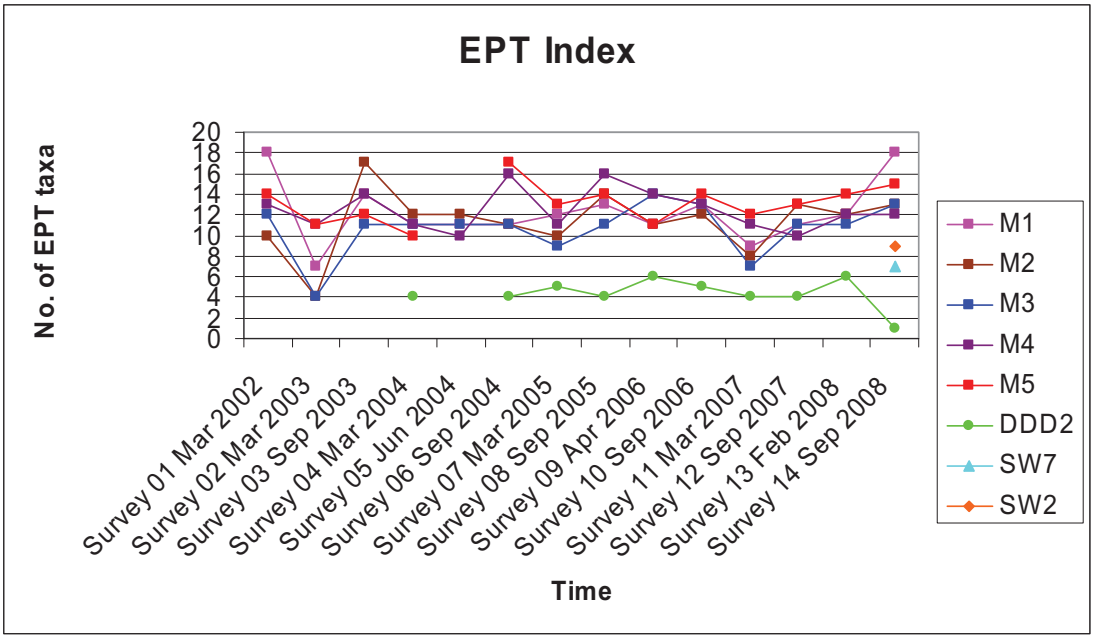


Figure 4. The observed variation in the EPT values for all sites since September 2002.

The EPT values are best examined against the total number of taxa sampled i.e. the EPT ratio, as the variation of values is usually significantly reduced. Figure 5 illustrates the EPT ratio for all the sites since 2002. The ratio recorded a significant increase in values for Sites M1 and M3 compared with the three previous surveys but a decrease for all other sites. Although the

number of EPT taxa has risen for each site, those that recorded a drop in the EPT ratio indicate there had been a higher significant increase in the non EPT taxa. The EPT ratio values ranged from 0.34 to 0.49 for the river sites with Site M4 recording the lowest and Site M1 the highest value. Therefore, Site M1 had the highest proportion of EPT taxa, while Site M4 had the lowest. The EPT ratio values in the past clearly separated the three major habitats i.e. the Karuah River (Site M5 – the higher flow system) recording a relative high value, the Mammy Johnsons River (lower flow, finer sediment and coarser substrate system) sites have very similar values and Site DDD2 (the non-flowing system) recorded the lowest value. However, the recent high flow events have reversed the boundaries between Site M5 and the rest of the Mammy Johnsons River sites with Site M5 sitting below the Mammy Johnson sites. The significant increasing in number of EPT taxa within the Mammy Johnsons River has made the distinction between the rivers no longer clear cut The differences between the two river systems are most noticeable during periods of low flow when average flow velocities are higher in the Karuah River with larger substrate types.

The other off river sites recorded much lower values than the river sites with Site SW2 recording the highest values for both EPT taxa and EPT ratio, followed by Sites SW7 and DDD2 with the lowest values. Site DDD2 also recorded the lowest value compared with all previous surveys.

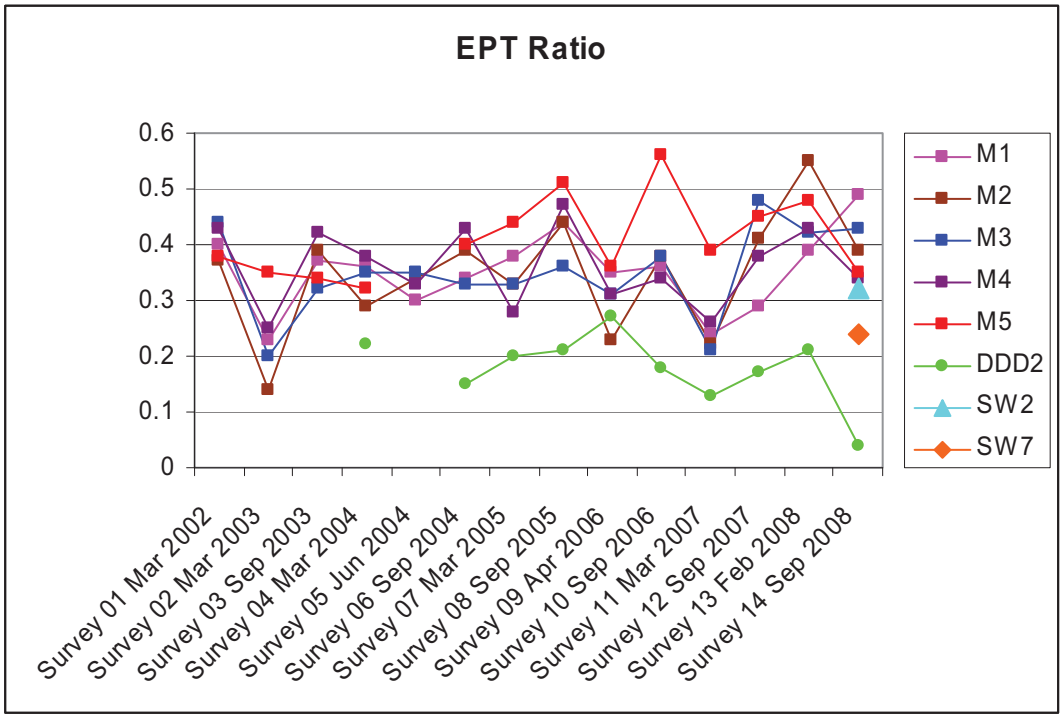


Figure 5. The observed variation in the EPT ratio values for all sites since September 2002.

The shredder ratio values are illustrated in Figure 6 and are similar to the EPT Ratio index with a significant decrease in values at all sites, except for Site M1that recorded its highest value yet. All sites, except Site M1, were lower than the previous survey and ranged from 0.51 for Site M4 to 0.70 for Site M1. Although most values were lower than the last survey they were still higher than most previous surveys.

The most significant change in the community found during this survey was the apparent increase in the number of grazer species (including the EPT group of taxa) compared with a varied response in numbers of silt tolerant taxa (see below). The common and consistently recorded taxa belong to the following groups: The freshwater Shrimp *Paratya australiensis*, the coleopteran family Elmidae (beetles); the dipteran family Chironominae and

Orthocladinae (midges); the ephemeropteran families Leptophlebiidae and Baetidae (mayflies), the plecopteran family Grypopterygidae (stone flies), the trichopteran families Hydropsychidae, Philopotamidae (caddis flies) and the Molluscs Sphaeridae (*Pisidium*) and Hydrobiidae (*Posticobia brazieri*).

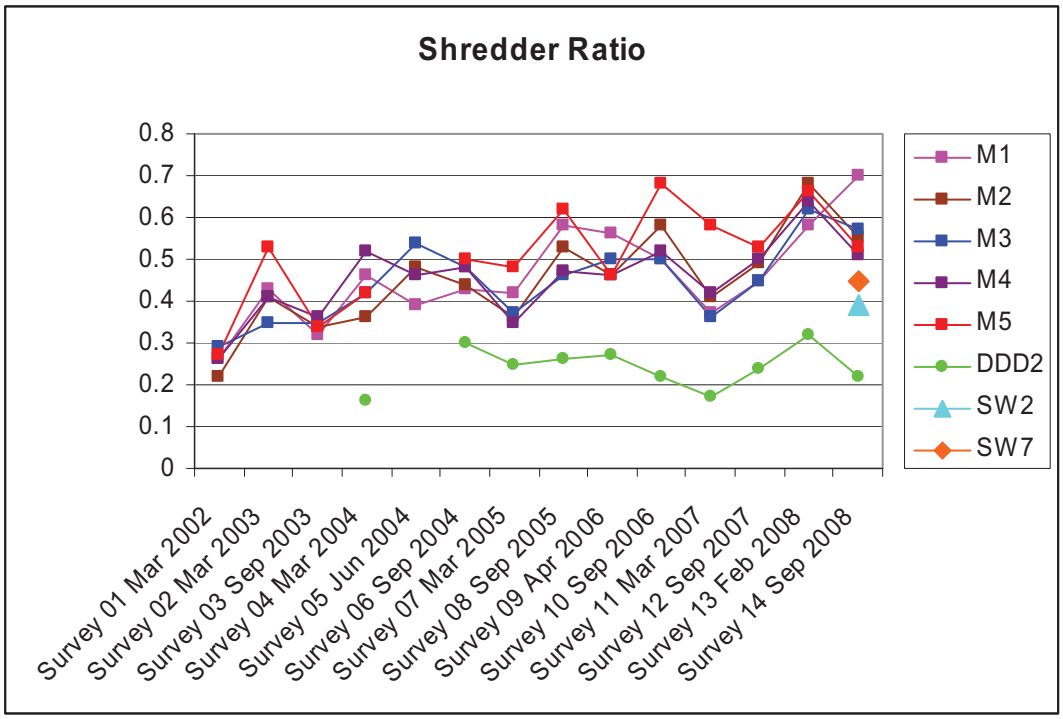


Figure 6. The observed variation in the Shredder ratio values for all sites since September 2002.

The increase in the presence of dipterans at all sites including the subfamilies of the Chironomidae (particularly the Orthocladinae) are indicative of a change to the environment leading to an increase in numbers. The chironomid subfamilies Chironominae and Orthocladinae formed the dominant component of all the Chironomidae recorded. The Orthocladinae is associated with rivers in good to excellent conditions with minimal silt build up and high water quality. The Chironominae, which were recorded at all sites, appear to be increasing in numbers substantially compared with previous surveys indicating a change to more stable, flow conditions in general. The re-occurrence of the Simulidae in the Mammy Johnsons River is also indicative of more stable flow conditions.

Some notably sensitive taxa were found in most sites, are associated with pristine or near pristine systems and include: the dipteran subfamily Orthocladinae, the plecopteran *Illiesoperla brevicauda* (Grypopterygidae), the dragonfly, Hemigomphus, the ephemeropteran family Leptophlebiidae, the trichopteran families Leptoceridae, Philopotamidae, Calamoceratidae, Helicopsychidae, the hydrobiid *Posticobia brazieri* (snail) and the freshwater shrimp *Australatya striolata*. There were larger numbers of the plecopteran family Grypopterygidae found at most sites, which is consistent with the previous survey. The dragonfly *Hemigomphus* (Gomphidae) is characteristic of gravel and sandy bed streams with high water quality and was found only at Sites M3 and M5. A notable discovery in the Mammy Johnsons River (Site M1) was the first record of a relatively rare mayfly from the Family Ameletopsidae (*Mirawara* sp). These are very large mayfly nymphs that can get up to 30 mm long. They occur in stony streams with high water quality and apparently burrow into the cobble substrate during the day and emerge at the surface at night to feed (Campbell, 1980) and this is considered the probable reason why they have not been collected before. Although no SIGNAL rating is available for these nymphs they occur in streams with high

water quality and are a good indicator of high stream condition. The only previous record of this family is from the Karuah River in the previous survey.

There were also some noticeable absences or low numbers in the community composition, particularly in the upper reaches of the Mammy Johnsons River. These included many of the common larger, highly mobile and predominantly predatory insects such as the water beetles (Dystiscidae), dragonflies and damselflies (Odonata) and many of the common true bugs (Hemiptera) such as the Notonectidae and the larger Corixidae. A combination of an absence of pool macrophytes and the low light conditions produced by the closed canopy as well as the high flow levels may have contributed to the absences. These groups are visual predators that prefer still open water bodies as habitat. No dragonflies were recorded from three sites (Sites M1, M4 and SW2), while *Ischnura heterosticta* (Coenagrionidae) was only recorded at two sites (Sites M2 and DDD2), and *Hemigomphus* (Gomphidae) from two sites (Sites M3 and M5).

The almost completely native species composition of the aquatic macroinvertebrate community of both river systems is largely attributed to the undisturbed nature of each river system, particular the Mammy Johnsons River and the heavily forested upper sections and dense riparian zone, which often forms a closed canopy, e.g. Site M3 (see Photos 5 and 6). A noticeable absence at all river sites was the introduced snail, *Haitia acuta*. This appears to be a consistent trend from the previous survey where it was absent from all the river sites prior to 2007.

The majority of common insect taxa found at all sites are those that do not fly far or high as adults and require a natural riparian zone close to the river to complete their life cycles. The larvae also require good water quality and a constant supply of high quality allochthonous material to feed on. The insect taxa that are absent are the highly mobile (wide dispersers) predators that hunt by sight and are commonly found in more open water bodies such as Site DDD2. Therefore, the intact natural structure of the river and the riparian zone is contributing directly to the high biodiversity and overall community structure.

A notable feature of the current survey is the increase in the numbers of the EPT/shredder/grazer functional feeding group within the invertebrate community. The major components of this feeding group include: the coleopteran family Elmidae, the Ephemeroptera, Plecoptera, Trichoptera and Gastropoda. The presence of this guild is significant, as they normally comprise a large proportion of healthy aquatic communities. The high consistent number of EPT and Shredder taxa, particularly the trichopteran and ephemeropteran families Baetidae and Leptophlebiidae, indicates that most sites have very healthy environmental conditions. However, the previous low flow conditions do appear to have had an impact on the number of taxa present, more consistent flow regimes have probably encouraged their numbers to increase. The river sites recorded between 12 and 18 taxa within these groups whereas Site DDD2 recorded the lowest number with 2 taxa, which even for this non-flowing system is a very low number. Another notable feature of both river systems is the high numbers of Plecoptera, represented by the species *Illiesoperla brevicauda*. This plecopteran was found in high numbers at most sites, except Site DDD2 and the two new sites. Most of the EPT and shredder taxa register 8 - 10 on the SIGNAL index, as they are highly sensitive to pollution. This indicates that the Mammy Johnsons and Karuah Rivers are both in very good condition.

Silt Tolerant Species

A graph and table are presented below to show the changes in silt tolerant taxa along the catchment and over time (see Figure 7, Table 7). A large decrease in silt tolerant taxa was observed for Sites M1 and DDD2, whereas the other sites recorded a similar value or an increase (Site M3). Sites M1 and M5 recorded the highest number (6) of taxa followed by 5 at Site SW2, where as Sites M2 and DDD2 recorded the lowest number of 3 and 2 taxa, respectively. Although these results are variable between the two rivers unlike previous years

they are indicative of the flow conditions that have prevailed at each site i.e. the sites that have the lowest numbers have probably had the highest scouring effect.

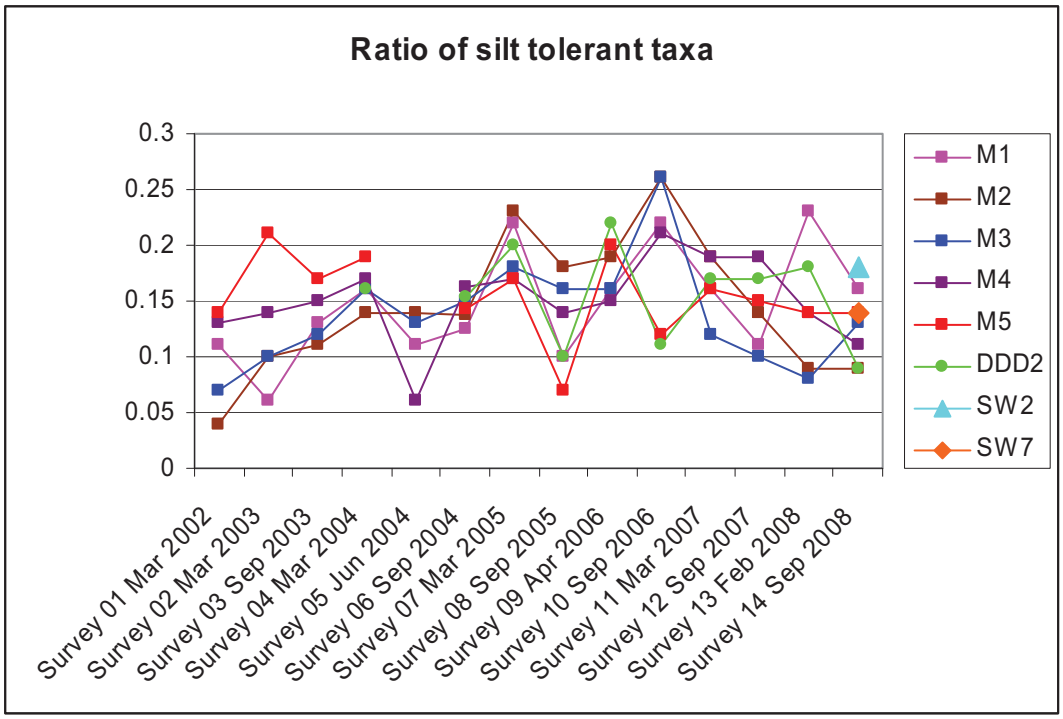


Figure 7. The observed variation in the silt tolerant taxa ratio values since September 2002.

