Appendix 5

Macroinvertebrate Sampling Program Operations Survey: Spring 2013 and Autumn 2014

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Note: A copy of this Appendix is available on the Project CD

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Report for
Donaldson Coal Pty Ltd

Tasman Coal Mine

Macroinvertebrate Sampling Program Stream Survey: Spring 2013

17th October, 2013

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TASMAN COAL MINE: MACROINVERTEBRATE STREAM SURVEY

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TASMAN COAL MINE: MACROINVERTEBRATE STREAM SURVEY

1 INTRODUCTION

As part of environmental monitoring for the Tasman Coal mine, Blue Gum Creek was investigated for aquatic ecological health, using the indicator macroinvertebrate fauna.

2 STUDY AREA

2.1 CATCHMENT

Blue Gum Creek has its source at Mount Sugarloaf. Prior to Pambalong Nature Reserve, it drains a catchment area of approximately 16km^2. Catchment landuse at the upstream site at George Booth Drive is predominantly bushland as well as underground mining and associated surface infrastructure. By the second site (Dog Hole Road crossing), the catchment also includes grazing activity.

2.2 STREAM SAMPLING

Site Locations

The streams were sampled at two locations:

Blue Gum Creek at Stockrington Road (6.5 km from stream source) Grid Reference: Beresfield 1:25,000 AMG 680 621

Blue Gum Creek at Dog Hole Road (8 km from stream source)
Grid Reference: Beresfield 1:25,000 AMG 693 635

Sampling Event

The stream was sampled in Spring (29th September, 2013) under dry weather conditions, although 16 mm was recorded on 16th September.

3 METHODS

3.1 PARAMETERS

Biological Parameters

Assessment of stream fauna can be used to assess areas of environmental stress through the diversity of the macroinvertebrate population and the presence of pollutant-sensitive or pollutant tolerant animals. Healthy systems are usually characterised by a high diversity but relatively low abundance. Conversely, stressed systems favour the growth of only a few pollution-tolerant organisms, which results in a lower diversity but often higher abundance. Also, as animal diversity and abundance are relatively slow to change when compared to chemical parameters, biological data has the advantage of reflecting the long-term average condition of a system rather than at a single point in time.

Macroinvertebrates are aquatic animals including insect larvae, snails and worms which live amongst aquatic vegetation, wood debris and bed material. They can provide an indication of water quality as well as a measure of the diversity and sensitivity of the aquatic ecosystem. Data was collected on the number of families present as well as the abundance of each family. The biotic index, SIGNAL has been especially developed for freshwaters of South Eastern Australia.

The edge/pool habitat of the streams were sampled at each of the sites using a fine net for a period of 10 minutes. The complete sample was assessed for the abundance of each family as a percentage. Specimens of each discrete taxa were then transferred to a 100 mL phial and preserved with ethanol. Specimens were identified to family using a dissecting microscope.

SIGNAL Index

The SIGNAL index (Chessman, 1995) is a measure of water quality using the factors of indicator animals and abundance. The animals are identified to family level classification, with each family assigned a sensitivity grade between 1 and 10 depending on the tolerance to common pollutants (higher values represent lower levels of tolerance). Each species is then assessed for abundance on a 5 point scale. Scores for each type are calculated from the product of grade and abundance. The Index is derived from the sum of scores divided by the sum of abundances. This provides a comprehensive ecological indicator that takes into account the number and abundance of pollutant sensitive animals.

SIGNAL indices are classified into 5 levels:

• less than 4	= severely impaired	= very poor water quality
• 4-5	= moderately impaired	= poor water quality
• 5-6	= mildly impaired	= fair water quality
• 6-7	= unimpaired	= good water quality
• 7	= unimpaired & rich in sensitive taxa	= excellent water quality

The percentage of sensitive organisms at each site can be calculated using the SIGNAL rankings, with sensitive animals rating a 7 or more. This allows a more detailed picture of the macroinvertebrate community to be ascertained and thus a greater understanding of the degree of impairment of a site.

Riparian Channel Inventory (RCE)

At each site a detailed field observation sheet was completed covering riparian (stream bank) vegetation and stream geomorphology to provide a Riparian-Channel-Environmental Inventory (RCE).

