

Appendix 5

Macroinvertebrate Sampling Program Operations Survey: Autumn 2013*

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Report for
Donaldson Coal Pty Ltd
Donaldson Coal Mine



**Macroinvertebrate Sampling Program
Operations Survey: Autumn 2013**

16th April, 2013

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DONALDSON COAL MINE: OPERATIONS MACROINVERTEBRATE SURVEY

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APPENDIX 1 BIOLOGICAL DATA

Donaldson Operation Stage Macroinvertebrate Survey

DONALDSON COAL MINE: OPERATIONS MACROINVERTEBRATE SURVEY

1 INTRODUCTION

As part of the environmental assessment of the Donaldson mining site, a macroinvertebrate monitoring program has been established. The program includes replicable methods for measuring macroinvertebrates as well as water quality and catchment-riparian conditions. These quantitative measures are used to evaluate the effectiveness of water quality protection measures during development of the area for mining. By targeting biological assessment in conjunction with physico-chemical parameters and surrounding abiotic features, a robust measure of stream ecosystem impact and water quality can be obtained.

The program consists of:

- 1 a pre mining baseline survey
- 2 a construction survey
- 3 twice yearly operational surveys

The pre-mining survey was performed on 26th September 2000. Six sites were targeted on the 3 major tributaries traversing the site. Results indicated the streams supported a relatively diverse ecology including some sensitive families of macroinvertebrates. Catchment condition scores (RCE scores) were good to excellent. A full report is contained in 'Donaldson Coal Mine Macroinvertebrate Sampling Program Pre-mining Survey - Robyn Tuft and Associates, November 2000). The construction phase survey was conducted on the 19th and 20th March 2001 and showed no impairment of aquatic fauna due to construction activities ('Donaldson Coal Mine Macroinvertebrate Sampling Program: Construction Survey - Robyn Tuft and Associates, May 2001).

This report provides data the for operational survey in Autumn 2013. The streams were sampled on the 21st March, 2013 under dry weather conditions, although 2.8 mm was recorded on 17th March and 125 mm fell over 3 days from February 28th to March 2nd.

2 STUDY AREA

2.1 CATCHMENT

The study area mostly consists of gently undulating land currently predominantly open woodland.

Three main streams traverse the site:

- Scotch Dairy Creek,
- Weakleys Flat Creek and
- Four Mile Creek

Scotch Dairy Creek has a catchment area of approximately 4km² and is situated towards the northern boundary of the mining area. The upstream site is not totally isolated from mining activities as some roads are within its catchment. The catchment is predominantly bushland. Weakleys Flat Creek is located in the south-east corner of the site. This stream has a catchment area of some 7 km² which includes farming activities as well as bushland. A large western tributary of Weakleys Flat Creek drains the central section of the Donaldson mining area. Four Mile Creek flows from south to north across the western portion of the site. There is



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approximately 8 km² of catchment upstream of the northern site boundary which is currently predominantly bushland with some grazing and rural housing in the headwaters.

Scotch Dairy and Weakleys Flat Creek discharge into Woodberry Swamp and Four Mile Creek continues north to the Hunter River floodplain.

2.2 STREAM STUDY

Site Locations

The streams were due to be sampled at six locations:

- Site 1: Four Mile Creek upstream (1.5km from stream source) Grid Reference: Beresfield 1:25,000 AMG 682 672
- Site 2: Four Mile Creek downstream (3.5 km from stream source) Grid Reference: Beresfield 1:25,000 AMG 685 686
- Site 3: Scotch Dairy Creek upstream (1 km from stream source) Grid Reference: Beresfield 1:25,000 AMG 696 695
- Site 4: Scotch Dairy Creek downstream (3.5 km from stream source) Grid Reference: Beresfield 1:25,000 AMG 719 702
- Site 5: Weakleys Flat Creek downstream (3 km from stream source) Grid Reference: Beresfield 1:25,000 AMG 709 687
- Site 6: Weakleys Flat Creek upstream (4.5 km from stream source) Grid Reference: Beresfield 1:25,000 AMG 679 705

These sites are adjacent to Donaldson Mine Water Quality site which reflect the different sectors of the study area.

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/riffle 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

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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, except for Chironomids which were identified to subfamily.

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.