During periods of low flow, particularly during the extended dry period over the previous four years, there has been a gradual build-up of silt in the streams. Reduced flow allows the settling out of fine particles and a reduction in scouring due to low water velocities. This in turn encourages silt tolerant taxa to increase in numbers. However, under normal flow conditions these coastal cobble systems typically have regular high-energy flows that remove most of the silt within the system. This leads to relatively low numbers of silt tolerant taxa in these communities under normal flows.

Ratio Silt tolerant Taxa	M1	M2	M3	M4	M5	DDD2	SW2	SW7
Survey 01 03/09/2002	0.11	0.04	0.07	0.13	0.14			
Survey 02 28/03/2003	0.06	0.1	0.1	0.14	0.21			
Survey 03 25/09/2003	0.13	0.11	0.12	0.15	0.17			
Survey 04 19/03/2004	0.16	0.14	0.16	0.17	0.19	0.16		
Survey 05 03/06/2004	0.11	0.14	0.13	0.06				
Survey 06 21/09/2004	0.125	0.137	0.15	0.162	0.142	0.153		
Survey 07 10/03/2005	0.22	0.23	0.18	0.17	0.17	0.2		
Survey 08 15/09/2005	0.1	0.18	0.16	0.14	0.07	0.1		
Survey 09 07/04/2006	0.16	0.19	0.16	0.15	0.2	0.22		
Survey 10 19/09/2006	0.22	0.26	0.26	0.21	0.12	0.11		
Survey 11 07/03/2007	0.16	0.19	0.12	0.19	0.16	0.17		
Survey 12 12/09/2007	0.11	0.14	0.1	0.19	0.15	0.17		
Survey 13 29/02/2008	0.23	0.09	0.08	0.14	0.14	0.18		
Survey 14 16/09/2008	0.16	0.09	0.13	0.11	0.14	0.09	0.18	0.14

Table 7. The observed variation in the silt tolerant taxa ratio values since September 2002.

Table 7 shows the distribution and diversity of silt tolerant taxa along the catchment since September 2002. The current pattern is similar to that observed in Survey 1 in September 2002, where the number of silt tolerant taxa was high at Site M1, lower at Site M2, and gradually increasing in numbers downstream. All sites show evidence of scour via the impacts of elevated water levels, however, during this survey, the scouring was most prevalent at Site M2 and M4, with the least impacted location was at Site M1.

Site DDD2

This is the tenth survey of this artificial dam and has generally been precluded from the analysis and discussion of the other sites as they represent flowing water systems and constitute a very different aquatic ecosystem. The dam substrate has changed somewhat since the first survey. In the initial survey the substrate consisted mainly of a thick covering of dead or dieing vegetation made up mostly of grass, which had been submerged as the dam was filled. During the second survey all of the submerged terrestrial vegetation had died and decomposed resulting in a thick layer of organic detritus. With the current survey the organic detritus had been removed resulting in the substrate been composed of sand and gravel on the surface with thick clay/mud underneath. Macrophytes are well established in the shallow water with sedges starting at approximately 0.5-1.0 metres from the shore followed by floating macrophytes out to approximately 10 metres. This density of variety of different macrophyte species add to the number and complexity of habitats available within the ecosystem. The riparian zone now contains grasses growing down to the waters edge and starting to overhang the water. This riparian zone is providing good habitat for frogs and invertebrates. However, the presence of cattle has reduced the extent and cover of the grasses with many of the sedges showing signs of grazing.

As this ecosystem has only recently been formed it still largely contains the early colonising, wide-ranging species. However, a new secondary community is becoming well established and includes representatives of the EPT guide. The community is generally composed of predators such as the coleopteran family Hydrophilidae, the Odonata families Libellulidae (*Nannophlebia*) and Coenagrionidae (*Ischnura heterosticta*), the large hemipteran families such as the Notonectidae and Corixidae and the chironomid midges particularly the subfamily Chironominae. All of these taxa are very tolerant of disturbance and poor water quality, although the water quality of this site has generally been good. There are now also representatives of the EPT shredder guide such as caddis flies (Leptoceridae) and the filter feeder guild including the shrimp, *Paratya australiensis* and the bivalve *Pisidium*. The EPT taxa are present at this site due to the close proximity to the Mammy Johnsons River and a close riparian corridor allowing the dispersal of these taxa to this site. These taxa normally do not disperse far from a riverine environment. Although EPT taxa are generally regarded as disturbance sensitive, the species observed at this site occur over a wide range of habitats and are opportunists that will become established if there is appropriate water quality and food source.

Physico-Chemical Data

All physico-chemical parameters were again remarkably consistent along the length of the study area and all were well above the minimum requirements as set out by the ANZECC (Australian and New Zealand Environment and Conservation Council) and ARMCANZ (Agricultural and Resource Management Council of Australia and New Zealand) guidelines (2000) (see website http://www.mincos.gov.au/publications/national_water_quality_management_strategy). The range and variation of the physico-chemical parameters along the length of the rivers and over time for the Mammy Johnsons River as well as rainfall figures for the Mammy Johnsons River catchment can be seen in Figures 8-13.

Rainfall over the last twelve months has been higher than for the previous period particularly in the first seven months from September 2007 to March 2008 with the following period

recording lower, more sporadic falls. Over the last twelve month period there have been 2 rainfall events that were greater than 50 mm and 11 that ranged between 20-50 mm.

Survey 14	Units	M1	M2	M3	M4	M5	DDD2	SW2	SW7
Temperature	°C	14.2	14.7	14.3	14.3	14.4	19.1	16.1	13.7
Dissolved Oxygen	mg/l	3.8	6.8	6.2	7.0	7.2	3.7	3.7	4.0
Conductivity	MS	197	241	201	202	122	329	575	585
pH	ph units	7.9	7.8	7.6	7.7	7.6	6.9	7.9	7.5

Table 8. Physico-chemical data from each site sampled.

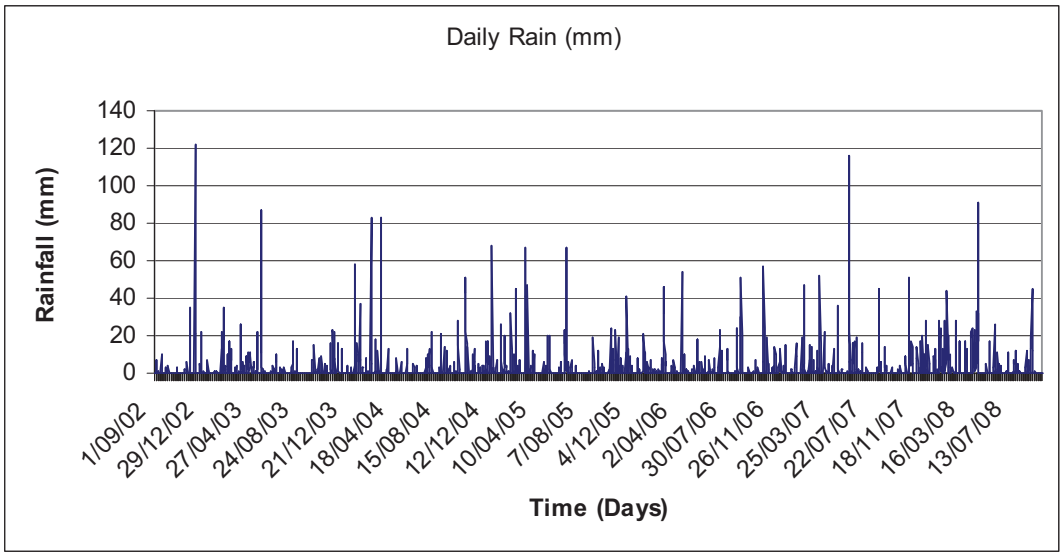


Figure 8. Rainfall values for the Mammy Johnsons River catchment since 2002.

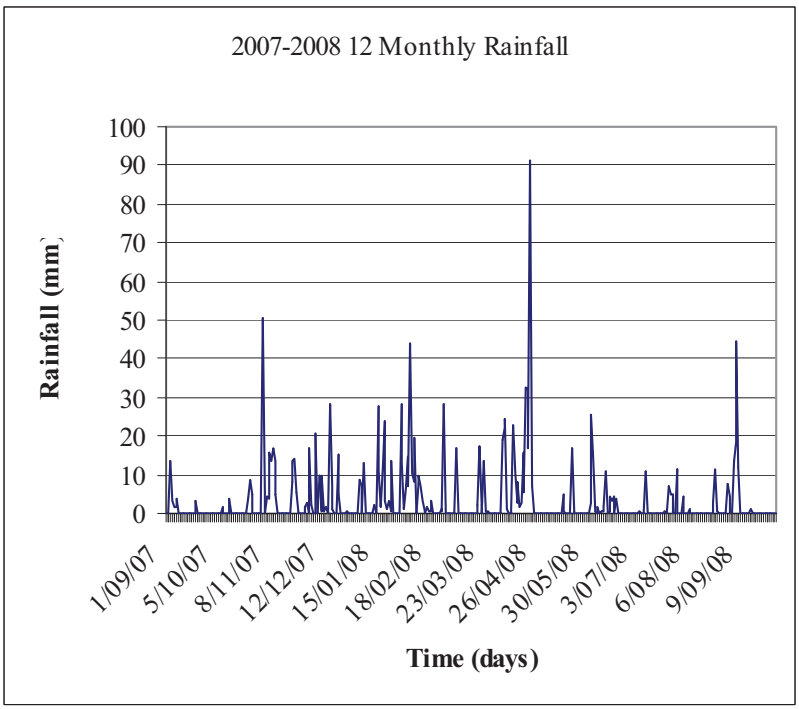


Figure 9. Rainfall values for the Mammy Johnsons River catchment over the last 12 months 2007-08.

During the current survey the temperatures were lower than recorded previously but comparable with the same time last year ranging from 14.2°C at Site M1 to 14.7°C at Site M2. Conductivity was comparable for the river sites with the last few surveys including the Karuah River. The new sites, Sites SW2 and SW7, recorded significantly higher levels that the river sites.

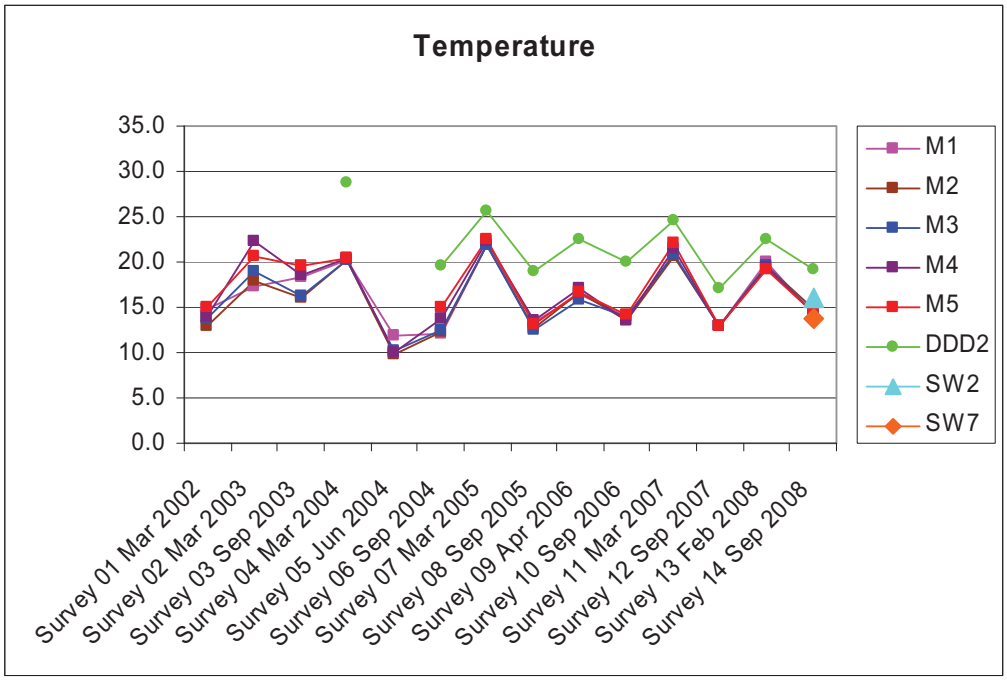


Figure 10. Water temperature values for all sites since September 2002.

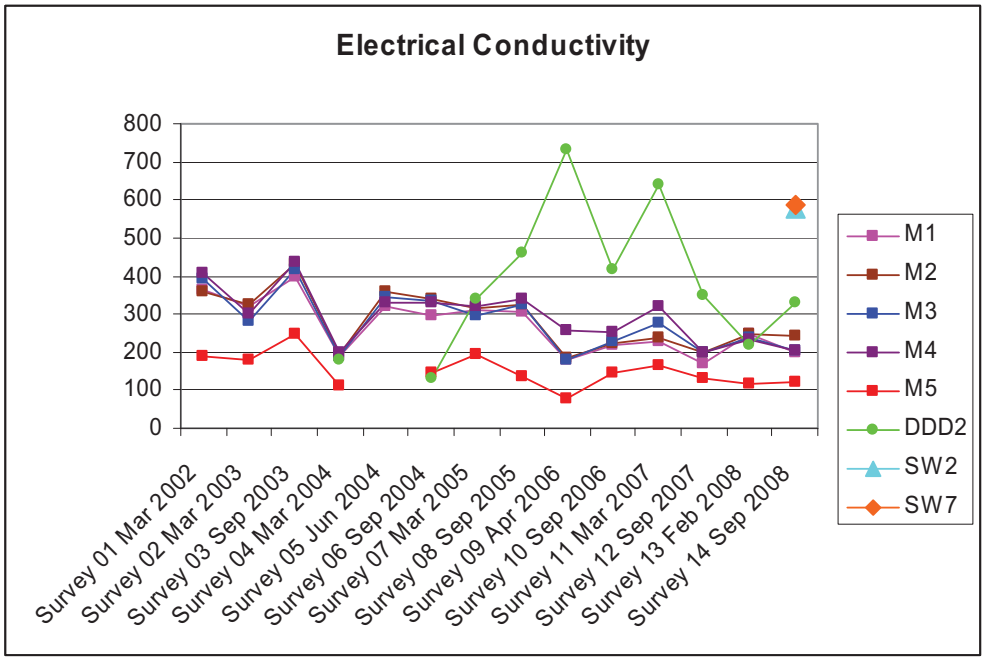


Figure 11. Conductivity values for all sites since September 2002.

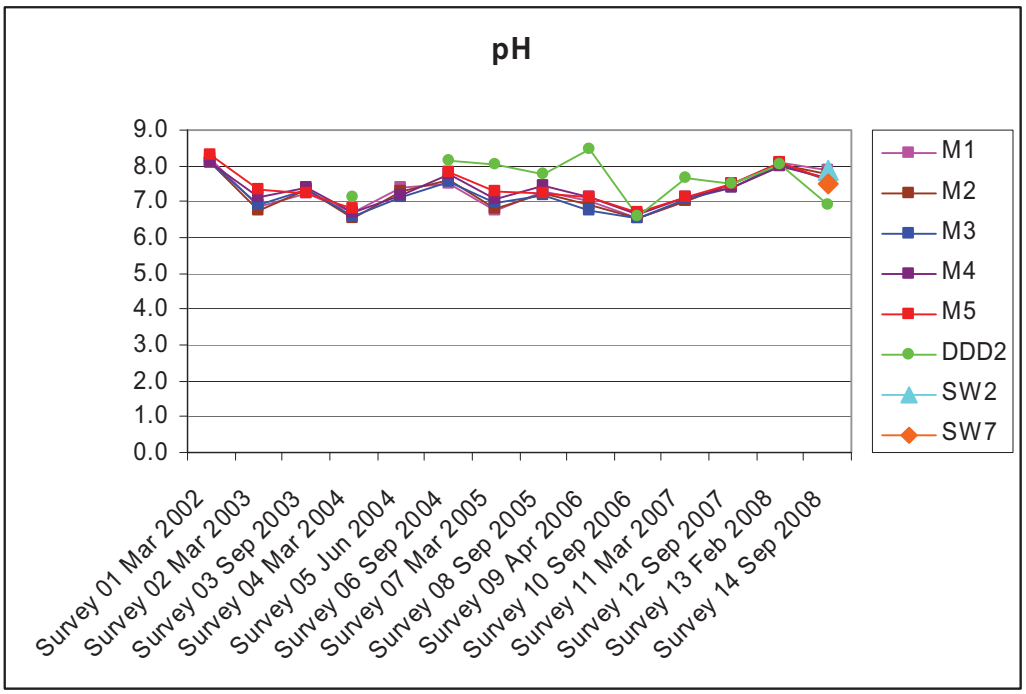


Figure 12. pH values for all sites since September 2002.

pH was again essentially neutral tending towards slightly alkaline conditions but varied little across all sites ranging from 7.6 to 7.9. pH has remained very constant over time varying no more than 1 pH unit throughout the monitoring program.