This assessment was developed by Peterson (1992) and evaluates the condition of:

- adjacent land
- banks
- channel & bed (includes instream vegetation and algae)
- riparian vegetation

Each attribute is assigned a value of 1 to 4 depending on the state of impact. A total score is derived from the sum of the component values which indicates the degree of impairment of the stream geomorphology, riparian zone and stream habitat. A rating from very poor to excellent has been developed by Robyn Tuft & Associates for stream bank, stream bed and the total stream condition (RCE) score. The score ranges between 13 to 52, with poor sites generally scoring below 20 and very good to excellent sites above 45. Sites near or over 40 are generally in good condition.

4 RESULTS

4.1 SITE OBSERVATIONS

Blue Gum Creek at Stockrington Road: This site was sampled upstream of the road. The creek was 1 to 3m wide and 0.2 to 0.8m in depth, and water level was low to moderate. Sand, silt and gravel were the main sediments, along with some boulders. Most of the stream was in channel form. Water clarity was fair, and there was leaf litter but no odour . The riparian vegetation was dominated by Acacia, Blue Gum Eucalypts and Lantana. The emergent macrophyte Typha occupied approximately 30% of the site.

Blue Gum Creek at Dog Hole Road: The stream was 1 to 8m wide and approximately 0.1 to 1+m deep channel. The water level was low. Sand, silt and gravel were the main sediments with some organic detritus and submerged logs. Water clarity was good and there was no odour. The riparian vegetation consisted of Blue Gum eucalypts with an understory of mixed natives and exotics, incuding Acacia, Lantana and Cassia.

4.2 RCE RANKING

Results for the Riparian, Catchment and Environment score are given in Table 1. RCE scores reflect a slight improvement in bed and total stream condition for both sites, possibly due to improved flow conditions.

Table 1 RCE Ranking

Site	Date	Bank Condition Score	Bank Condition Rating	Bed Condition Score	Bed Condition Rating	Stream Condition (RCE)	RCE Rating
Blue Gum Ck @ Stockrington Rd	20/5/09	14	Good	11	Excellent	40	Good
	16/11/09	14	Good	6	Poor	36	Fair
	14/12/10	15	Good	5	Poor	32	Fair
	1/4/11	15	Good	5	Poor	32	Fair
	18/10/11	14	Good	6	Poor	33	Fair
	1/11/12	16	Good	6	Poor	35	Fair
	21/3/13	13	Good	7	Fair	35	Fair
	30/9/13	**15**	**Good**	**10**	**Good**	**38**	**Good**
Blue Gum Creek @ Dog Hole Rd	1/8/08	15	Good	8	Fair	37	Good
	20/5/09	13	Good	11	Excellent	39	Good
	16/11/09	12	Fair	7	Fair	31	Fair
	27/4/10	15	Good	12	Excellent	38	Good
	14/12/10	15	Good	11	Excellent	41	Good
	1/4/11	16	Good	7	Fair	36	Fair
	18/10/11	15	Good	8	Fair	38	Good
	12/4/12	12	Fair	9	Good	36	Fair
	1/11/12	13	Good	10	Good	34	Fair
	21/3/13	15	Good	6	Poor	33	Fair
	30/9/13	**15**	**Good**	**10**	**Good**	**39**	**Good**

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4.3 AQUATIC ECOLOGY

Biological characteristics are summarised in Tables 4 and 5. The aquatic ecosystem consisted of a moderate diversity of fauna. The SIGNAL index for both sites were similar to the last survey, placing the upstream and downstream sites in the moderately and mildly impaired categories, respectively. Pollution sensitive Leptophlebiidae (mayfly nymphs) were present at both sites.

No vertebrate fauna were observed in this survey. Macrophytes, predominantly the reed Typha was widespread at the upper site.