Other Observations

In addition to macroinvertebrate sampling, any sightings or signs of vertebrates within the stream environment (e.g. fish, amphibia, aquatic birds or reptiles) were also recorded. The relative abundance of algae and macrophytes were included as observations, to assess the degree of eutrophication as well as the degree of weed infestation of the riparian zone.

3.2 SITE CHARACTERISTICS

At each site a detailed field observation sheet was completed covering riparian (stream bank) vegetation, stream geomorphology, visual characteristics and odour. Furthermore, a Riparian-Channel-Environmental Inventory (RCE) was calculated.

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.

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4 RESULTS

4.1 SITE OBSERVATIONS

Four Mile Creek upstream: was situated downstream of John Renshaw Drive. Native shrubs dominated the understorey with a Eucalypt/Acacia canopy. The stream consisted of a channel, 1 to 3m in width and 0.2 to 1m in depth. Much of the substrate was bedrock, overlain with decaying vegetation, and submerged logs. The water level was moderate in the channel. The bank was overhanging in some parts and vegetated. The water clarity was poor with some scum and foam.

Four Mile Creek downstream: was sampled in a shallow section of riffle and channel, 1 to 4m wide and 0.1 to 0.6m in depth. The water level was moderate and water clarity was good. Substrate was mainly sand, silt, pebble and gravel, with submerged logs. The banks were lined with Eucalypts, Lomandra, Lantana, rainforest, ferns, moss and maidenhair which held the banks in place.

Scotch Dairy upstream: was sampled in wide pool, 1 to 4m in width and 0.2 to 1.2 in depth. Water clarity was murky and there was no flow. There was no odour. Submerged logs and some detritus cover was present. The substrate was sand, clay and silt and there were some aquatic plants. Shading of the site was moderate from native trees and the banks were lined with native grasses and shrubs. Some exotic shrubs were present.

Scotch Dairy downstream: was sampled in a channel, 0.5 to 4m wide and 0.1 to 1.5m deep. Water clarity was poor and the water level was high. The substrate was mostly sand with some pebble and gravel. An earthy odour was present. Eucalypts provided moderate shading for the site and the understorey was dominated by native shrubs, grasses and herbs and exotics such as Lantana. The majority of the bank was lined with trailing vegetation and moss.

Weakleys Flat Creek upstream: was located downstream of John Renshaw Drive. Shading was moderate from *Acacia/Eucalyptus* trees. The understorey was dominated by *Lomandra* and exotic shrubs, such as Lantana. The stream consisted of a 1 to 10m channel of 0.1 to 0.6m depth. The stream substrate was mostly sand and bedrock with some detritus cover and submerged logs. The water level was low and water clarity was fair. The majority of the channel was vegetated with emergent Typha and Phragmites reeds. The bank was lined with native and exotic grasses and herbs, Eucalypts/Acacia and Lantana.

Weakleys Flat Creek downstream: was sampled in a channel, 0.1 to 2.5m wide and 0.1 to 0.8m deep. The water level was moderate and the clarity fair. The substrate was sand and boulder with submerged logs. There was no odour present, but there was some scum and foam. The site was moderately shaded from native trees such as eucalypts, with the understorey significantly populated by exotics, mostly Lantana and Crofton. Much of the bank was lined with native and exotic grasses and herbs.

4.2 RCE RANKING

Results for the Riparian, Catchment and Environment score are given in Table 3. All sites showed little change from the spring sampling.