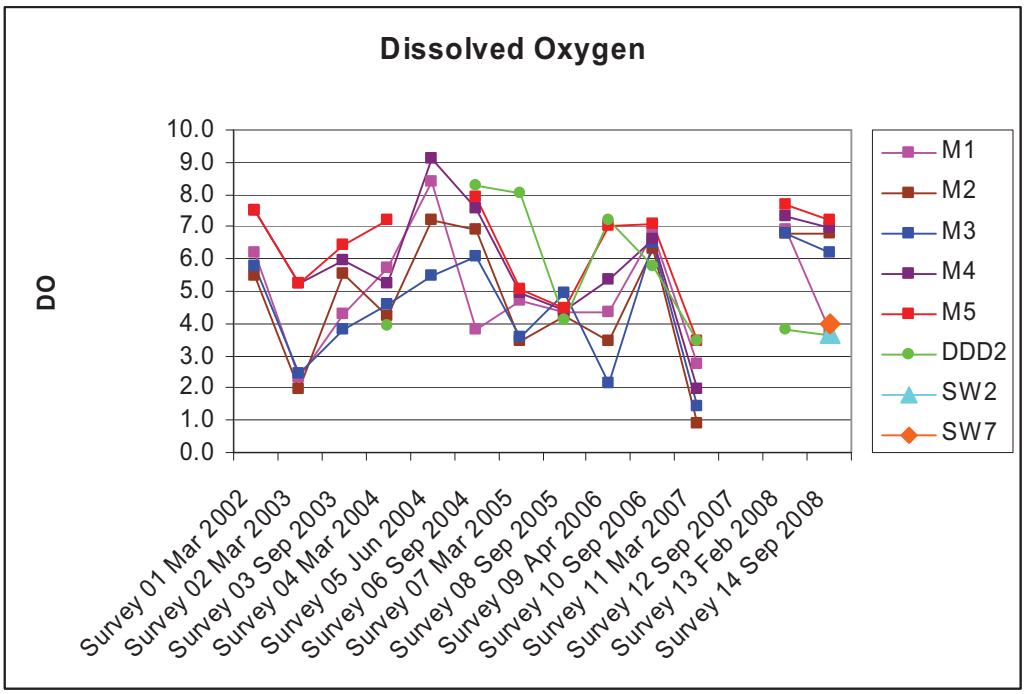


Figure 13. Dissolved Oxygen values for all sites since September 2002.

Dissolved oxygen (DO) followed a continuation of the pattern of the last two autumn surveys with a range of elevated values. The DO values showed a similar variability to the previous years' results. All DO readings were well within the healthy range for aquatic organisms as

set out by the ANZECC guidelines. The lower levels at the upper sites, particularly, Sites M3 and M2 are suggested to be caused by the large accumulation of leaves. Unlike the northern hemisphere where the majority of leaf fall occurs in autumn most of the leaf fall for Australian native species, particularly, *Eucalyptus* occurs during summer. The combination of a large leaf fall and low flows causes the accumulation of leaf packs to have an impact on water quality by reducing oxygen by decomposing and adding large amount of tannins and other chemicals to the water through the leaching process. This reduction in dissolved oxygen is evident in the slower water bodies such as pools where there is limited re-oxygenation by riffles. Therefore the smaller, slower water sites show lower oxygen levels, however with the regular flows the impact from the above leaf fall is minimised.

Site DDD2

The physico-chemical properties of the dam site indicated relatively good water quality. Temperature was quite high compared with the other sites, which is to be expected given the shallow edges and essentially no riparian zone to cover the water body. DO was lower in this instance when compared with the river sites. Conductivity in Site DDD2 has continued to remain low and is comparable with the previous surveys. Although this is high compared to previous survey, it is still low compared with regional groundwater levels and is considered fresh in the ANZECC and ARMCANZ guidelines (2000). pH was neutral but consistent with previous surveys. Therefore, the site has relatively high water quality.

Discussion

The results of the current survey indicate that both the Mammy Johnsons and Karuah Rivers are still in good to very good condition and possess a highly complex and diverse aquatic ecosystem.

In summary, the results show an overall increase in biodiversity values in all sites, except for Site DDD2, compared with those of the previous survey and are comparable to those observed for the same period in 2007. This indicates that the riverine sites have remained stable while Site DDD2 is showing a change in condition. The condition indices (SIGNAL, EPT Ratio and Shredder Ratio) mirrored each other. These results indicate that the riverine ecosystem condition values at Sites M1 - M5 are in fair to excellent condition, whereas, the high species diversity and number of EPT taxa indicate that the sites are in good to excellent condition. This signifies that the community composition has remained very consistent in the number of pollution/disturbance sensitive taxa in a highly dynamic flow regime.

The seasonality of the normal lifecycle for most of the EPT taxa (as well as the majority of other aquatic insects) has major impact on the apparent biodiversity of a river system. The lifecycles of aquatic invertebrates involves the development of the aquatic larvae over the winter months with mature larval emerging as adults from late spring to late summer resulting in an apparent increase in numbers of animals and species during this early spring period. This contrasts with the late summer period where many adults have left the water and larvae are young, small and highly cryptic (i.e. they live in the hyporheic zone / under the gravel substrate). This results in an apparent reduction in biodiversity and abundance and is reflected in the lower diversity of the EPT groups. However, the overall increase in diversity is caused by the lower flows producing a more stable environment, which then stimulates the numbers and diversity of silt/disturbance tolerant taxa.

The two main factors influencing the biological diversity and water chemistry are flow and landscape condition i.e. riparian zone condition. Flow is one of the main regulatory factors that determine biological activity and diversity within rivers, particularly in high-energy coastal systems. Aquatic communities are susceptible to change, in both numbers of organisms and community composition during periods of extreme flow conditions such as the rapid changes seen during high flows or the gradual change seen during low or no flows. Each extreme flow regime will produce flow conditions favourable to particular segments of the

community and these components will then increase in numbers. The second major factor that has contributed to the high biodiversity and high water quality of both the Karuah and Mammy Johnsons River systems is the intact, native riparian vegetation found along the banks of the rivers and the mature upland native forests. The lack of excessive sedimentation from erosion of the catchment and riverbanks has allowed a range of niches in the riverbed to be retained allowing the aquatic community to maintain a high diversity and efficiency in processing the nutrients and allochthonous matter that enters the system. This in turn produces higher water quality for all uses.

Over the last six months there has been a decrease in the volume and regularity of rainfall events (particularly prior to August) producing lower regular flow levels in both rivers but a rainfall event in late August has provided sufficient flow to maintain higher water quality and provide a scouring impact on the substrate. The lower flow conditions have reduced the scouring effects of the floods, which normally remove the accumulated fine sediments, algae and associated invertebrate fauna from the substrate, resulting in an increase in occurrence of some of the silt tolerant fauna such as the Dipteran (flies) group including the Simuliidae and Chironomidae. Under prolonged low flow conditions this would then decrease the amount of available habitat for the grazer and shredder fauna and there would be a decrease in these groups. During the current survey this was not the case with an abundance of the EPT and shredder taxa due to only a moderate rainfall event in late August that has kept the substrate relatively clean up until this point but was not sufficient to remove them. The results however, have registered a decrease in overall ecosystem condition with an apparent increase in the number of EPT and grazer components in the community. This paradoxical situation i.e. a decrease in condition with an increase in the number of high (highly sensitive) value taxa has been caused by the differences in life cycle characteristics of the highly sensitive taxa and the low senstive taxa. The EPT taxa have longer (usually annual) life spans and are narrow range dispersers that require extended periods of regular flows to grow and mature, therefore a large number is indicative of suitable environmental conditions over at least a 6 to 12 months prior. The large number of EPT taxa is the result of a stable period of flow during the previous summer, autumn and winter period. Whereas the sensitive or disturbance tolerant taxa typically have short life spans, are wide dispersers and maximise productivity during the spring-summer period. Therefore, there has been optimum conditions for both groups at different times resulting in an overall increase in numbers of all groups that is not translated into an increase in condition because of the relative proportions of each group in the community.

Overall, there has been a consistent number of taxa with a reduction at some sites of silt tolerant taxa and an apparent increase in EPT taxa. Although there has been an overall decrease in condition of the two river systems there was significant variability among the sites, often with contradicting results. There are four possible causes for this variability: i) differences in site geomorphology and river size; ii) variations in the habitat produced by the different flow regimes; iii) differences in the composition of the faunal communities associated with each particular type of river flow regime and iv) the seasonal life cycle differences of the different community components.

Therefore, the result of the current survey confirm what has previously been predicted and demonstrated, i.e. that the aquatic biodiversity is continuing to show the same or similar trends to that observed in previous years. The continued presence of high numbers of EPT taxa recorded at all river sites (12 - 18 taxa) indicates that both river systems are very healthy and showing no signs of environmental stress. The other off river sites recorded much lower values than the river sites with Site SW2 recording the highest values both in EPT taxa and EPT ratio, followed by Sites SW7 and DDD2 with the lowest values. Site DDD2 also recorded the lowest values compared with all previous surveys. The results from Site DDD2 showed a drop in both biodiversity and condition that is suggestive of a change in water quality that requires additional monitoring to determine if this is a sampling anomoly or an actual decline in ecosystem condition.

In conclusion, the results from the current survey suggest that the overall biodiversity and river environmental conditions are very good and that there are no apparent adverse effects on the aquatic macroinvertebrate fauna in the Mammy Johnsons River as a result of any activities arising from the operations of the Duralie Mine.

Acknowledgements

We are grateful to Mr. John Trotter and James Benson for their continued assistance in the field and for providing background information on water quality and site history.

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Appendix 1

A list of the macroinvertebrate species collected at the eight sample sites on the Mammy Johnsons and the Karuah Rivers on the16th September 2008.

Order	Family	Species	M1	M2	M3	M4	M5	DDD2	SW2	SW7
Acarina	Hygrobatidae	*undetermined*								*
Bivalvia	Hyriidae	*Hyridella*	*	*		*	*			
Bivalvia	Sphaeridae	*Pisidium*		*	*	*		*	*	*
Coleoptera	Dystiscidae	*Batrachomatus*					*			
Coleoptera	Dystiscidae	*Chostonectes*						*		*
Coleoptera	Dystiscidae	*Hyphydrus*			*	*	*	*	*	
Coleoptera	Dystiscidae	*Necterosoma*	*	*	*	*				*
Coleoptera	Elmidae	*Austrolimnius*	*	*	*	*	*			*
Coleoptera	Elmidae	*Kingolus*	*	*		*	*			
Coleoptera	Elmidae	*Notriolus simsoni*					*			*
Coleoptera	Elmidae	*Simsonia*					*			
Coleoptera	Gyrinidae	*Macrogyrus*	*		*				*	*
Coleoptera	Haliplidae	*Haliplus*	*	*		*		*		*
Coleoptera	Hydraenidae	*undetermined*	*					*		*
Coleoptera	Hydrophilidae	*Berosus*	*	*	*	*	*	*	*	
Coleoptera	Psephenidae	*Sclerocyphon maculatus*	*			*	*			
Decapoda	Atyidae	*Australatya striolata*				*	*			
Decapoda	Atyidae	*Paratya australiensis*	*	*	*	*	*	*	*	
Diptera	Ceratopogonidae	*Bezzia*				*	*	*	*	*
Diptera	Chironomidae	*Chironominae*	*	*	*	*	*	*	*	*
Diptera	Chironomidae	*Orthocladinae*	*	*	*	*	*		*	*
Diptera	Chironomidae	*Tanypodinae*		*	*	*	*	*	*	*
Diptera	Culicidae	*Culicinae*						*	*	
Diptera	Dixidae	*Dixa*		*		*				
Diptera	Simulidae	*Simulium*	*	*		*	*		*	
Diptera	Tanyderidae	*Tanyderus*		*	*					*
Diptera	Tipulidae	*sp.*					*			*
Ephemeroptera	Ameletopsidae	*Mirawara sp.*	*							
Ephemeroptera	Baetidae	*Bungona sp. 1*	*	*	*	*	*		*	*
Ephemeroptera	Baetidae	*Bungona sp. 2*	*	*			*			
Ephemeroptera	Caenidae	*Tasmanocoenis*	*		*		*		*	*
Ephemeroptera	Leptophlebiidae	*Atalophlebia sp. AV12*	*	*	*	*	*		*	*
Ephemeroptera	Leptophlebiidae	*Austrophlebioides sp. AV9*	*	*	*		*		*	*
Ephemeroptera	Leptophlebiidae	*Jappa*		*						
Ephemeroptera	Leptophlebiidae	*Nousia*	*	*	*	*	*			
Gastropoda	Ancylidae	*Ferressia petterdi*	*		*	*	*			
Gastropoda	Hydrobiidae	*Posticobia brazieri*	*	*	*	*	*			*
Gastropoda	Physidae	*Haitia acuta*						*	*	
Gastropoda	Planorbidae	*Glyptophysa*					*	*	*	
Gastropoda	Planorbidae	*Gyraulus*	*	*	*					*
Hemiptera	Corixidae	*Agraptocorixa*						*	*	
Hemiptera	Corixidae	*Micronecta*					*	*		
Hemiptera	Gerridae	*Limnogonus*					*			*
Hemiptera	Naucoridae	*Naucoris*						*		
Hemiptera	Notonectidae	*Anisops*						*	*	
Hemiptera	Notonectidae	*Enithares*				*				*
Hemiptera	Pleidae	*Plea*						*		
Hemiptera	Veliidae	*Microvelia*	*				*	*	*	*
Hirudinea	Glossiphoniidae	*Undetermined*			*		*	*	*	

Megaloptera	Corydalidae	*Archichauliodes guttiferus*	*	*		*	*			
Odonata	Coenagrionidae	*Ischnura*		*				*		
Odonata	Gomphidae	*Hemigomphus*			*		*			
Odonata	Libellulidae	*Diplacodes*		*	*			*		*
Oligochaete	Lumbriculidae	*Lumbricus variegatus*				*	*			
Oligochaete	Tubificidae	*Undetermined*	*			*			*	
Platyhelminthes	Dugesiidae	*Undetermined*		*			*		*	*
Plecoptera	Grypopterygidae	*Illiesoperla*	*	*	*	*	*			
Trichoptera	Calamoceratidae	*Anisocentropus*	*		*	*			*	*
Trichoptera	Conoesucidae	*Coenoria sp. AV1*			*	*				
Trichoptera	Ecnomidae	*Ecnomus*	*			*			*	
Trichoptera	Helicopsychidae	*Helicopsyche*	*				*			
Trichoptera	Hydrobiosidae	*Apsilochorema*	*	*		*	*			
Trichoptera	Hydropsychidae	*Asmicridea sp.AV1*	*				*			
Trichoptera	Hydropsychidae	*Cheumatopsyche sp.AV1*	*	*		*	*			
Trichoptera	Leptoceridae	*Notalina spira*		*	*		*		*	*
Trichoptera	Leptoceridae	*Oecetis*	*	*	*	*	*		*	
Trichoptera	Leptoceridae	*Triplectides ciuskus cuiskus*	*	*	*	*			*	*
Trichoptera	Leptoceridae	*Triplectides volda*			*		*	*		
Trichoptera	Philopotamidae	*Chimarra*	*	*	*	*	*			
Trichoptera	Philopotamidae	*Hydrobiosella*	*							
	49	70	**M1**	**M2**	**M3**	**M4**	**M5**	**DDD2**	**SW2**	**SW7**
		SIGNAL - HU97B	6.3	6.1	5.9	5.9	5.9	4.0	5.1	5.6
		No of Families	30	24	22	28	30	20	23	23
		No of Genera	37	33	30	35	43	23	28	29
		EPT	18	13	13	12	15	1	9	7
		EPT ratio	0.49	0.39	0.43	0.34	0.35	0.04	0.32	0.24
		Shredder Ratio	0.7	0.55	0.57	0.51	0.53	0.22	0.39	0.45
		Silt Tolerant Taxa	6	3	4	4	6	2	5	4
		Silt Tolerant Taxa Ratio	0.16	0.09	0.13	0.11	0.14	0.09	0.18	0.14

INVERTEBRATE IDENTIFICATION AUSTRALASIA
• Identifications • Surveys • Environmental Interpretations

Duralie Coal Project
-
Biological Monitoring of the Streams Adjacent to the Duralie Coal Mine
Study 1, Survey 15, March 2009.

INVERTEBRATE IDENTIFICATION AUSTRALASIA
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Executive Summary

Duralie Coal Pty Ltd commenced the establishment of an open cut coalmine in 2002, adjacent to the Mammy Johnsons River, and upstream from the township of Stroud Road. As part of Duralie Coal's environmental monitoring program, Invertebrate Identification Australasia was commissioned to conduct biological monitoring of the streams near the mine including portions of the Mammy Johnsons and Karuah Rivers. This report is the 15th environmental assessment of the aquatic ecosystems associated with the Duralie Mine and is the 14th since the mine became operational.

A total of eight sites (including one new additional site) were sampled on the 5th March 2009 for aquatic macroinvertebrates and water quality using rapid assessment techniques. One new site, Diversion Drain Dam 1 (DDD1), has been added to this and future surveys to replace the temporarily decommissioned, Diversion Drain Dam (Site DDD2). Site DDD2 was drained during the construction of a larger water reservoir. The environmental monitoring of the water quality and the aquatic ecosystem above the mine water storage dam (west of the mining operation) will continue `at the new site. This monitoring program was established to assess any impacts of potential saline run-off from the irrigation of saline mine water onto the ridges and slopes surrounding the mining area on water quality and/or the local macroinvertebrate community.