Table 4: Biological Characteristics (Macroinvertebrates)

Parameter	Date	Blue Gum Ck at Stockrington Rd	Blue Gum Creek at Dog Hole Rd
DIVERSITY	1/8/08	-	22
	20/5/09	29	25
	16/11/09	20	22
	27/4/10	-	11
	14/12/10	33	35
	1/4/11	24	20
	18/10/11	24	16
	12/4/12	-	23
	1/11/12	28	20
	21/3/13	10	12
	29/9/13	**22**	**16**
SIGNAL INDEX	1/8/08		5.1
	20/5/09	5.7	5.8
	16/11/09	4.6	4.6
	27/4/10	-	3.4
	14/12/10	4.7	4.7
	1/4/11	4.7	4.4
	18/10/11	5.0	5.3
	12/4/12	-	5.6
	1/11/12	4.4	5.0
	21/3/13	4.9	5.6
	29/9/13	**4.8**	**5.3**
PREDOMINANT TYPES	**29/9/13**	Chironomidae (midge larvae) Moinidae (water fleas) Leptophlebiidae (mayfly nymphs) Corixidae (water boatman bug) Dytiscidae (beetle)	Leptoceridae (caddisfly nymphs) Leptophlebiidae (mayfly nymphs) Dytiscidae (water boatmen) Moinidae (water fleas) Copepods (microcrustacea)

Table 5: Biological Characteristics (Non Macroinvertebrates)

Biota	Parameter	Blue Gum Ck at Stockrington Rd	Blue Gum Creek at Dog Hole Rd
Vertebrates	Predominant types	-	-
Macrophytes	Coverage	30%	<2%
	Predominant types	Typha	-
Algae	Coverage		25%
	Predominant types		Brown scum

5 CONCLUSIONS

The stream's ecology showed an improvement diversity since last autumn and still containing some sensitive animal families, particularly at the downstream site.

6 REFERENCES

Australian and New Zealand Environment and Conservation Council (1992) Australian Water Quality Guidelines for Fresh and Marine Waters. National Water Quality Management Strategy November 1992.

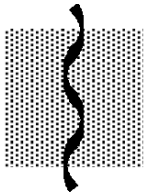
Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000.

Chessman B. C., Growns J.E and Kotlash A.R. (1997) Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: allocation to the Hunter River system, New South Wales. Mar. Freshwater Res. 48, 159-172.

Connell D.W., (1983) Water Pollution, Causes and Effects in Australia and New Zealand, third Edition, University of Queensland Press.

Peterson R.C. Jr (1992) The RCE: a riparian, channel and environmental inventory for small streams in the agricultural landscape. Freshwater Biology 27, 295-306

APPENDIX 1 – BIOLOGICAL DATA



ROBYN TUFT & ASSOCIATES

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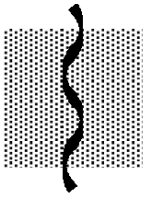
SIGNAL INDEX SUMMARY

		SIGNAL Index
Blue Gum Creek at Stockrington Rd	29 Sep 2013	4.8
Blue Gum Creek at Dog Hole Rd	29 Sep 2013	5.3



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MACROINVERTEBRATE SAMPLING RESULTS

Blue Gum Creek at Stockrington Rd **29 Sep 2013**

Total Number of Taxa 22

Taxon ID	Number of Taxa	Abundance	Score
Ceratopogonidae	1	1	5
Chironomidae	2	4	12
Copepoda	1	2	0
Corixidae	1	2	6
Culicidae	1	1	6
Dugesiidae	1	1	3
Dytiscidae	1	2	4
Gyrinidae	1	1	5
Hydracarina	2	2	10
Hydraenidae	1	1	5
Hydrophilidae	1	2	8
Leptophlebiidae	1	2	20
Limnesiidae	1	2	14
Moinidae	1	3	0
Naucoridae	1	1	5
Notonectidae	1	2	12
Oxidae	1	1	7
Physidae	1	1	1
Planorbidae	1	1	5
Simuliidae	1	1	5

Blue Gum Creek at Dog Hole Rd **29 Sep 2013**

Total Number of Taxa 16

Taxon ID	Number of Taxa	Abundance	Score
Chironomidae	4	2	6
Coenagrionidae	1	2	4
Copepoda	1	3	0
Culicidae	1	2	12

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MACROINVERTEBRATE SAMPLING RESULTS

Dytiscidae	1	3	6
Glossiphoniidae	1	1	3
Gomphidae	1	1	6
Gyrinidae	1	1	5
Isostictidae	1	1	6
Leptoceridae	1	3	21
Leptophlebiidae	1	3	30
Moinidae	1	3	0
Veliidae	1	1	6

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Blue Gum Creek at Dog Hole Road (8 km from stream source)
Grid Reference: Beresfield 1:25,000 AMG 693 635

Sampling Event

The stream was sampled in Autumn (24th March, 2014) under dry weather conditions, although a total of 8 mm was recorded in the three days prior to sampling and 10 mm on 5th March.