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Table 3 RCE Ranking

Site	Date of Collection	Bank Condition Score	Bank Condition Rating	Bed Condition Score	Bed Condition Rating	Stream Condition (RCE)	RCE Rating
Site 1 Four Mile U/S	26/09/00	22	Excellent	10	Good	45	Excellent
	19/03/01	16	Good	6.5	Fair	45	Excellent
	11/10/01	16	Good	9	Good	40	Good
	15/4/02	12	Fair	7	Fair	34	Fair
	9/10/02	18	Good	9	Good	43	Good
	17/4/03	19	Excellent	8	Fair	43	Good
	10/10/03	16	Good	11	Excellent	43	Good
	1/4/04	19	Excellent	9	Good	48	Excellent
	6/10/04	14	Good	8	Fair	40	Good
	15/4/05	15	Good	7	Fair	40	Good
	27/9/05	15	Good	9	Good	41	Good
	11/4/06	15	Good	10	Good	41	Good
	17/11/06	14	Good	9	Good	40	Good
	20/4/07	15	Good	7	Fair	39	Good
	5/10/07	15	Good	11	Excellent	41	Good
	8/4/08	14	Good	11	Excellent	41	Good
	21/11/08	17	Good	8	Fair	41	Good
	20/5/09	16	Good	10	Good	38	Good
	16/11/09	15	Good	5	Poor	33	Fair
	27/4/10	16	Good	9	Good	40	Good
	14/12/10	17	Excellent	9	Good	41	Good
	1/4/11	15	Good	6	Poor	36	Fair
	18/10/11	17	Excellent	8	Fair	41	Good
	12/4/12	15	Good	10	Good	41	Good
	1/11/12	14	Good	11	Excellent	42	Good
	21/3/13	15	Good	9	Good	40	Good
Site 2 Four Mile D/S	26/09/00	21	Excellent	6	Poor	39	Good
	20/03/01	15	Good	7	Fair	39	Good
	11/10/01	16	Good	7	Fair	37	Good
	15/4/02	16	Good	6	Poor	36	Fair
	9/10/02	20	Excellent	9	Good	45	Good
	17/4/03	19	Excellent	10	Good	45	Good
	10/10/03	16	Good	11	Excellent	43	Good
	1/4/04	17	Good	10	Good	44	Good
	6/10/04	14	Good	10	Good	41	Good
	15/4/05	14	Good	10	Good	39	Good
	27/9/05	15	Good	10	Good	40	Good
	11/4/06	15	Good	8	Fair	38	Good
	17/11/06	16	Good	10	Good	43	Good
	20/4/07	16	Good	8	Fair	40	Good
	5/10/07	15	Good	10	Good	40	Good
	8/4/08	13	Good	10	Good	40	Good
	21/11/08	12	Fair	9	Good	35	Fair
	20/5/09	13	Good	5	Poor	30	Fair
	16/11/09	14	Good	10	Good	39	Good
	27/4/10	13	Good	11	Good	38	Good
	14/12/10	14	Good	11	Good	40	Good
	1/4/11	16	Good	5	Poor	35	Fair
	18/10/11	13	Good	7	Fair	36	Fair
	12/4/12	15	Good	9	Good	40	Good
	1/11/12	15	Good	9	Good	39	Good
	21/3/13	13	Good	7	Fair	36	Fair



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Site	Date of Collection	Bank Condition Score	Bank Condition Rating	Bed Condition Score	Bed Condition Rating	Stream Condition (RCE)	RCE Rating
Site 3 Scotch Dairy U/S	26/09/00	21	Excellent	8	Fair	39	Good
	20/03/01	15	Good	7	Poor	37	Good
	15/4/02	12	Fair	9	Good	37	Good
	9/10/02	16	Good	9	Good	43	Good
	17/4/03	17	Good	6	Poor	36	Fair
	21/10/03	15	Good	5	Poor	36	Fair
	1/4/04	19	Excellent	5	Poor	40	Good
	6/10/04	14	Good	5	Poor	36	Good
	15/4/05	14	Good	5	Poor	34	Fair
	27/9/05	14	Good	5	Poor	33	Fair
	11/4/06	13	Good	5	Poor	33	Fair
	17/11/06	16	Good	4	Very Poor	37	Good
	20/4/07	14	Good	5	Poor	36	Fair
	5/10/07	13	Good	5	Poor	35	Fair
	8/4/08	13	Good	4	Very Poor	33	Fair
	21/11/08	17	Excellent	4	Very Poor	41	Good
	20/5/09	15	Good	5	Poor	33	Fair
	16/11/09	15	Good	4	Very Poor	35	Fair
	27/4/10	15	Good	5	Very Poor	35	Fair
	14/12/10	18	Excellent	4	Very Poor	38	Good
	18/10/11	17	Excellent	4	Very Poor	38	Good
12/4/12	17	Excellent	4	Very Poor	36	Fair	
1/11/12	15	Good	4	Very Poor	39	Good	
21/3/13	17	Excellent	5	Poor	38	Good	
Site 4 Scotch Dairy D/S	26/09/00	20	Excellent	5	Poor	39	Good
	20/03/01	17	Good	7	Fair	39	Good
	11/10/01	16	Good	11	Excellent	42	Good
	15/4/02	15	Good	8	Fair	40	Good
	9/10/02	16	Good	5	Poor	34	Fair
	17/4/03	17	Good	5	Poor	35	Fair
	21/10/03	15	Good	6	Poor	37	Good
	1/4/04	17	Good	5	Poor	40	Good
	6/10/04	13	Good	7	Fair	37	Good
	15/4/05	15	Good	6	Poor	37	Good
	27/9/05	16	Good	6	Poor	38	Good
	11/4/06	14	Good	5	Poor	35	Fair
	17/11/06	15	Good	6	Poor	36	Fair
	20/4/07	16	Good	8	Fair	35	Fair
	5/10/07	16	Good	8	Fair	40	Good
	8/4/08	13	Good	5	Poor	33	Fair
	21/11/08	16	Good	8	Fair	39	Good
	20/5/09	14	Good	6	Poor	34	Fair
	16/11/09	14	Good	5	Poor	34	Fair
	27/4/10	13	Good	10	Fair	37	Good
	14/12/10	15	Good	7	Fair	37	Good
18/10/11	17	Excellent	6	Poor	39	Good	
12/4/12	15	Good	7	Fair	39	Good	
1/11/12	13	Good	6	Poor	36	Fair	
21/3/13	15	Good	9	Good	41	Good	