A total of 73 species were recorded representing 51 families. In addition, five biological indices were calculated to determine the condition of the streams in and adjacent to the study area. Over the last six months, nine significant rainfall events have occurred with a major rainfall event occurring within two weeks of this survey. These events have resulted in increased river flows leading to a change in the community composition from a low flow silt tolerant community to a reduced community that reflects the scouring affects of the higher flow conditions. A combination of a senescent period in the annual life cycle of the rivers and the recent flood event have lowered the number of animals present in the streams across all sampling sites resulting in lower observed values for the environmental indices compared with those of the previous September survey. Available data indicates that all sites still have very healthy macroinvertebrate communities with lower numbers of silt tolerant taxa and high numbers of EPT and shredder community components due to the higher river flows and increased water quality conditions.

The results of the current survey indicate that there has been a sustained improvement in ecosystem condition compared to previous years and shows no evidence of any adverse effects on the aquatic macroinvertebrate community. Therefore, there appears to no adverse effects on the aquatic ecosystem as a result of the mine's operations.

The new diversion drain dam site was constructed at the same time as Site DDD2, however, it has a valve that allows the volume of water in the dam to be controlled whereas Site DDD2 had an unregulated spill pipe that essentially created a constant water level and thus more stable conditions. The higher water level variability at Site DDD1 has resulted in the creation of slightly different habitats that may lead to some differences in the macroinvertebrate community. The first survey of Site DDD1 suggests that water chemistry and ecological community are comparable to those found at Site DDD2 with relatively low electrical conductivity and a diverse, established aquatic community. Site DDD1 is directly adjacent to Site DDD2 and receives the same potential saline irrigated runoff water from the surrounding slopes and thus appears to be a suitable replacement for Site DDD2 as an indicator habitat for any impacts of run-off from the irrigation of saline mine water in terms of water quality and/or the local macroinvertebrate community.

Introduction

Duralie Coal Pty Ltd commenced an open cut coalmine operation in 2002, adjacent to the Mammy Johnsons River, upstream of the township of Stroud Road. As part of Duralie Coal's environmental monitoring program, Invertebrate Identification Australasia was commissioned to conduct biological monitoring of the streams near the mine. Eight sites (one new replacement site) were sampled on the 5th March 2009 for aquatic macroinvertebrates and water quality using rapid assessment techniques. This is the 15th environmental assessment of the aquatic ecosystems of Mammy Johnsons River and the Karuah River above the junction with Mammy Johnsons River. A new site Diversion Drain Dam No.1 has been added in order to replace the decommissioned Water Diversion Drain Dam No. 2 (Site DDD2). The new site will monitor the water quality and/or the local macroinvertebrate community for any adverse impact as a result of potential saline run-off from irrigation onto the ridges and slopes surrounding the mining area.

Aquatic macroinvertebrate communities have been used as a reliable and cost effective environmental indicator of stream condition for more than 30 years across Australia. These communities have long been recognised as being ideally suited for the assessment of river health and condition as they are diverse, occupy every niche within a water body including the riverbed, water column and surface, are one of the major contributors to the processing of energy through a river system and respond directly to physico-chemical changes within the aquatic environment. The composition of this community consists of a range of predators, grazers, shredders and filter feeders and reliably reflects both natural and threatening processes operating within a catchment. The ubiquitous distribution and specific habitat requirements of each component at both the species and community levels, enables the use of their diversity as an indicator of ecological disturbance within a catchment.

Study Area and Sampling Sites

General Description

The Duralie Coal Mine is situated approximately 10 km northeast of the township of Stroud Road on the western side of Mammy Johnsons River on the New South Wales lower North Coast. The Mammy Johnsons River is a tributary of the Karuah River. The Mammy Johnsons and the Karuah Rivers are the two major watercourses which have the potential to be affected by operations from the Duralie mine.

Eight sites were sampled on the 5th March 2009 for aquatic macroinvertebrates and water quality using rapid assessment techniques (Figure 1, Table 1). Four sites are located along the Mammy Johnsons and Karuah Rivers, with two sites located above the mine (Sites M1 and M2) and two below the mining area (Sites M3 and M4). One site is located on the Karuah River (Site M5) at Stroud Road, upstream of the junction with Mammy Johnsons River. Site M3 was relocated in March, 2005 approximately 50m downstream from the original site in order to incorporate a larger, stony riffle section, a habitat that was previously absent from Site M3. One site is located on the Diversion Drain Dam No.1 (Site DDD1). For the current and future surveys two new sites were added during the previous survey. These are 1) Site SW2 - the bottom pool of Coal Shaft Creek and 2) Site SW7 - a small tributary of the Mammy Johnsons River which has its confluence with the river between Sites M1 and M2.

Mammy Johnsons River

For a more complete description of Sites M1-M4 see Survey 13. During the current survey the pools and riffles were quite turbid due to a major flood event just prior to the current survey. In addition there were no green filamentous algae found at any of the sites. There also appears to be little silt deposition, as there has been extensive scouring due to the recent flood.

Karuah River

For a more complete description of Site M5 see Survey 13. The water appeared turbid and consistent with the Mammy Johnsons River for the current survey. No green filamentous algae were observed in the Karuah River, and the cobbles and boulders in the riffles had been obviously scoured clean of any algae, silt or detritus.

Site code	Site name and description	Grid Reference
M1	Mammy Johnsons River (MJR) above mine area, near gauging station.	400607N, 6430921E
M2	MJR - downstream of Site M1, above the mine area	401262N, 6427007E
M3	MJR - downstream of Site M2 and below mine area	401463N, 5425640E
M4	MJR - downstream of Site M3 below mine area, 30m W. of Johnsons Ck Rd	400388N, 6422495E
M5	Karuah River at Stroud-Dungog Rd, Stroud Road	401462N, 6425639E
DDD1	Diversion Drain Dam 1 above Mine Water Storage Dam in mining area.	387750N, 6424400E
SW2	Coal Shaft Creek at last pool before it enters the MJR above Site M3.	400762N, 6425309E
SW7	Small tributary stream that joins with MJR between Sites M1 & M2.	399832N, 6429906E

Table 1. Sampling sites.

Diversion Drain Dam No.1 (DDD1)

Diversion Drain Dam 1 has been added to this survey to replace Site DDD2. The previous site has been used as an indicator habitat for the past 11 surveys to monitor for any adverse environmental impacts of using the saline mine water for irrigation on the surrounding hills and slopes. The new diversion drain dam site was constructed at the same time as Site DDD2, however, the design is different in that it has a valve that allows for the controlled release of the water in the dam, whereas Diversion Drain Dam 2 had an unregulated spill pipe that essentially created a constant water level within the dam and, therefore, more stable conditions. These stable conditions allowed the development of fringing macrophyte beds which created habitat for a variety of aquatic organisms. The higher water level variability at Diversion Drain Dam 1 has resulted in the creation of slightly different habitats that may lead to some differences in the macroinvertebrate community. There is little development of macrophytes and at the time of this survey and the water was quite turbid. There is little to no riparian vegetation or shading and it is anticipated that the macroinvertebrate community will be composed largely of the common larger, highly mobile and predominantly predatory insects such as the water beetles (Dystiscidae), dragonflies and damselflies (Odonata) and many of the common true bugs (Hemiptera) such as the Notonectidae and the larger Corixidae. A combination of an absence of pool macrophytes, riparian zone and the high light conditions as well as the variable water levels may contribute to a simplified ecosystem structure that is composed predominantly of disturbance tolerant species. These groups are predominantly visual predators that prefer still open water bodies as habitat.

There had been limited recent irrigation of the hillsides (personal communication John Trotter) due to the high rainfall levels and this has resulted in very low conductivity levels within the dam.

Small tributary sites (Sites SW2 and SW7)

These two sites were added in the previous survey in order to monitor the ecosystems within Coal Shaft Creek (Site SW2) and an unnamed small tributary stream (Site SW7 – sampled within the Zulumovski property) both of which enter the Mammy Johnsons River (see Figure 1).

The purpose of monitoring the northern unnamed stream is to provide background data in light of a pending Part 3A (Environmental Planning & Assessment Act, 1979) application to extend existing approved mining operations to the north. The sampling location is downstream of proposed areas to be impacted by mining. The purpose of monitoring the lower Coal Shaft Creek sampling is to assess this area prior to a potential release of stored water from the mine.

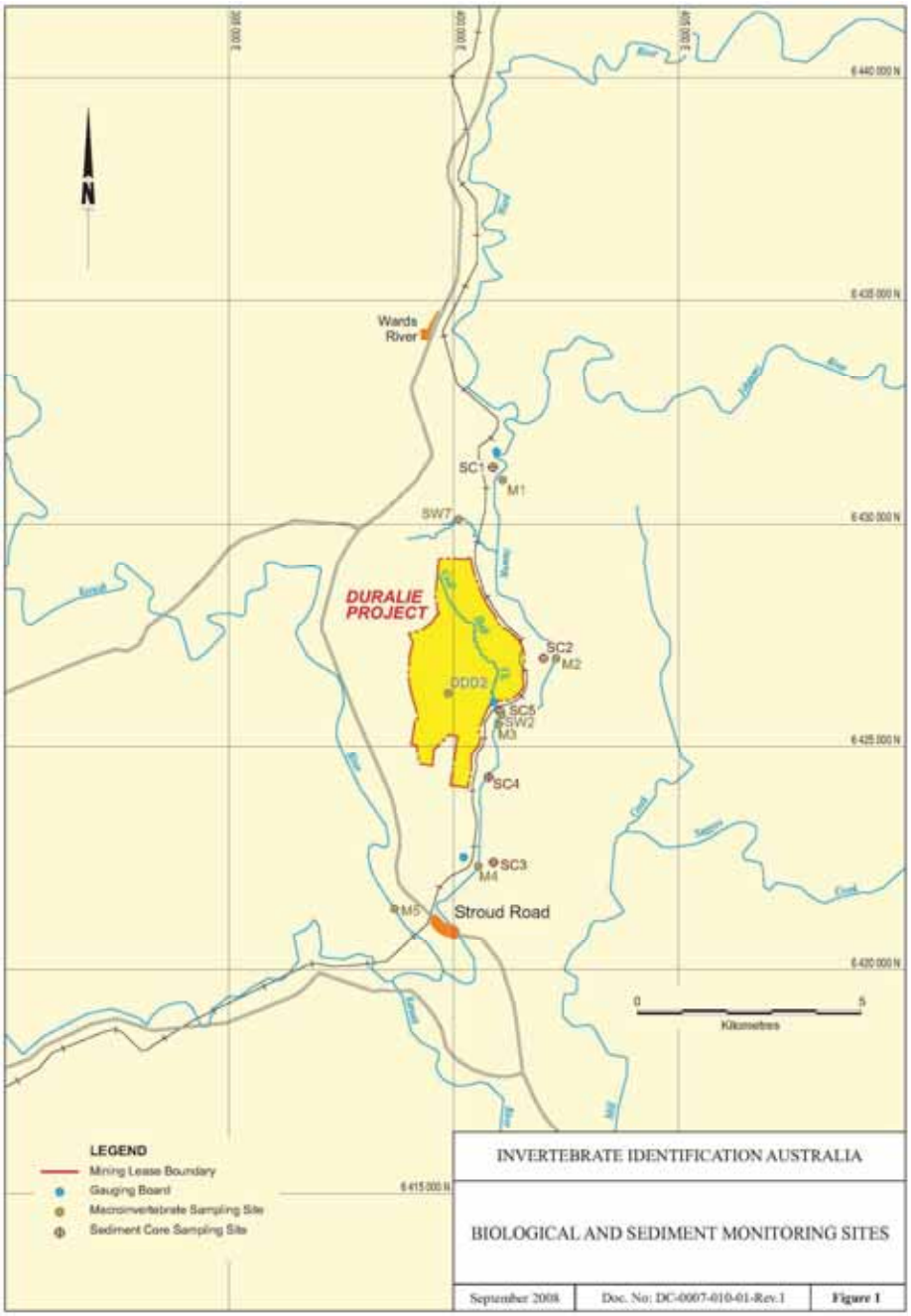

Figure 1. Map showing the locations of Sites M1 to M5 and Sites SW2 and SW7.

Site SW7 within the Zulumovski property is a very small drainage line/tributary stream of Mammy Johnsons River. It drains into the Mammy Johnsons River between Sites M1 and

M2. The stream consists of a steep, mostly dry ephemeral upper gully that only flows during rainfall, with a dense, open, dry sclerophyll riparian zone that narrows down in the lower portion to a series of small pools connected by small runnels and is surrounded by a narrow riparian zone of PaperBark (*Melaleuca*) and wet sclerophyll species. The sampling site is in the break of slope at the beginning of the lower reaches of the stream where the first, large permanent pool is encountered. The lower half of the stream is essentially fed by groundwater seepage. Several springs/seepage zones were evident during the initial survey. Most of the surrounding slopes have been cleared and are currently used for cattle grazing. There is some minor erosion on the banks caused by the cattle around the seepage zones. The stream substrate consists mainly of fine sands and fine sediments covered with large amounts of allochthonous material (leaves and twigs). During the current survey there was little to no flow with small patches of green filamentous algae in the pools. The stream was relatively clear although the water was quite tea coloured due to the leaching of tannins from the surrounding riparian vegetation.

Coal Shaft Creek (Site SW2) is a small ephemeral stream, which lies partially within the mining lease and has been diverted around the mining operation and discharges into the Mammy Johnsons River approximately 50-100 m upstream of survey Site M3. The diverted section of stream has limited vegetation but has a dense native riparian zone in the lower reaches adjoining Mammy Johnsons River. This dense vegetation provides substantial shading and terrestrial habitat for terrestrial and aquatic invertebrates. The stream, below the diversion, contains permanent water in large pools which are possibly fed by groundwater seepage. The stream in the lower reaches does respond quickly to rainfall events but still continues to have a low flow for extended periods after rain. The substrate within the lower pools is bedrock lined with deep fine sediments and detrital material. The sediments are anoxic at depth due to the build up of allochthonous (leaves and twigs). The pool at the time of the survey was quite turbid due to recent rainfall events.

March 2009 Site Images

The following fifteen photographs (Photos 1-15) are of all sites surveyed and illustrate the prevailing conditions of the two rivers, the dam as well as the two new sites.

1.  **2**. 

Site M1, Mammy Johnsons River, viewed across the stream (**1**); viewed upstream (**2**), taken March, 2009.

3. 

Site M2, Mammy Johnsons River, viewed upstream (**3**), taken March, 2009.

4.  **5**. 

Site M3, Mammy Johnsons River, viewed downstream (**4**); viewed upstream (**5**), taken March, 2009.

6.  **7**. 

Site M4, Mammy Johnsons River, viewed downstream (**6**); viewed upstream (**7**), taken March, 2009.

8.  **9**. 

Site M5, Karuah River, viewed downstream (**8**); viewed upstream (**9**), taken March, 2009.

10.  **11**. 

Site DDD1, (**10**) viewed to the east; (**11**) viewed to the west, taken March, 2009.

12.  **13**. 

Site SW7, (**12**) viewed downstream (**13**); viewed upstream, taken March, 2009.

14.  15. 

Site SW2, Coal Shaft Creek, viewed downstream (14); viewed upstream (15), taken March, 2009.

Methodology

Macroinvertebrate Sampling

Each site was sampled using two standardised methods outlined in the River Bioassessment Manual (Anonymous, 1994) and the NSW AUSRIVAS (Australian River Assessment System) sampling and processing manual (Turak *et al*., 2004). For a more detailed outline of the methods used see Survey 13.

Identification

All samples were sorted under a stereomicroscope and stored in 70% alcohol. Specimens were identified to genus where possible, (except for Chironomidae, Oligochaeta and Platyhelminthes which are identified to family/subfamily), using a combination of current taxonomic works and keys and comparison with voucher specimens in the reference collections of Invertebrate Identification. Identification references included Williams (1981) and the taxonomic identification series produced by the Murray Darling Freshwater Research Centre.

Data Analysis

Measured Indices

SIGNAL. . SIGNAL is an acronym for 'Stream Invertebrate Grade Number - Average Level', and is a biotic index of pollution tolerance or sensitivity of stream invertebrates and was originally developed for use in the lower Blue Mountains (Chessman, 1995). Chessman *et al*., (1997) released a modified version; SIGNAL HU97, developed for the Hunter Valley, which is to the south, and its aquatic communities are more comparable to those found within the study area. See Table 2 for a breakdown of the SIGNAL values and water quality status.
EPT Richness. The EPT (Ephemeroptera, Plecoptera and Trichoptera) score is based on the observation that the majority of these taxa are particularly pollution sensitive (Lenat, 1988, see Table 3). For further details sees Survey 13.

Comparative Indices

Number of Families. All macroinvertebrate families are separated and counted. The number of families present generally decreases with decreasing water quality and is used as a comparative measure of community change over time.

Functional Feeding Groups. Ratio of shredder taxa to total number of taxa. As with Numbers of Families the higher the ratio of shredders the better the water quality and is used as a comparative measure of community change over time.

Silt Tolerant Species

The Environmental Management Plan of the Duralie Mine states that the aquatic fauna assemblages need to be assessed for silt tolerant fauna, as the presence of such fauna can provide an indication of the degree of heavy sediment pollution. The main indicator families

are the Dugesiidae, Lymnaeidae, Ancylidae, Planorbidae, Psephenidae, Chironomidae, Caenidae, Pyralidae and Ecnomidae.