3 METHODS

3.1 PARAMETERS

Biological Parameters

Assessment of stream fauna can be used to assess areas of environmental stress through the diversity of the macroinvertebrate population and the presence of pollutant-sensitive or pollutant tolerant animals. Healthy systems are usually characterised by a high diversity but relatively low abundance. Conversely, stressed systems favour the growth of only a few pollution-tolerant organisms, which results in a lower diversity but often higher abundance. Also, as animal diversity and abundance are relatively slow to change when compared to

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generally scoring below 20 and very good to excellent sites above 45. Sites near or over 40 are generally in good condition.

4 RESULTS

4.1 SITE OBSERVATIONS

Blue Gum Creek at Stockrington Road: The creek was 0.1 to 3m wide and 0.1 to 0.8m in depth, and water level was low and there was no observable flow. Sand, silt and gravel were the main sediments, along with some boulders. Most of the stream was in pools. Water clarity was poor, and there was leaf litter but no odour . The riparian vegetation was dominated by *Acacia*, Blue Gum Eucalypts and Lantana. The emergent macrophyte *Typha* occupied approximately 30% of the site.

Blue Gum Creek at Dog Hole Road: The stream was 0.5 to 4m wide and approximately 0.1 to 0.3m deep channel. The water level was low and there was no flow. Sand, silt and clay were the main sediments with some organic detritus and submerged logs. Water clarity was fair and there was a sulphurous odour, indicative of decaying vegetation. Green scum algae covered the majority of the water's surface. The riparian vegetation consisted of Blue Gum eucalypts with an understory of mixed natives and exotics, incuding *Acacia*, Lantana and *Cassia*.

4.2 RCE RANKING

Results for the Riparian, Catchment and Environment score are given in Table 1. RCE scores reflect a slight deterioration in bed and total stream condition for both sites, possibly due to improved flow conditions.

Table 1 RCE Ranking

Site	Date	Bank Condition Score	Bank Condition Rating	Bed Condition Score	Bed Condition Rating	Stream Condition (RCE)	RCE Rating
Blue Gum Ck @ Stockrington Rd							
	20/5/09	14	Good	11	Excellent	40	Good
	16/11/09	14	Good	6	Poor	36	Fair
	14/12/10	15	Good	5	Poor	32	Fair
	1/4/11	15	Good	5	Poor	32	Fair
	18/10/11	14	Good	6	Poor	33	Fair
	1/11/12	16	Good	6	Poor	35	Fair
	21/3/13	13	Good	7	Fair	35	Fair
	30/9/13	15	Good	10	Good	38	Good
	24/3/14	**14**	**Good**	**7**	**Fair**	**35**	**Fair**
Blue Gum Creek @ Dog Hole Rd							
	1/8/08	15	Good	8	Fair	37	Good
	20/5/09	13	Good	11	Excellent	39	Good
	16/11/09	12	Fair	7	Fair	31	Fair
	27/4/10	15	Good	12	Excellent	38	Good
	14/12/10	15	Good	11	Excellent	41	Good
	1/4/11	16	Good	7	Fair	36	Fair
	18/10/11	15	Good	8	Fair	38	Good
	12/4/12	12	Fair	9	Good	36	Fair
	1/11/12	13	Good	10	Good	34	Fair
	21/3/13	15	Good	6	Poor	33	Fair
	30/9/13	15	Good	10	Good	39	Good
	24/3/14	**13**	**Good**	**8**	**Fair**	**34**	**Fair**

4.3 AQUATIC ECOLOGY

Biological characteristics are summarised in Tables 4 and 5. The aquatic ecosystem consisted of a low diversity of fauna. The SIGNAL index for the upstream sites was similar to the last survey, placing it in the moderately and mildly impaired categories. The Dog Hole Road site showed a mark drop in SIGNAL index, placing the site in the severely impaired ecological category. Pollution sensitive Leptophlebiidae (mayfly nymphs) were observed, albeit rare, at the upstream site.