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Site	Date of Collection	Bank Condition Score	Bank Condition Rating	Bed Condition Score	Bed Condition Rating	Stream Condition (RCE)	RCE Rating
Weakleys Flat U/S	26/09/00	19	Excellent	5	Poor	34	Fair
	19/03/01	14	Good	6.5	Fair	33.5	Fair
	11/10/01	15	Good	6	Poor	34	Fair
	15/4/02	12	Fair	9	Good	37	Good
	9/10/02	16	Good	8	Fair	39	Good
	17/4/03	15	Good	9	Good	38	Good
	10/10/03	15	Good	7	Fair	36	Fair
	1/4/04	17	Good	9	Good	39	Good
	6/10/04	14	Good	6	Poor	35	Fair
	15/4/05	14	Good	5	Poor	30	Fair
	27/9/05	14	Good	8	Fair	36	Fair
	11/4/06	11	Fair	8	Fair	34	Fair
	17/11/06	13	Good	6	Poor	29	Fair
	20/4/07	11	Fair	7	Fair	33	Fair
	5/10/07	14	Good	7	Fair	34	Fair
	8/4/08	13	Good	8	Fair	37	Good
	21/11/08	15	Good	6	Poor	34	Fair
	20/5/09	13	Good	4	Very poor	23	Very poor
	16/11/09	14	Good	5	Poor	34	Fair
	27/4/10	15	Good	8	Fair	34	Fair
	14/12/10	15	Good	6	Poor	34	Fair
	1/4/11	14	Good	6	Poor	34	Fair
	18/10/11	14	Good	7	Fair	34	Fair
	12/4/12	15	Good	8	Fair	35	Fair
	1/11/12	15	Good	8	Fair	36	Fair
	21/3/13	13	Good	8	Fair	34	Fair
Weakleys Flat D/S	26/09/00	21	Excellent	7	Fair	41	Good
	20/03/01	18	Good	6	Poor	40	Good
	11/10/01	14	Good	10	Good	40	Good
	15/4/02	14	Good	5	Good	37	Good
	9/10/02	17	Good	8	Fair	42	Good
	17/4/03	17	Good	8	Fair	39	Good
	10/10/03	15	Good	12	Excellent	42	Good
	1/4/04	17	Good	9	Good	45	Good
	6/10/04	14	Good	7	Fair	39	Good
	15/4/05	13	Good	6	Poor	36	Fair
	27/9/05	12	Fair	8	Fair	37	Good
	11/4/06	15	Good	9	Good	37	Good
	17/11/06	14	Good	10	Good	36	Fair
	20/4/07	17	Good	8	Fair	37	Good
	5/10/07	15	Good	8	Fair	38	Good
	8/4/08	16	Good	8	Fair	40	Good
	21/11/08	15	Good	8	Fair	39	Good
	20/5/09	15	Good	7	Fair	37	Good
	16/11/09	15	Good	7	Fair	34	Fair
	27/4/10	16	Good	6	Poor	34	Fair
	14/12/10	15	Good	6	Poor	36	Fair
	18/10/11	15	Good	7	Fair	39	Good
	12/4/12	16	Good	9	Good	41	Good
	1/11/12	14	Good	8	Fair	40	Good
	21/3/13	15	Good	8	Fair	38	Good



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4.3 AQUATIC ECOLOGY

Biological characteristics are summarised in Tables 6 and 7. The diversity of fauna had decreased substantially at all sites apart from Scotch Dairy downstream, where it remained similar. The SIGNAL index showed little change at any site. All sites were populated by pollutant sensitive families such as shrimps, caddisfly and mayfly nymphs.