The silt tolerant taxa values are best examined against the total number of taxa sampled from each site i.e. the silt tolerant ratio, as the variation of values is significantly reduced compared with examining the number of taxa alone. This index is used as a comparative measure of community changes over time.

SIGNAL -HU97B	Probable water quality status
>7	Excellent
6-7	Good
5-6	Fair
4-5	Poor
<4	Very poor

Table 2. Interpretation of water quality status using SIGNAL -HU97B scores (Chessman *et al*., 1997).

EPT genus richness	Probable condition of macroinvertebrate community
>6	Healthy
5-6	Slightly impaired
3-4	Moderately impaired
1-2	Severely impaired
0	Grossly impaired

Table 3. Interpretation of the EPT genus richness scores (Besley *et al*., 1996; Besley & Growns, 1998).

Physico-Chemical Data

Physical and chemical parameters were measured at each site *in situ* and included temperature, dissolved oxygen, electrical conductivity and pH. The results are presented in Table 5.

Results

Macroinvertebrate Data

Synopsis of Indices

The results for each index are presented in Tables 4 and 5 with the 'Taxa Based' and 'Ratio Based' values graphed in Figures 2 and 3 respectively. A total of 73 genera representing 51 families were recorded during the current survey. The indices demonstrated that the river system sites were in fair to good condition with healthy aquatic ecosystems. All indices showed a general increase in condition or ecological health from upstream to downstream within the Mammy Johnsons River with some variation between sites, depending on whether the values were based on numbers of taxa or were based on ratios. These variations are a reflection of the geomorphology of the stream at each site and the structure of the associated invertebrate community.

In terms of total numbers of species collected, they were considerably lower across all sites compared with the previous record high numbers in the last survey. The largest comparative decline was recorded at Site M5 for the river sites and Site SW7 for the off river sites. These relative declines are similar in magnitude and pattern to the 2003-2005 and 2008 surveys and represent mid range values within the range of variation observed from Surveys 1-15. Site SW7 (Zulumovski Property) recorded the lowest overall diversity amongst the stream and river sites with only 6 genera. The highest values were recorded at Sites M5, M2 and M4 with 33, 30 and 29 taxa, respectively.

Survey 15	M1	M2	M3	M4	M5	SW2	SW7	DDD1
SIGNAL - HU97B	5.0	5.5	5.7	6.2	6.4	4.5	5.7	5.1
No of Families	26	25	22	24	25	16	4	15
No of Genera	29	30	27	29	33	20	6	19
EPT	7	5	9	7	13	6	1	2
EPT ratio	0.24	0.16	0.33	0.24	0.39	0.30	0.16	0.10
Shredder Ratio	0.44	0.36	0.63	0.48	0.60	0.50	0.16	0.31
Silt Tolerant Taxa	4	2	4	4	2	4	1	2
Silt Tolerant Taxa Ratio	0.13	0.06	0.14	0.13	0.06	0.20	0.16	0.10

Table 4. Summary Table of numbers of genera, families and indices. A full list of the taxa found is presented in Appendix 1.

Survey 15	M1	M2	M3	M4	M5	SW2	SW7	DDD1
SIGNAL-HU97B	Fair	Fair	Fair	Good	Good	Poor	Fair	Fair
EPT	Healthy	SI	Healthy	Healthy	Healthy	Healthy	SI*	SI*

Table 5. Summary Table of the SIGNAL and EPT condition Indices. Abbreviations: SI – slightly impaired, SI* - severely impaired.

The variation in the number of genera observed at each site since September, 2002 is presented in Table 6 and Figure 2. The biodiversity values (= number of observed genera) recorded for the current survey shows comparative results for all sites for the same time last year (February, 2008 survey). The normal pattern of diversity recorded along the river commences with Site M1 having a high diversity followed by a drop in diversity at Sites M2 and M3 followed by a steady increase downstream to Sites M4 and M5. This pattern is once again demonstrated in numbers of families in this survey (Table 6) although the biodiversity index (No. of genera) values for each river site showed a slight increase from Site M1 to M2 followed by the normal reduction in number at Site M3 and an increase to Sites M4 and M5. These values have remained relatively consistent since Survey 3 in 2003. The two additional sites recorded substantially lower values dropping from 28 to 20 genera at Site SW2, while Site SW7 dropped from and 29 to 6 genera.

The SIGNAL value recorded a steady increase along the river with no major deviations. The EPT, Shredder numbers, and ratio indices recorded a slightly different pattern reflecting the impacts on different components of the aquatic community. The pattern illustrated by the EPT community is also reflected in the Shredders trophic guild. They recorded a high diversity at Site M1 followed by a decrease at Site M2, then an increase at Site M3 followed by a decline downstream to Site M4 and an increase at Site M5. This is repeated to a lesser extent for the silt tolerant taxa except that Sites M4 and M5 showed a decrease in numbers.

These results reflect the impact the recent flooding had on the different elements of the aquatic community via the different structures and flow velocities present at each site and the varying severity of the scouring that occurred during the flood. That is, the stream sections that had the highest flows (Sites M2, M4 and M5) had the largest scour effect and therefore,

the largest loss of surface invertebrates. The results also demonstrate the removal of the finer sediments which resulted in the removal of the silt tolerant taxa at a greater rate, while the EPT taxa are adapted to high flow conditions.

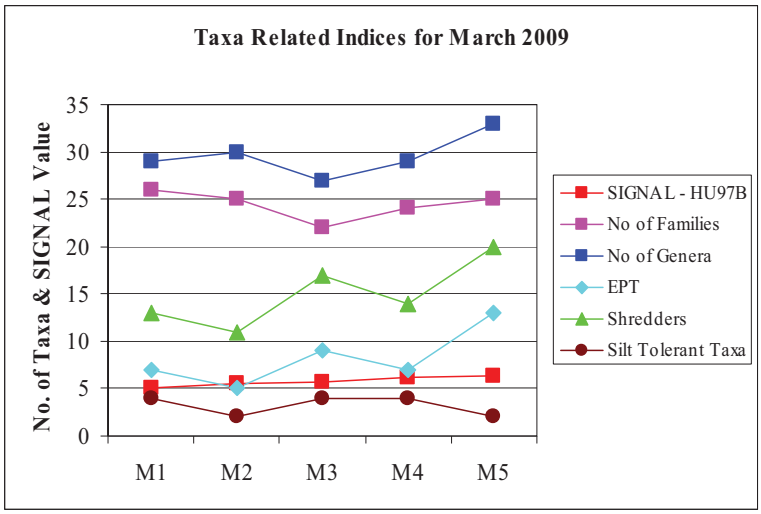

Figure 2. The observed variation in taxa based indices recorded for all sites in March 2009.

The condition indice (SIGNAL) values differed from the biodiversity values by showing a small increase in values at all sites relative to the previous survey, except for Sites M1 and SW7, which were lower. However, these values are still higher than most of the earlier values and there is still a trend for an overall increase in stream ecosystem condition. Figure 3 illustrates a gradual increase in condition of the river. The SIGNAL values for this survey ranged from 5.0 to 6.4 for the river Sites M1 and M5, respectively. The lowest overall value observed was 4.5 for Site SW2, whereas SW7 recorded 5.7. A significant feature of these results is the consistently moderate values recorded along the surveyed length of the Mammy Johnsons River and its comparative similarity to the Karuah River site. These values indicate that Sites M1 to M5, SW7 and DDD1 were in fair to good condition while Site SW2 is in poor condition.

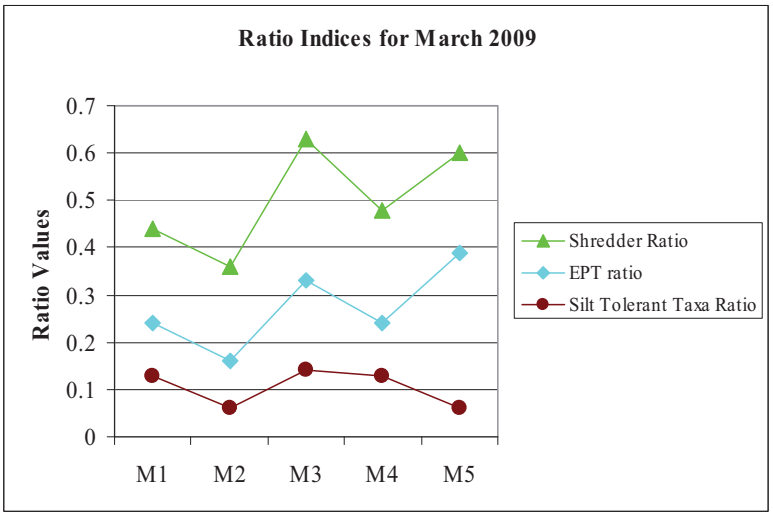

Figure 3. The observed variation in taxa based indices recorded for all sites in March 2009.

No of Genera	M1	M2	M3	M4	M5	SW2	SW7	DDD1	DDD2	Totals
Survey 1 - Sep 2002	33	18	16	22	25					58
Survey 2 - Mar 2003	30	29	20	44	32					60
Survey 3 - Sep 2003	38	43	34	33	35					64
Survey 4 - Mar 2004	30	42	31	29	31				18	58
Survey 5 - Jun 2004	36	35	31	30						47
Survey 6 - Sep 2004	32	29	33	37	42				26	68
Survey 7 - Mar 2005	31	30	27	39	29				24	70
Survey 8 - Sep 2005	29	32	30	34	27				19	57
Survey 9 - Apr 2006	31	47	44	45	30				22	72
Survey 10 - Sep 2006	36	31	34	38	25				27	67
Survey 11 - Mar 2007	38	37	33	43	31				30	71
Survey 12 - Sep 2007	38	37	29	32	34				29	76
Survey 13 - Feb 2008	31	22	26	28	29				28	61
Survey 14 - Sep 2008	37	33	30	35	43	28	29		23	70
Survey 15 - Mar 2009	29	30	27	29	33	20	6	19		73

Table 6. The observed variation in the number of genera recorded for all sites since September 2002.

SIGNAL-HU97B	M1	M2	M3	M4	M5	SW2	SW7	DDD1	DDD2
Survey 1 - Sep 2002	6.0	6.0	6.3	5.9	6.0				
Survey 2 - Mar 2003	5.3	4.8	5.2	5.2	5.2				
Survey 3 - Sep 2003	5.6	5.6	5.9	5.7	5.4				
Survey 4 - Mar 2004	5.7	5.3	5.5	5.8	5.4				4.6
Survey 5 - Jun 2004	5.0	5.4	5.5	5.6					
Survey 6 - Sep 2004	5.4	6.0	5.9	5.9	6.0				3.9
Survey 7 - Mar 2005	5.4	5.5	5.5	5.5	6.2				4.4
Survey 8 - Sep 2005	6.4	5.9	5.7	6.3	6.44				4.4
Survey 9 - Apr 2006	5.7	5.3	5.8	5.7	5.6				4.6
Survey 10 - Sep 2006	5.8	6	5.6	6.1	6.7				4.3
Survey 11 - Mar 2007	5.2	5.5	5.5	5.3	6.6				4.5
Survey 12 - Sep 2007	5.9	6.1	6.0	6.7	6.2				5.1
Survey 13 - Feb 2008	5.8	6.8	6.4	6.4	6.7				5.0
Survey 14 - Sep 2008	6.3	6.1	5.9	5.9	5.9	5.1	5.6		4.0
Survey 15 - Mar 2009	5.0	5.5	5.7	6.2	6.4	4.5	5.7	5.1	

Table 7. The observed variation in the SIGNAL-HU97 values for all sites since September, 2002.

The EPT index values (see Figure 5) demonstrate a significant decrease in numbers of EPT taxa across all sites compared with all surveys since September 2002. This trend is the same as the previous annual patterns showing an increase/decrease in spring/autumn numbers although the magnitude of the decrease from spring to autumn has increased. These results suggest that the pronounced decrease in values has occurred as a result of aseasonal climatic trends, i.e. the recent floods. Surveys in September, 2007 and 2008 demonstrated similar patterns and experienced high flow events (although not of the magnitude of the February, 2009 event) just prior to this survey. Therefore the impact on the biodiversity was reduced.

The EPT values are best examined against the total number of taxa sampled i.e. the EPT ratio, as the variation of values is usually significantly reduced. Figure 6 illustrates the EPT ratio for all sites since 2002. The EPT ratio results recorded a significant decrease in values for all sites, except Site M5, which recorded a small increase compared with previous surveys. Site M1 recorded the largest decrease, while Site M2 continued decreasing from the previous

survey. Although the number of EPT taxa has fallen for most sites, those that recorded a drop in the EPT ratio also recorded a drop in the non EPT taxa. The EPT ratio values ranged from 0.16 to 0.39 for the river sites with Site M2 recording the lowest value and Site M5 the highest value. Therefore, Site M5 had the highest proportion of EPT taxa, while Site M2 had the lowest. The EPT ratio values in the past clearly separated the three major habitats i.e. the Karuah River (Site M5 – the higher flow system) recording a relative high value, the Mammy Johnsons River (lower flow, finer sediment and coarser substrate system) sites have very similar but variable values along its length, while Sites DDD1-DDD2 (the non-flowing system) usually recording the lowest values. However, during this survey the lowest value observed was at Site SW7. The differences between the two river systems are most noticeable during periods of low flow when average flow velocities are higher in the Karuah River with larger substrate types, which also leads to a greater scouring effect.

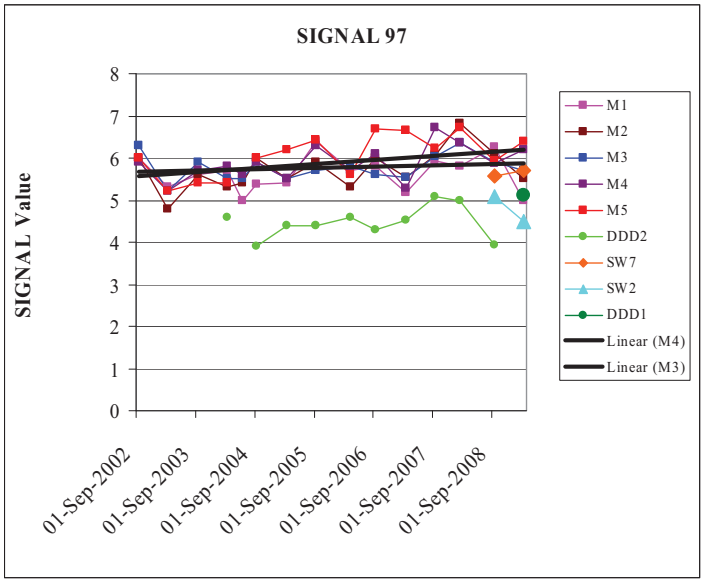

Figure 4. The observed variation in the SIGNAL-97 values for all sites since September 2002.

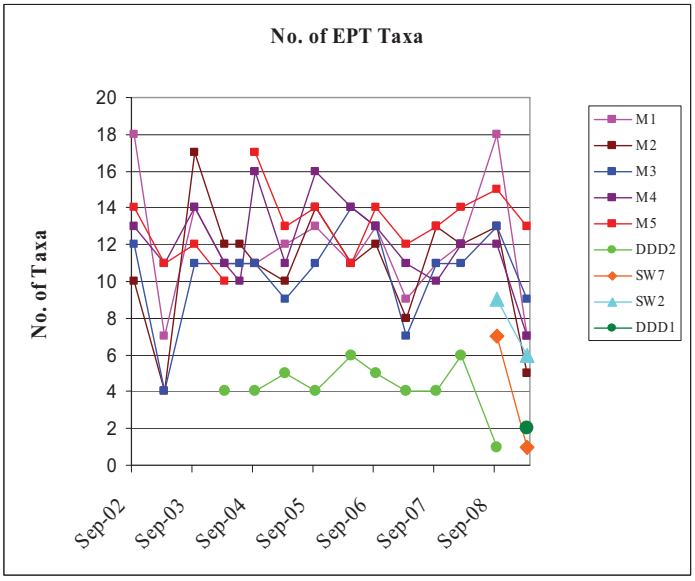

Figure 5. The observed variation in the EPT values for all sites since September 2002.

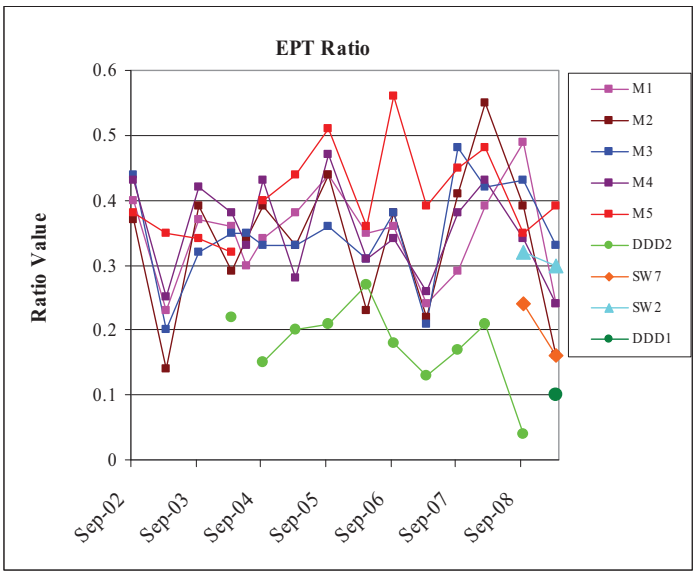

Figure 6. The observed variation in the EPT ratio values for all sites since September 2002.