In terms of vertebrate fauna, the exotic fish *Gambusia* was observed in the upstream site and the native fish, Cox'x gudgeon was found at the lower site. Macrophytes, predominantly the reed *Typha*_ was widespread at the upper site.

Table 4: Biological Characteristics (Macroinvertebrates)

Parameter	Date	Blue Gum Ck at Stockrington Rd	Blue Gum Creek at Dog Hole Rd
DIVERSITY	1/8/08	-	22
	20/5/09	29	25
	16/11/09	20	22
	27/4/10	-	11
	14/12/10	33	35
	1/4/11	24	20
	18/10/11	24	16
	12/4/12	-	23
	1/11/12	28	20
	21/3/13	10	12
	29/9/13	22	16
	24/3/14	**9**	**8**
SIGNAL INDEX	1/8/08		5.1
	20/5/09	5.7	5.8
	16/11/09	4.6	4.6
	27/4/10	-	3.4
	14/12/10	4.7	4.7
	1/4/11	4.7	4.4
	18/10/11	5.0	5.3
	12/4/12	-	5.6
	1/11/12	4.4	5.0
	21/3/13	4.9	5.6
	29/9/13	4.8	5.3
	24/3/14	**4.8**	**3.2**
PREDOMINANT TYPES	**24/3/14**	Gyrinidae (whirligig beetle) Hydrophilidae (beetle) Leptophlebiidae (mayfly nymphs)	Hydrophilidae (beetle) Chironomidae (midge larvae) Dytiscidae (water boatmen)

Table 5: Biological Characteristics (Non Macroinvertebrates)

Biota	Parameter	Blue Gum Ck at Stockrington Rd	Blue Gum Creek at Dog Hole Rd
Vertebrates	Predominant types	*Poeciliidae (Gambusia)*	*Gobiidae (Cox's gudgeon)*
Macrophytes	Coverage	30%	<2%
	Predominant types	Typha	-
Algae	Coverage	<2%	75-100%
	Predominant types	-	Green scum

5 CONCLUSIONS

The stream's ecology showed a marked reduction in diversity at both sites since last spring. Both sites showed a predominance of moderately tolerant families. The ecological deterioration was particularly marked at Dog Hole Road site. There is no obvious reason for this trend, which may a temporary aberration. Any influence from Tasman Mine would have been expected to have impacted both sites.

6 REFERENCES

Australian and New Zealand Environment and Conservation Council (1992) Australian Water Quality Guidelines for Fresh and Marine Waters. National Water Quality Management Strategy November 1992.

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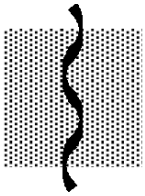

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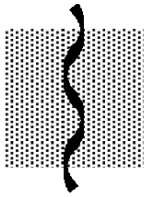
SIGNAL INDEX SUMMARY

		SIGNAL Index
Blue Gum Creek at Stockrington Rd	24 Mar 2014	4.8
Blue Gum Creek at Dog Hole Rd	24 Mar 2014	3.2



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MACROINVERTEBRATE SAMPLING RESULTS

Blue Gum Creek at Stockrington Rd **24 Mar 2014**

Total Number of Taxa 9

Taxon ID	Number of Taxa	Abundance	Score
Austrocorduliidae	1	1	4
Chironomidae	1	1	3
Corixidae	1	1	3
Dytiscidae	1	1	2
Gyrinidae	1	2	10
Hydrochidae	1	1	4
Hydrophilidae	1	3	12
Leptophlebiidae	1	1	10
Poeciliidae	1	2	0

Blue Gum Creek at Dog Hole Rd **24 Mar 2014**

Total Number of Taxa 8

Taxon ID	Number of Taxa	Abundance	Score
Belostomatidae	1	1	5
Chaoboridae	1		
Chironomidae	1	3	9
Dytiscidae	3	3	6
Gobiidae	1	2	0
Hydrophilidae	1	3	12

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