The native fish Cox's Gudgeon was sampled at Four Mile Creek upstream.

Algal growth was low at all sites, Reeds of the genus *Phragmites* and *Typha* were the only substantial macrophytic growth and were restricted to Weakleys Flat upstream in a sunny sediment laden channel.

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Table 6: Biological Characteristics (Macroinvertebrates)

Parameter	Site 1 Four Mile Ck, u/s	Site 2 Four Mile Ck, d/s	Site 3 Scotch Dairy Ck, u/s	Site 4 Scotch Dairy Ck, d/s	Site 6 Weakleys Flat Ck, u/s	Site 5 Weakleys Flat Ck, d/s
Diversity						
Autumn, 2013	10	11	12	16	16	9
Spring, 2012	20	19	17	15	27	18
Autumn, 2012	16	20	15	15	23	18
Spring 2011	8	9	13	16	15	15
Autumn 2011	15	13	-	-	19	-
Spring 2010	21	22	13	22	30	17
Autumn 2010	20	27	15	11	30	6
Spring 2009	28	26	21	18	30	19
Autumn 2009	17	7	17	9	20	19
Spring 2008	32	24	23	25	25	28
Autumn 2008	19	12	18	22	18	14
Spring 2007	28	20	16	19	24	27
Autumn 2007	22	20	11	16	22	19
Spring 2006	(24)	(20)	(17)	(20)	(17)	(18)
Autumn 2006	(16)	(23)	(13)	(18)	(21)	(16)
Spring 2006	(19)	(24)	(23)	(23)	(26)	(15)
Autumn 2005	(11)	(27)	(20)	(21)	(25)	(12)
Spring 2004	(17)	(25)	(12)	(15)	(30)	(10)
Autumn 2004	(17)	(31)	(17)	(31)	(34)	(22)
Spring 2003	(17)	(27)	(17)	(13)	(28)	(16)
Autumn 2003	(14)	(28)	(19)	(27)	(33)	(27)
Spring 2002	(21)	(24)	(12)	(20)	(25)	(22)
Autumn 2002	(22)	(19)	(33)	(27)	(34)	(24)
Spring, 2001	(37)	(30)		(30)	(31)	(26)
Autumn, 2001	(20)	(30)	(18)	(25)	(31)	(36)
baseline	(30)	(36)	(39)	(32)	(44)	(39)
result						
SIGNAL Index						
Autumn, 2013	5.8	5.4	5.7	6.0	5.7	5.6
Spring, 2012	5.2	5.7	5.7	5.9	5.4	5.6
Autumn, 2012	6.0	6.6	5.6	6.3	5.6	5.7
Spring 2011	6.3	5.3	6.1	6.0	4.8	6.0
Autumn 2011	5.9	5.4	-	-	4.8	-
Spring 2010	5.3	5.3	5.8	5.2	5.0	5.3
Autumn 2010	5.1	4.9	4.4	4.2	4.5	5.8
Spring 2009	5.3	5.7	5.8	5.8	5.4	5.4
Autumn 2009	5.9	7.1?	5.5	6.0	4.9	5.4
Spring 2008	5.3	5.9	5.4	6.2	5.6	5.4
Autumn 2008	5.6	5.4	5.5	5.6	5.3	5.7
Spring 2007	5.4	6.1	5.1	4.7	4.7	5.1
Autumn 2007	5.7	5.3	6.0	5.2	4.8	5.4
Spring 2006	(5.4)	(5.3)	(5.5)	(5.3)	(4.3)	(4.3)
Autumn 2006	(6.4)	(4.8)	(4.7)	(5.6)	(4.4)	(5.7)
Spring 2006	(5.7)	(5.7)	(5.1)	(6.0)	(4.3)	(5.7)
Autumn 2005	(5.2)	(5.6)	(5.2)	(6.2)	(4.4)	(4.6)
Spring 2004	(5.7)	(5.5)	(5.2)	(4.9)	(5.0)	(4.6)
Autumn 2004	(6.0)	(5.5)	(5.0)	(4.9)	(5.0)	(5.4)
Spring 2003	(6.0)	(5.9)	(4.6)	(5.7)	(5.3)	(5.5)
Autumn 2003	(6.1)	(5.7)	(5.2)	(5.5)	(5.0)	(4.6)
Spring 2002	(6.0)	(5.7)	(4.0)	(5.9)	(5.4)	(5.7)
Autumn 2002	(5.7)	(5.4)	(5.2)	(6.0)	(5.3)	(5.5)
Spring, 2001	(5.8)	(5.8)	-	(5.6)	(5.4)	(5.7)
Autumn, 2001	(5.6)	(5.3)	(5.3)	(5.6)	(5.0)	(5.3)
baseline	(6.0)	(5.7)	(5.7)	(5.6)	(5.4)	(5.5)
result						