The off river sites (Sites SW2, SW7 and DDD1) recorded much lower values of the EPT Ratio with 0.30, 0.16 and 0.10 respectively. The value observed at Site DDD1 is comparable to those previously recorded at Site DDD2.

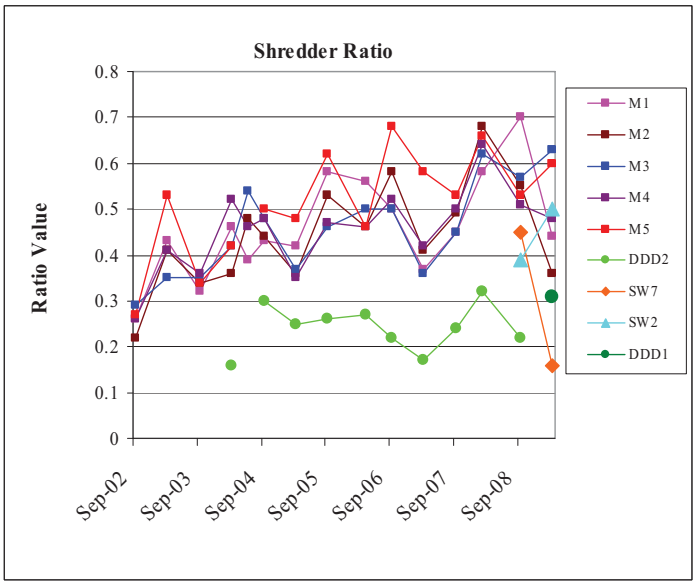

Figure 7. The observed variation in the Shredder ratio values for all sites since September 2002.

The shredder ratio values are illustrated in Figure 7 and are similar to the EPT Ratio index with a significant decrease in values at Sites M1, M2, M4 and SW7. However, Sites M3, M5 and SW2 showed a significant increase. Although most values were lower than the last survey they were still higher than most previous surveys, particularly for Site M3, which recorded its highest level yet.

The most significant change in the community found during this survey was the apparent increase in the number of grazer species (including the EPT group of taxa) compared with a varied response in numbers of silt tolerant taxa (see below). The common and consistently recorded taxa belong to the following groups: The freshwater shrimp *Paratya australiensis*, the coleopteran family Elmidae (beetles); the dipteran subfamilies Chironominae and Orthocladinae (midges); the ephemeropteran families Leptophlebiidae and Baetidae (mayflies), the plecopteran family Grypopterygidae (stone flies), the trichopteran families Hydropsychidae, Philopotamidae (caddis flies) and the molluscan families Sphaeridae (pea clams) and the Hydrobiidae (snails).

The decrease in the presence of dipterans at all sites including the Chironomidae subfamilies (particularly the Orthocladinae) are indicative of a change in the environment resulting in a reduction in numbers. The chironomid subfamilies Chironominae and Tanypodinae formed the dominant component of all the Chironomidae recorded. The Orthocladinae is associated with rivers in good to excellent conditions with minimal silt build up and high water quality. The Chironominae, which were recorded at all sites, appear to be decreasing in numbers substantially compared with previous surveys indicating a change to less stable, flow conditions in general. The very low numbers of the Simulidae in the Mammy Johnsons River is also indicative of less stable, higher flow conditions.

Some notably sensitive taxa were found in most sites, and are associated with pristine or near pristine systems and include: the dipteran subfamily Orthocladinae, the plecopteran *Illiesoperla brevicauda* (Grypopterygidae), the dragonfly, *Hemigomphus*, the ephemeropteran family Leptophlebiidae, the trichopteran families Leptoceridae, Philopotamidae, the hydrobiid snail *Posticobia brazieri* and the freshwater shrimp *Australatya striolata*. There were larger numbers of the plecopteran family Grypopterygidae found at most sites, which is consistent with the previous survey. The dragonfly *Hemigomphus* (Gomphidae) is characteristic of gravel and sandy bed streams with high water quality and was found at Sites M2 and M4. A notable discovery in the Mammy Johnsons River (Site M1) was another record of a relatively rare mayfly from the Family Ameletopsidae (*Mirawara* sp). These are very large mayfly nymphs that can get up to 30 mm long. They occur in stony streams with high water quality and apparently burrow into the cobble substrate during the day and emerge at the surface at night to feed (Campbell, 1980) and this is most likely reason why they have not been collected before. Although no SIGNAL rating is available for these nymphs they occur in streams with high water quality and are a very good indicator of high stream condition. The only previous record of this family is from the Karuah River in the previous survey.

There were also some noticeable absences or low numbers in the community composition, particularly in the upper reaches of the Mammy Johnsons River. These included many of the common larger, highly mobile and predominantly predatory insects such as the water beetles (Dystiscidae), dragonflies and damselflies (Odonata) and many of the common true bugs (Hemiptera) such as the Notonectidae and the larger Corixidae. A combination of an absence of pool macrophytes and the low light conditions produced by the closed canopy as well as the high flow levels may have contributed to the absences. These groups are visual predators that prefer still open water bodies as habitat. No dragonflies were recorded from three sites (Sites M1, M3 and M5), while *Ischnura heterosticta* (Coenagrionidae) was only recorded at two sites (Sites SW7 and DDD1), and *Hemigomphus* (Gomphidae) from two sites (Sites M2 and M4).

The almost completely native species composition of the aquatic macroinvertebrate community of both river systems is largely attributed to the undisturbed nature of each river system, particular the Mammy Johnsons River and the heavily forested upper sections and dense riparian zone, which often forms a closed canopy, e.g. Site M3 (see Photos 5 and 6). A noticeable absence at all river sites was the introduced snail, *Haitia acuta* (note this species was previously placed in the genus *Physa*). This appears to be a consistent trend with previous surveys, as it has not been recorded from any of the river sites since 2007.

The majority of common insect taxa found at all sites are those that do not fly far or high as adults and require a natural riparian zone close to the river to complete their life cycles. The larvae also require good water quality and a constant supply of high quality allochthonous material to feed on. The insect taxa that are absent are the highly mobile (wide dispersers) predators that hunt by sight and are commonly found in more open water bodies such as Site DDD2. Therefore, the intact natural structure of the river and the riparian zone is contributing directly to the high biodiversity and overall community structure.

A notable feature of the current survey is the increase in the numbers of the EPT/shredder/grazer functional feeding group within the invertebrate community. The major components of this feeding group include: the coleopteran family Elmidae, the Ephemeroptera, Plecoptera, Trichoptera and Gastropoda. The presence of this guild is significant, as they normally comprise a large proportion of healthy aquatic communities. The high consistent number of EPT and Shredder taxa, particularly the trichopteran and ephemeropteran families Baetidae and Leptophlebiidae, indicates that most sites have very healthy environmental conditions. However, the previous low flow conditions do appear to have had an impact on the number of taxa present, more consistent flow regimes have probably encouraged their numbers to increase. The river sites recorded between 11 and 20 taxa within these groups whereas Sites SW7 and DDD1 recorded the lowest number with 1 and 2 taxa, respectively, which even for this non-flowing system is a very low number.

Another notable feature of both river systems is the high numbers of Plecoptera, represented by the species *Illiesoperla brevicauda*. This plecopteran was found in high numbers at most sites, except Sites DDD1, SW2 and SW7. Most of the EPT and shredder taxa register 8 - 10 on the SIGNAL index, as they are highly sensitive to pollution. This indicates that the Mammy Johnsons and Karuah Rivers are both in very good condition.

Silt Tolerant Species

A graph and table are presented below to show the changes in silt tolerant taxa along the catchment and over time (see Figure 8). A large decrease in silt tolerant taxa was observed for Sites M1 and M5, whereas the other sites recorded either a small increase or similar values to the last survey. Sites M1, M3, M4 and SW2 recorded the highest number at 4 taxa followed by 2 taxa at Sites M2, M5, and DDD1, with only one taxon at Site SW7. Although these results are variable between the two rivers unlike previous years they are indicative of the flow conditions that have prevailed at each site i.e. the sites that have the lowest numbers have probably had the highest scouring effect.

During periods of low flow, particularly during the extended dry period over the previous four years, there has been a gradual build-up of silt in the streams. Reduced flow allows the settling out of fine particles and a reduction in scouring due to low water velocities. This in turn encourages silt tolerant taxa to increase in numbers. However, under normal flow conditions, these coastal cobble systems typically have regular high-energy flows that remove most of the silt within the system. This leads to relatively low numbers of silt tolerant taxa in these communities under normal flows.

Site DDD1

One new site, Diversion Drain Dam 1 (DDD1), has been added to this and future surveys to replace the temporarily decommissioned Diversion Drain Dam (Site DDD2). The Diversion Drain Dam 2 was drained just prior to this survey for the construction of Auxiliary Dam 1. This monitoring program (Sites DDD2/DDD1) was established to assess any impacts of potential saline run-off while using saline mine water to irrigate the ridges and slopes surrounding the mining area on water quality and/or the local macroinvertebrate community.

This is the first survey of Site DDD1 and has generally been precluded from the analysis and discussion of the other sites as they represent flowing water systems and constitute a very different aquatic ecosystem. The current survey of Site DDD1 indicates that water chemistry and ecological community are comparable to Site DDD2 with relatively low electrical

conductivity and a diverse, established aquatic community. Considering that DDD1 is directly adjacent to DDD2 and receives the same potential saline irrigated runoff water from the surrounding slopes it would appear to be a suitable replacement for Site DDD2.

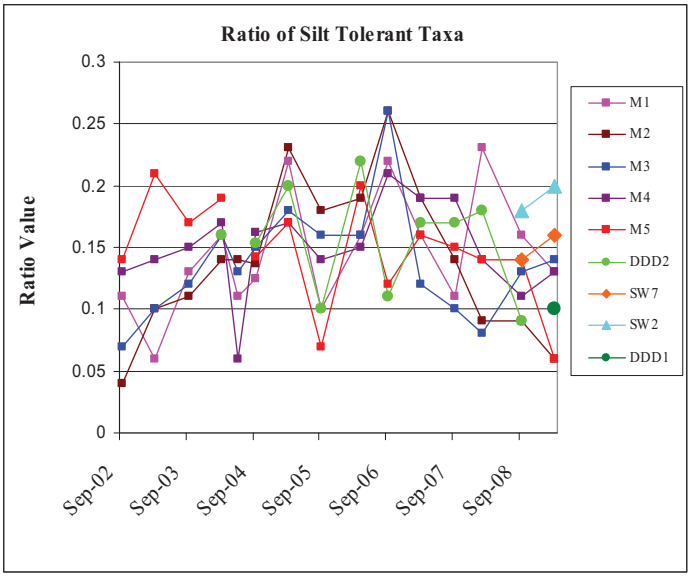

Figure 8. The observed variation in the silt tolerant taxa ratio values since September 2002.

The community is generally composed of predators such as the coleopteran family Hydrophilidae, the Odonata families Libellulidae (*Hemicordulia*) and Coenagrionidae (*Ischnura heterosticta*), the large hemipteran families such as the Notonectidae and Corixidae and the chironomid midges particularly the subfamily Chironominae. All of these taxa are very tolerant of disturbance and poor water quality, although the water quality of this site is generally good. There are also representatives of the EPT shredder guide such as caddis flies (Leptoceridae) and the filter feeder guild including the shrimp, *Paratya australiensis* and the pea clam, *Pisidium*. The EPT taxa present at this site are due to the close proximity of the Mammy Johnsons River and a close riparian corridor allowing the dispersal of these taxa into this site. These taxa normally do not disperse far from a riverine environment. Although EPT taxa are generally regarded as disturbance sensitive, the species observed at this site occur over a wide range of habitats and are opportunists which will become established if there is appropriate water quality and food source.

Physico-Chemical Data

All physico-chemical parameters were again remarkably consistent along the length of the study area and all were well above the minimum requirements as set out by the ANZECC (Australian and New Zealand Environment and Conservation Council) and ARMCANZ (Agricultural and Resource Management Council of Australia and New Zealand) guidelines (2000) (see website http://www.mincos.gov.au/publications/national_water_quality_management_strategy). The range and variation of the physico-chemical parameters along the length of the rivers and over time for the Mammy Johnsons River as well as rainfall figures for the Mammy Johnsons River catchment can be seen in Figures 9-15.

Rainfall over the last twelve months has been lower than for the previous 12 month period recording 1138 mm in 2008-2009 compared with 1302 mm for the same period in 2007-2008. This is particularly true for the period May, 2008 to January, 2009 with lower, more sporadic falls.

Survey 15	Units	M1	M2	M3	M4	M5	SW2	SW7	DDD1
Temperature	°C	20.2	20.5	20.5	20.4	20.5	22.3	18.8	25.2
DO	mg/l	5.8	4.6	4.8	4.7	5.9	3.5	1.2	4.6
Conductivity	mS	229	232	239	255	124	429	606	633
pH	ph units	7.8	7.9	7.9	7.8	8.0	7.9	7.8	8.0

Table 8. Physico-chemical data from each site sampled.

Over the last twelve months there have been only two major rainfall events that were greater than 50 mm and 13 that ranged between 20-50 mm. The major influence on the conditions and community structure for the current survey was the second major rainfall event for the last twelve months which occurred on the 14th February that resulted in a large flood. This occurred approximately two and half weeks prior to the current survey and has had a significant impact on the results.

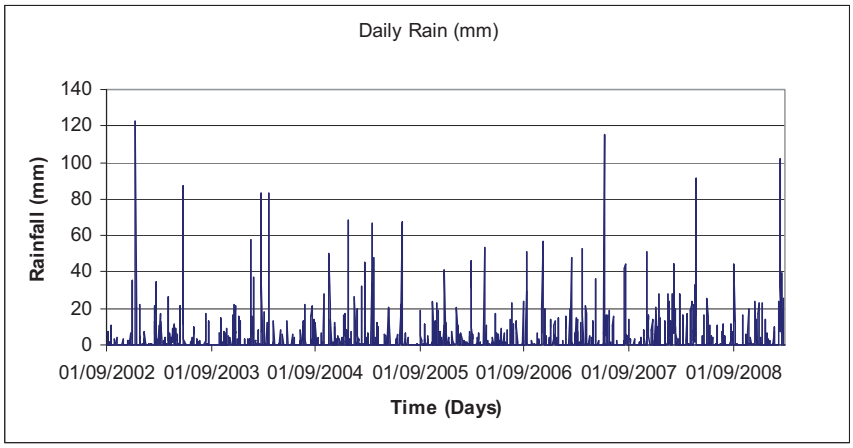

Figure 9. Rainfall values for the Mammy Johnsons River catchment since 2002.

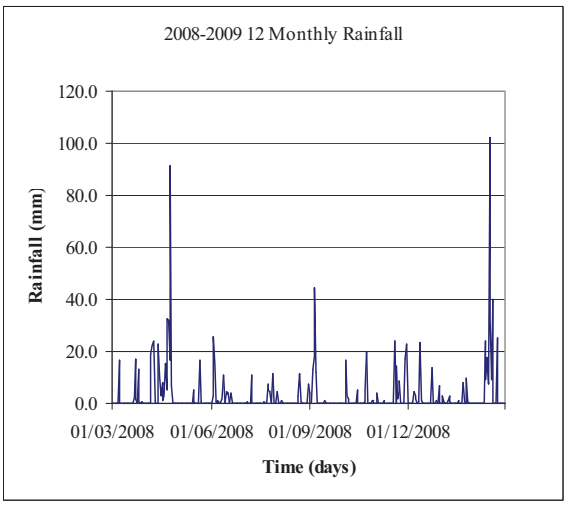

Figure 10. Rainfall values for the Mammy Johnsons River catchment over the last 12 months 2008-09.

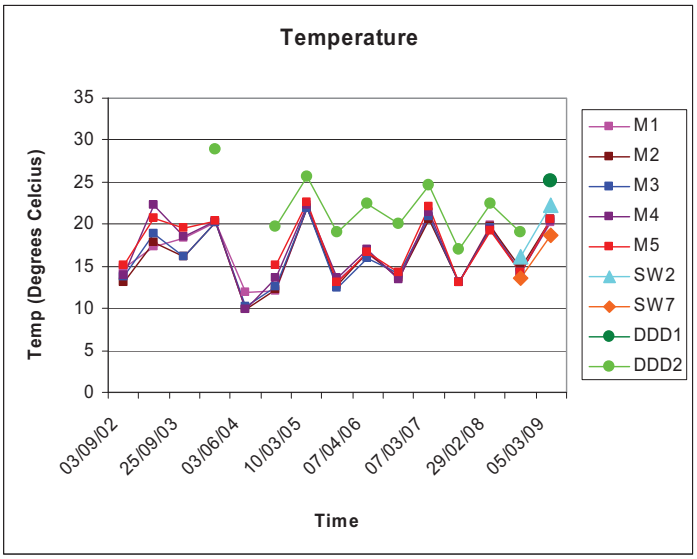

Figure 11. Water temperature values for all sites since September 2002.

During the current survey the temperatures were comparable with temperatures recorded at the corresponding time the previous year, ranging from 18.8°C at Site SW7 to 22.3°C at Site DDD1.

Conductivity was comparable for the river sites to those observed for the last few surveys including the Karuah River. The new sites, Sites SW2 and SW7, recorded significantly higher levels that the river sites. Conductivity did not change significantly in either river system over the last twelve months (Figure 13) as indicated by data supplied by James Benson (Duralie Coal). Coal Shaft Creek (Site SW2) recorded the most variability in EC with levels reaching a maximum of 550 uS/cm in mid December, 2008 during a period of low flow. This is a relatively low value that would not result in any major changes to the ecosystem. This result has also not been reflected in the EC of the Mammy Johnsons River water.

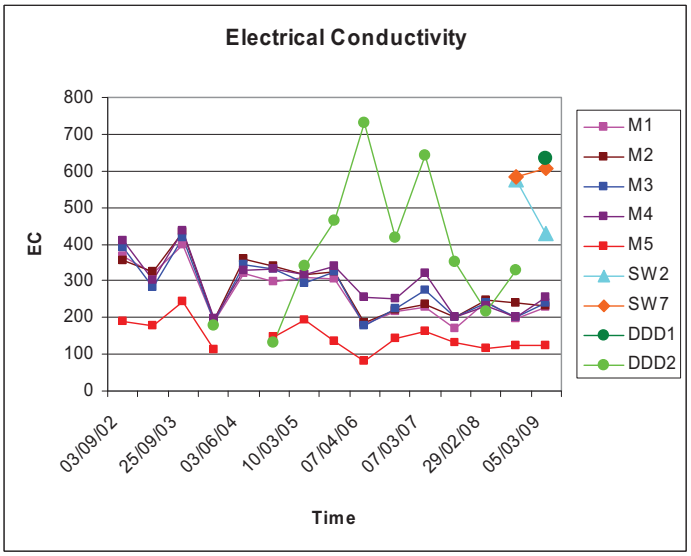

Figure 12. Conductivity values for all sites since September 2002.

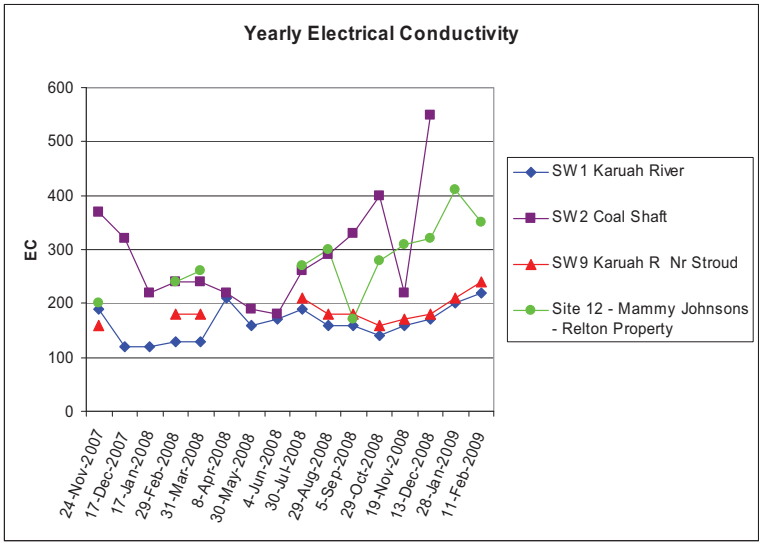

Figure 13. Electrical conductivity in each river system over the last twelve months 2008-2009.

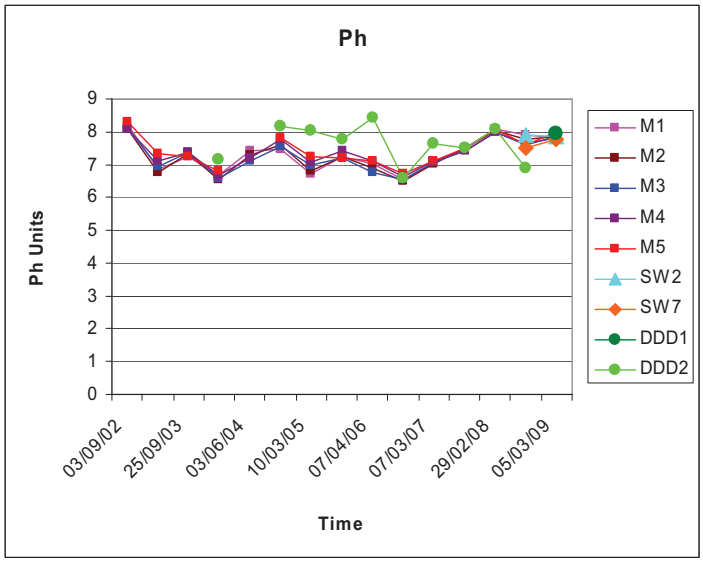

Figure 14. pH values for all sites since September 2002.

The pH was again slightly alkaline and varied little across all sites ranging from 7.8 to 8.0. The pH has remained very constant over time varying no more than 1 pH unit throughout the monitoring program.

Dissolved oxygen (DO) followed a continuation of the pattern of the last two autumn surveys with a range of elevated values that show a decline from the spring levels. The DO values showed a similar variability to the previous years' results. All DO readings were well within the healthy range for aquatic organisms as set out by the ANZECC guidelines.

Site DDD1

The physico-chemical properties of the dam site indicated relatively good water quality. Temperature was higher compared with the other sites, which is to be expected given the shallow edges and essentially no riparian zone to cover the water body. DO was comparable

to the river sites in this instance. Conductivity in Site DDD1 is high compared with the other sites but is very comparable with the previous autumn surveys of Site DDD2. Although this is high compared to previous survey, it is still low compared with regional groundwater and is considered fresh in the ANZECC and ARMCANZ guidelines (2000). The pH is slightly alkaline but consistent with previous surveys. Therefore, the site has relatively high water quality.

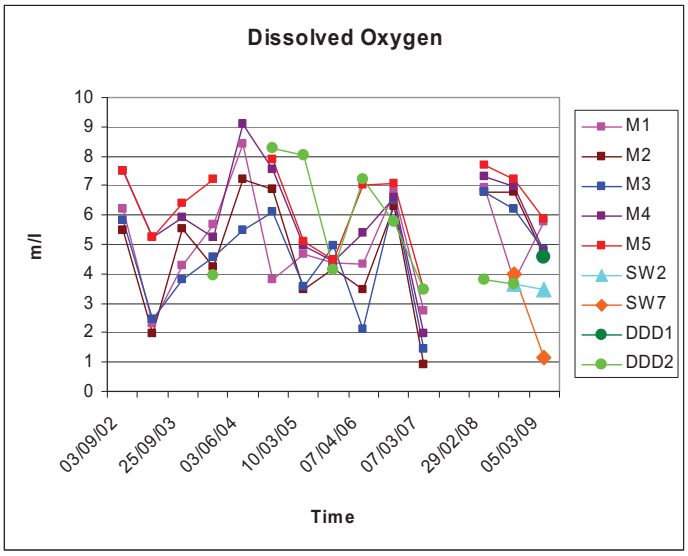

Figure 15. Dissolved Oxygen values for all sites since September 2002.

Discussion

The results of the current survey indicate that both the Mammy Johnsons and Karuah Rivers are still in fair to very good condition and possess a healthy, highly complex and diverse aquatic ecosystem.

In summary, the results show an overall decrease in biodiversity values at all sites, compared with those of the previous survey but are comparable to those observed for the same period in 2007-2008. This indicates that the riverine sites have remained stable. The condition indices (SIGNAL, EPT Ratio and Shredder Ratio) mirrored each other. These results indicate that the riverine ecosystem condition values at Sites M1 - M5 are in fair to good condition or slightly impaired (Site M2) to healthy (all other sites), whereas, the high species diversity and number of EPT taxa indicate that the sites are in good to excellent condition. This signifies that the community composition has remained very consistent in the number of pollution/disturbance sensitive taxa in a highly dynamic flow regime.

The seasonality of the normal lifecycle for most of the EPT taxa (as well as the majority of other aquatic insects) has a major impact on the apparent biodiversity of a river system. The lifecycles of aquatic invertebrates involves the development of the aquatic larvae over the winter months with mature larval emerging as adults from late spring to late summer resulting in an apparent increase in numbers of animals and species during this early spring period. This contrasts with the late summer period where many adults have left the water and larvae are young, small and highly cryptic (i.e. they live in the hyporheic zone / under the gravel substrate). This results in an apparent reduction in biodiversity and abundance and is reflected in the lower diversity of the EPT groups. However, the significant decrease in diversity recorded during this survey across all sites is caused by a combination of this senescent lifecycle period with the very high flows producing an impoverished environment. The results

indicate that a large component of the drop in biodiversity is due to the removal of much the silt tolerant taxa through scouring while the EPT and shredder guild remained essentially intact.

Over the last six months there has been a decrease in the volume and regularity of rainfall events (particularly prior to February, 2009) producing lower regular flow levels in both rivers. However, a significant rainfall event in mid February, 2009, provided a substantial flow that has maintained a higher water quality and scouring of the substrate. Lower flow conditions reduce the scouring effects of floods, which normally remove the accumulated fine sediments, algae and associated invertebrate fauna from the substrate. This in turn results in an increase in the occurrence of some of the more silt tolerant fauna, such as the dipterans (flies), including the Simulidae and Chironomidae. Under prolonged low flow conditions there is a decrease in the amount of available habitat for the grazer and shredder fauna and a corresponding decrease in the presence of these groups. During the current survey this was not the case as there was an abundance of the EPT and shredder taxa due to the rainfall event in February that cleaned the substrate.

The current observations indicate that there was an increase in the overall ecosystem condition even though there was an apparent decrease in biodiversity. This paradoxical situation i.e. a increase in condition with an decrease in the number of high value taxa (highly sensitive) is caused by differences in life cycles of the more sensitive taxa to the less sensitive taxa and the differential affect of high flows on the different elements that make up the aquatic communities. The EPT taxa have longer (usually annual) life spans, are narrow range dispersers and are generally, highly adapted to living in high flow conditions that require extended periods of regular flows to grow and mature. Therefore, the higher numbers of these more sensitive taxa are indicative of the maintenance of suitable environmental conditions for at least the last 6 to 12 months. Whereas the less sensitive or disturbance tolerant taxa typically have shorter life spans, are wide dispersers and maximise productivity during the spring-summer period and are generally adapted to living in soft sediments in areas with low flow. Therefore, the optimum conditions required for both groups have been present at different times over the last twelve months. However, the large flow event in February has preferentially reduced the number of silt tolerant species by removing their habitat through the scouring of the riffles and pools. This has resulted in an overall decrease in the numbers of all groups, but with a larger impact on the silt tolerant species leading to high condition values with lower biodiversity.

Overall, the number of taxa has remained relatively consistent even though there has been a reduction of silt tolerant taxa at some sites and an apparent increase in EPT taxa. Although there has been an overall increase in condition of the two river systems there was significant variability among the sites, often with contradicting results. There are four possible causes for this variability: i) differences in site geomorphology and river size; ii) variations in the habitat produced by the different flow regimes; iii) differences in the composition of the faunal communities associated with each particular type of river flow regime and iv) the seasonal life cycle differences of the different community components.

Therefore, the results of the current survey confirm what has previously been predicted and demonstrated, i.e. that the aquatic biodiversity is continuing to show the same or similar trends to that observed in previous years. The continued presence of high numbers of EPT taxa recorded at all river sites (11 - 20 taxa) indicates that both river systems are very healthy and showing no signs of environmental stress. The other off river sites recorded much lower values than the river sites with Site SW2 recording the highest values both in EPT taxa and EPT ratio, followed by Site SW7 and Site DDD1 recording the lowest values. Site DDD1 also recorded the lowest values compared with all previous surveys. The results from Site SW7 showed a drop in both biodiversity and condition that is suggestive of a change in water quality that requires additional monitoring to determine if this is a sampling anomaly or an actual decline in ecosystem condition.

In conclusion, the results from the current survey suggest that the overall biodiversity and river environmental conditions are very good and that there are no apparent adverse effects on the aquatic macroinvertebrate fauna in the Mammy Johnsons River as a result of any activities arising from the operations of the Duralie Mine.

Acknowledgements

We are grateful to Mr. John Trotter and James Benson for their continued assistance in the field and for providing background information on water quality and site history.

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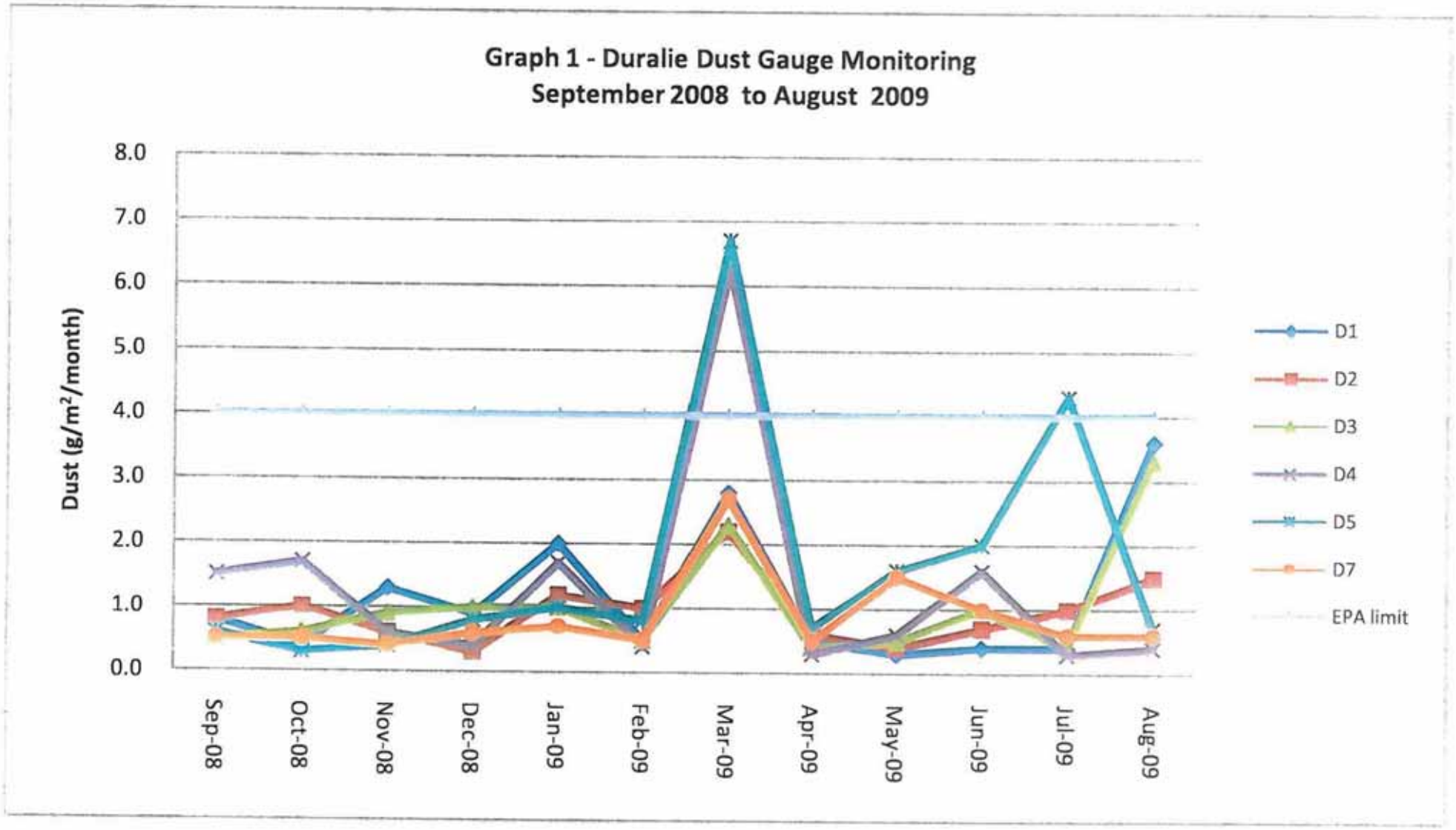
Appendix 1

A list of the macroinvertebrate species collected at the eight sample sites on the Mammy Johnsons and the Karuah Rivers on the 5th March 2009.