Donaldson Operation Stage Macroinvertebrate Survey

Parameter	Site 1 Four Mile Ck, u/s	Site 2 Four Mile Ck, d/s	Site 3 Scotch Dairy Ck, u/s	Site 4 Scotch Dairy Ck, d/s	Site 6 Weakleys Flat Ck, u/s	Site 5 Weakleys Flat Ck, d/s
Predominant types	Leptophlebiidae (mayfly nymphs)	Atyidae (shrimp)	Leptophlebiidae (mayfly nymphs)	Dytiscidae (beetle)	Leptophlebiidae (mayfly nymphs)	Dytiscidae (beetles)
Autumn, 2013	Dytiscidae (beetle)	Leptophlebiidae (mayfly nymphs)	Dytiscidae (beetle)	Leptoceridae (caddisfly nymphs)	Dytiscidae (beetle)	Leptophlebiidae (mayfly nymphs)
	Hydrophilidae (beetle)	Dytiscidae (beetle)	Atyidae (shrimp)	Leptophlebiidae (mayfly nymphs)	Veliidae (surface bug)	Culicidae (mosquito larvae)
	Veliidae (surface bug)	Chironomidae (fly larvae)	Megapodagrionidae (damselfly nymph)	Veliidae (surface bug)	Atyidae (shrimp)	
	Atyidae (shrimp)	Megapodagrionidae (damselfly nymph)				
	Parastacidae (yabbie)	Parastacidae (yabbie)				

Table 7: Biological Characteristics (Non Macroinvertebrates)

Biota	Parameter	Site 1 Four Mile Ck, u/s	Site 2 Four Mile Ck, d/s	Site 3 Scotch Dairy, u/s	Site 4 Scotch Dairy Ck, d/s	Site 6 Weakleys Flat Ck, u/s	Site 5 Weakleys Flat Ck, d/s
Vertebrates	Predominant types	Cox's gudgeon	-	-	-	-	-
Macrophytes	Coverage	-	-	-	-	50%	-
	Predominant types	-	-	-	-	<i>Phragmites</i> <i>Typha</i>	-
Algae	Coverage	-	-	-	-	-	-
	Predominant types	-	-	-	-	-	-

5 CONCLUSIONS

The streams in the study area tended to show low diversity of fauna indicative of mildly impaired fauna and fair water quality. However all sites were populated by several pollutant sensitive families of invertebrates.

All systems performed relatively favourably with downstream comparison.

Individual site conclusions are provided below.

Four Mile Creek Upstream

This site was moderately turbid and was flowing. The Bed, Bank and RCE scores for this site remained good. The faunal diversity had decreased since spring to 10 taxa but included some pollution sensitive families, with mayflies predominant. The SIGNAL score was typical for this site and was higher than in spring, 2012. The native fish, Coxs gudgeon was also observed.

Four Mile Creek Downstream

Two kilometres further downstream, the RCE score was fair to good, with a slight reduction in bed score. Water clarity was good. Macroinvertebrate communities diversity was low and the SIGNAL index slightly reduced from spring, 2012 but not atypical for this site. Several pollutant sensitive families were present, such as mayfly nymphs and shrimp.

Donaldson Operation Stage Macroinvertebrate Survey

Scotch Dairy Creek Upstream

Turbidity was high at this site and again there was no flow. RCE scores remained good to excellent apart from a poor bed condition due to sediment accumulation. Macroinvertebrate diversity was low and the SIGNAL index unchanged. The pollutant sensitive family of mayflies were predominant.