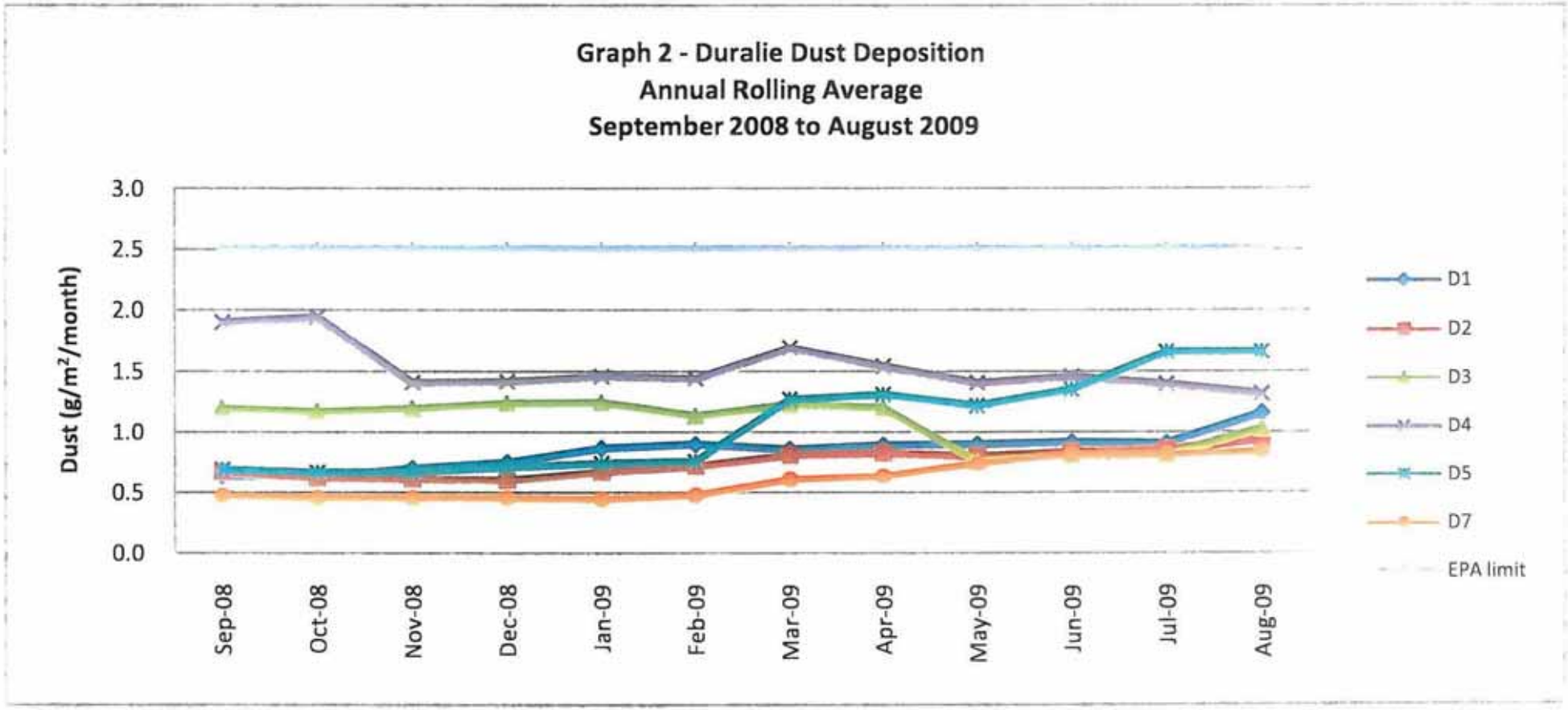
Order	Family	Species	M1	M2	M3	M4	M5	DDD1	SW2	SW7
Acarina	Eylaidae	*Eylais*						*		
Acarina	Hygrobatidae	*undetermined*						*		
Bivalvia	Sphaeridae	*Pisidium*		*		*	*		*	
Coleoptera	Dystiscidae	*Bidessodes*						*	*	
Coleoptera	Dystiscidae	*Bidessus*								*
Coleoptera	Dystiscidae	*Chostonectes*	*	*	*	*			*	
Coleoptera	Dystiscidae	*Necterosoma*	*							
Coleoptera	Elmidae	*Austrolimnius*	*	*	*	*	*			
Coleoptera	Elmidae	*Kingolus*	*				*			
Coleoptera	Elmidae	*Notriolus*		*		*	*			
Coleoptera	Elmidae	*Simsonia*		*	*	*				
Coleoptera	Gyrinidae	*Macrogyrus*		*		*	*			
Coleoptera	Haliplidae	*Haliplus*	*	*	*	*	*		*	
Coleoptera	Hydraenidae	*undetermined*			*		*			
Coleoptera	Hydrophilidae	*Berosus*		*	*			*		
Coleoptera	Psephenidae	*Sclerocyphon maculatus*		*	*	*	*			
Decapoda	Atyidae	*Australatya striolata*				*	*			
Decapoda	Atyidae	*Paratya australiensis*	*	*	*	*	*	*	*	*
Diptera	Ceratopogonidae	*Bezzia*	*	*	*	*	*			
Diptera	Chironomidae	*Chironominae*		*	*	*		*	*	*
Diptera	Chironomidae	*Orthocladinae*	*	*	*		*	*		*
Diptera	Chironomidae	*Tanypodinae*	*	*	*				*	
Diptera	Simulidae	*Simulium*	*		*	*				*
Diptera	Stratiomyidae	*Odontomyia*	*							
Diptera	Tabanidae	*Tabanus*		*						
Diptera	Tipulidae	*sp.*	*	*	*	*				
Ephemeroptera	Baetidae	*Bungona sp. 1*	*		*		*		*	
Ephemeroptera	Baetidae	*Bungona sp. 2*			*		*		*	
Ephemeroptera	Caenidae	*Caenid Genus C sp.*				*			*	
Ephemeroptera	Ameletopsidae	*Mirawara sp.*					*			
Ephemeroptera	Leptophlebiidae	*Atalophlebia sp. AV12*	*			*	*			
Ephemeroptera	Leptophlebiidae	*Austrophlebioides sp. AV9*				*	*			
Ephemeroptera	Leptophlebiidae	*Jappa*					*			
Ephemeroptera	Leptophlebiidae	*Nousia*		*		*				
Ephemeroptera	Leptophlebiidae	*Ulmerophlebia sp. AV1*			*				*	
Gastropoda	Ancylidae	*Ferrissia petterdi*	*		*					
Gastropoda	Hydrobiidae	*Posticobia brazieri*	*	*	*	*	*		*	
Gastropoda	Lymnaeidae	*Pseudosuccinea columella*						*		
Gastropoda	Physidae	*Haitia acuta*						*	*	
Gastropoda	Planorbidae	*Glyptophysa gibbosa*						*		
Gastropoda	Planorbidae	*Gyraulus*	*		*	*			*	
Hemiptera	Corixidae	*Agraptocorixa*						*		
Hemiptera	Corixidae	*Micronecta*	*			*		*	*	
Hemiptera	Gerridae	*Limnogonus*	*			*	*			
Hemiptera	Gerridae	*sp.*	*	*			*			
Hemiptera	Hydrometridae	*Hydrometra strigosa*	*	*						
Hemiptera	Notonectidae	*Anisops*						*		
Hemiptera	Notonectidae	*Enithares*						*		
Hemiptera	Pleidae	*Plea*						*		
Hemiptera	Veliidae	*Microvelia*		*		*				
Hirudinea	Erpobdellidae	*Undetermined*		*						
Isopoda	Sphaeromatidae	*Cymodetta*				*	*			
Megaloptera	Corydalidae	*Archichauliodes guttiferus*	*	*		*	*			
Odonata	Coenagrionidae	*Ischnura heterosticta*						*	*	
Odonata	Gomphidae	*Hemigomphus*		*		*				
Odonata	Hemicorduliidae	*Hemicordulia*						*		
Oligochaete	Lumbriculidae	*Lumbricus variegatus*	*	*			*			
Oligochaete	Tubificidae	*Undetermined*	*	*	*		*		*	
Platyhelminthes	Dugesiidae	*Undetermined*	*				*			
Plecoptera	Grypopterygidae	*Illiesoperla brevicauda*	*	*	*	*	*			
Trichoptera	Atriplectidae	*Atriplectides dubius*	*							
Trichoptera	Calamoceratidae	*Anisocentropus*			*					

Trichoptera	Conoesucidae	*Coenoria sp. AV1*					*			
Trichoptera	Ecnomidae	*Ecnomus*	*						*	
Trichoptera	Helicopsychidae	*Helicopsyche*		*	*					
Trichoptera	Hydrobiosidae	*Apsilochorema*					*			
Trichoptera	Hydropsychidae	*Asmicridea sp.AV1*				*	*			
Trichoptera	Leptoceridae	*Notalina spira*			*			*	*	
Trichoptera	Leptoceridae	*Oecetis*	*		*		*		*	
Trichoptera	Leptoceridae	*Triplectides ciuskus*					*			*
Trichoptera	Leptoceridae	*Triplectides volda*						*		
Trichoptera	Philopotamidae	*Chimarra*	*	*	*	*	*			
Trichoptera	Philopotamidae	*Hydrobiosella*		*						
Totals	**51**	**73**	**M1**	**M2**	**M3**	**M4**	**M5**	**DDD1**	**SW2**	**SW7**
		SIGNAL - HU97B	5.0	5.5	5.7	6.2	6.4	5.1	4.5	5.7
		No of Families	26	25	22	24	25	15	16	5
		No of Genera	29	30	27	29	33	19	20	6
		EPT	7	5	9	7	13	2	6	1
		EPT ratio	0.24	0.16	0.33	0.24	0.39	0.10	0.30	0.16
		Shredder Ratio	0.44	0.36	0.63	0.48	0.6	0.31	0.50	0.16
		Silt Tolerant Taxa	4	2	4	4	2	2	4	1
		Silt Tolerant Taxa Ratio	0.13	0.06	0.14	0.13	0.06	0.10	0.20	0.16

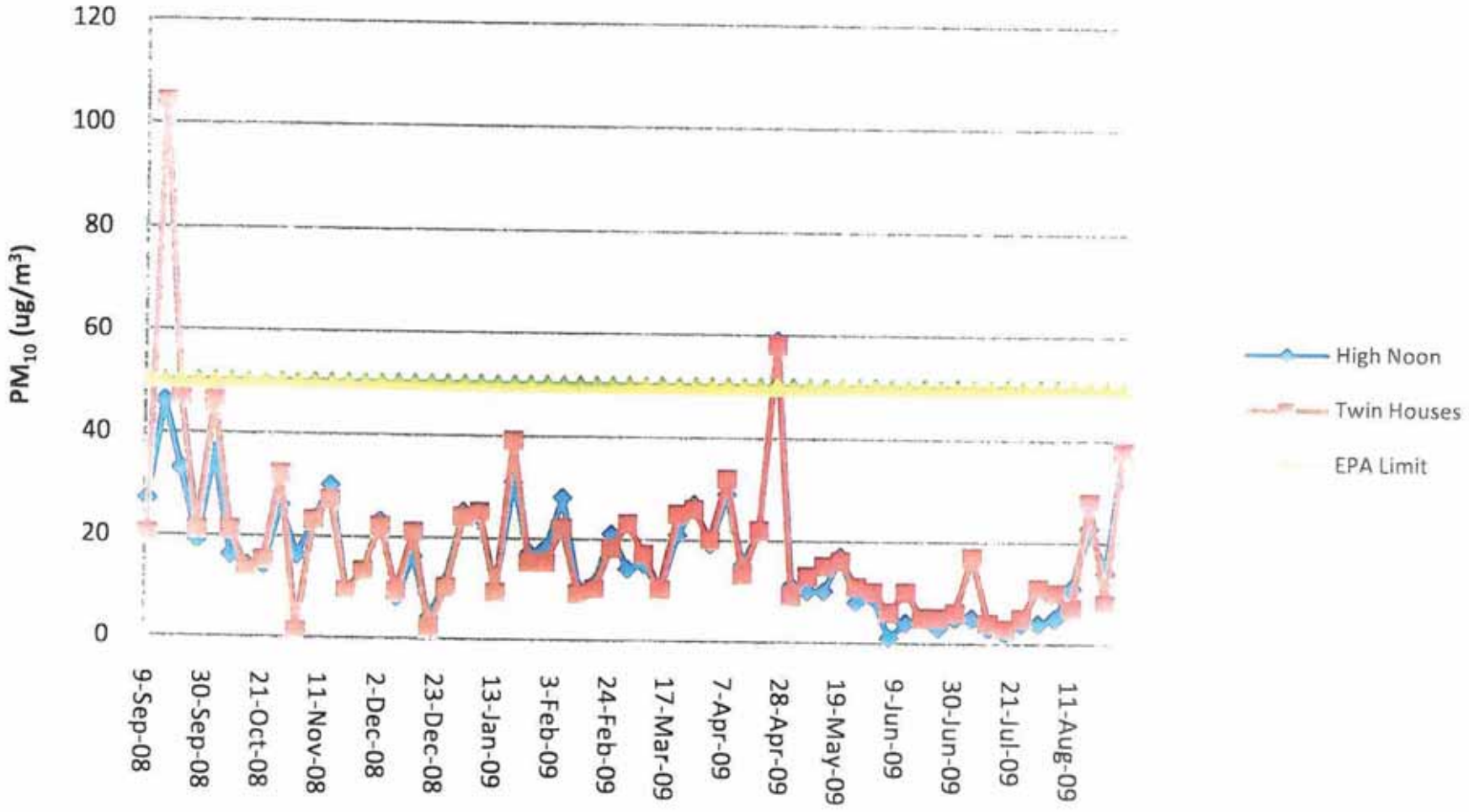
DUST MONITORING



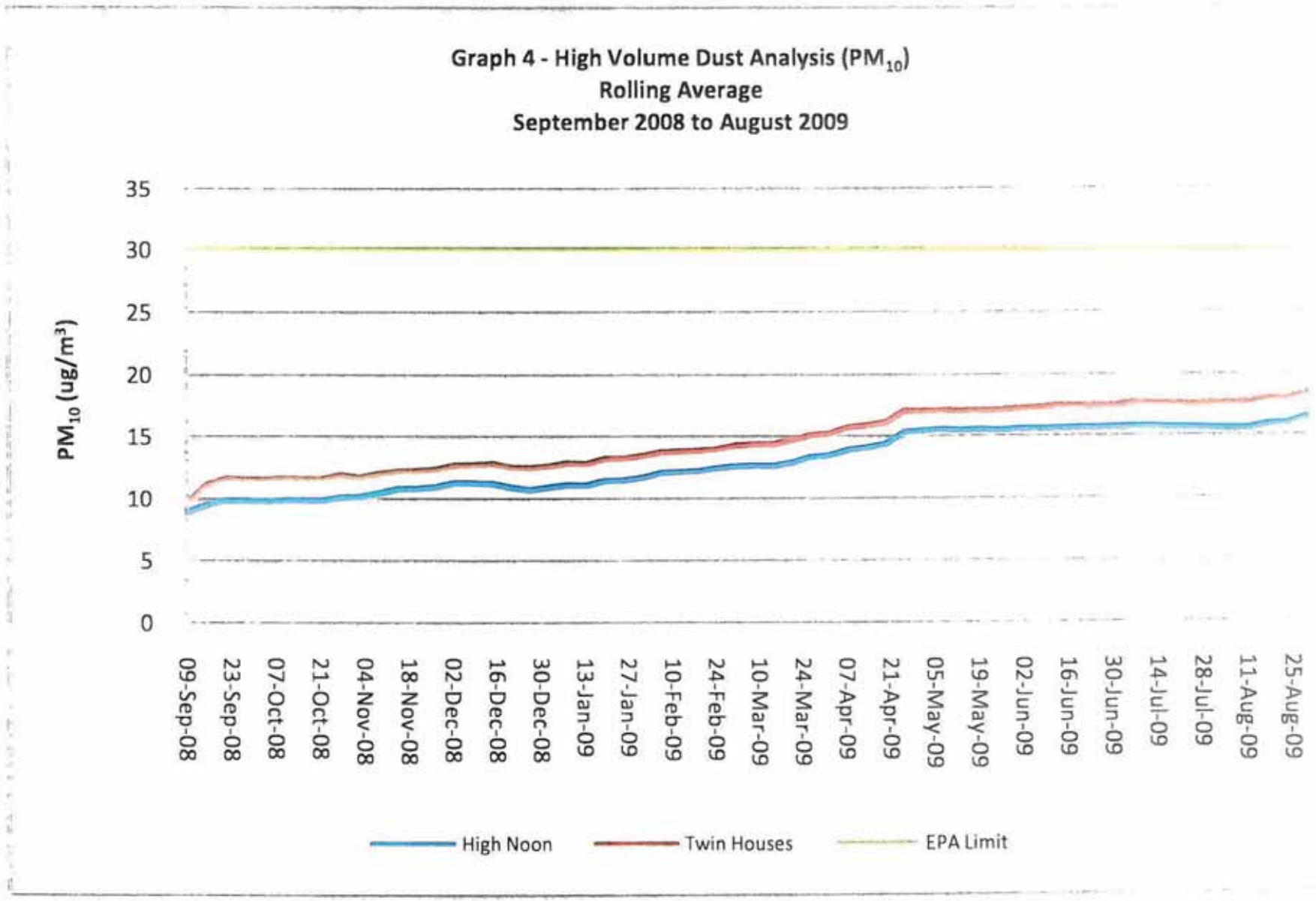
Site D4 in March contaminated by bird dung, insects and plant matter.
Site D5 in March contaminated by bird dung and a beetle.
Site D5 in July contaminated by algae.


Graph 2 - Duralie Dust Deposition
Annual Rolling Average
September 2008 to August 2009
Dust (g/m²/month)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
D1
D2
D3
D4
D5
D7
EPA limit

Graph 3 - Duralie High Volume Dust Sampling (PM_{10}) September 2008 to August2009



"Twin Houses" 15/9/08 elevated result not attributed to mining operations.
Elevated result for both monitoring sites 25/4/09 - no mine production.


Graph 4 - High Volume Dust Analysis (PM_{10})
Rolling Average
September 2008 to August 2009
PM_{10} (ug/m³)
35
30
25
20
15
10
5
0
09-Sep-08
23-Sep-08
07-Oct-08
21-Oct-08
04-Nov-08
18-Nov-08
02-Dec-08
16-Dec-08
30-Dec-08
13-Jan-09
27-Jan-09
10-Feb-09
24-Feb-09
10-Mar-09
24-Mar-09
07-Apr-09
21-Apr-09
05-May-09
19-May-09
02-Jun-09
16-Jun-09
30-Jun-09
14-Jul-09
28-Jul-09
11-Aug-09
25-Aug-09
High Noon
Twin Houses
EPA Limit