Scotch Dairy Creek Downstream

This site was moderately turbid and there was an earthy odour. RCE scores were good and the bed score has improved. Macroinvertebrate density was moderate and the SIGNAL index was unchanged. Beetles were the dominant fauna, with caddisfly and mayfly nymphs also common.

Weakleys Flat Creek Upstream

The open nature of this site encouraged some aquatic plant growth in terms of the reeds (Typha and Phragmites). Turbidity was moderately high. Macroinvertebrate diversity was moderate but substantially lower than in spring, 2012. The SIGNAL index was slightly higher. Pollutant sensitive Leptophlebiidae were abundant. The RCE score was similar to last sampling.

Site 5 Weakleys Flat Creek Downstream

Turbidity at this site was moderately high. The RCE score was unchanged. Macroinvertebrate diversity was low with beetles dominant, but mayfly nymphs also common. The SIGNAL index was similar to spring, in the mildly impaired range.

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.

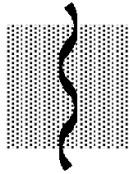
Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000.

Chessman B. C., Gowns 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.

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

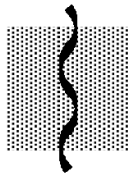


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RT152

SIGNAL INDEX SUMMARY

		SIGNAL Index
Four Mile Ck, upstream	21 Mar 2013	5.8
Four Mile Ck, downstream	21 Mar 2013	5.4
Weakleys Flat Ck, upstream	21 Mar 2013	5.7
Weakleys Flat Ck, downstream	21 Mar 2013	5.6
Scotch Dairy Ck, upstream	21 Mar 2013	5.7
Scotch Dairy Ck, downstream	21 Mar 2013	6.0



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MACROINVERTEBRATE SAMPLING RESULTS

Four Mile Ck, upstream

21 Mar 2013

Total Number of Taxa 10


<u>Taxon ID</u>	<u>Number of Taxa</u>	<u>Abundance</u>	<u>Score</u>
Atyidae	1	1	6
Calamoceratidae	1	1	9
Corixidae	1	1	3
Dytiscidae	1	3	6
Hydrophilidae	2	2	8
Leptophlebiidae	1	4	40
Parastacidae	1	1	7
Physidae	1	1	1
Veliidae	1	2	12

Four Mile Ck, downstream

21 Mar 2013

Total Number of Taxa 11

<u>Taxon ID</u>	<u>Number of Taxa</u>	<u>Abundance</u>	<u>Score</u>
Atyidae	1	4	24
Chironomidae	1	2	6
Coenagrionidae	1	1	2
Dytiscidae	1	3	6
Gomphidae	1	1	6
Hemicorduliidae	1	1	4
Isostictidae	1	1	6
Leptophlebiidae	1	3	30
Megapodagrionidae	1	2	12
Moinidae	1	2	0
Parastacidae	1	1	7

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MACROINVERTEBRATE SAMPLING RESULTS

Weakleys Flat Ck, upstream

21 Mar 2013

Total Number of Taxa 16

<u>Taxon ID</u>	<u>Number of Taxa</u>	<u>Abundance</u>	<u>Score</u>
Atyidae	1	2	12
Baetidae	1	2	14
Chironomidae	1	1	3
Coenagrionidae	1	1	2
Culicidae	1	2	12
Dugesidae	1	1	3
Dytiscidae	1	3	6
Gerridae	1	2	14
Hydrometridae	1	1	5
Leptoceridae	1	1	7
Leptophlebiidae	1	3	30
Megapodagrionidae	1	1	6
Oxidae	1	1	7
Parastacidae	1	1	7
Physidae	1	1	1
Veliidae	1	3	18

Weakleys Flat Ck, downstream

21 Mar 2013

Total Number of Taxa 9

<u>Taxon ID</u>	<u>Number of Taxa</u>	<u>Abundance</u>	<u>Score</u>
Atyidae	1	2	12
Chironomidae	1	1	3
Culicidae	2	3	18
Dytiscidae	1	3	6
Hydrophilidae	1	2	8
Leptophlebiidae	1	3	30
Parastacidae	1	1	7
Veliidae	1	2	12



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MACROINVERTEBRATE SAMPLING RESULTS

Scotch Dairy Ck, upstream

21 Mar 2013

Total Number of Taxa 12

<u>Taxon ID</u>	<u>Number of Taxa</u>	<u>Abundance</u>	<u>Score</u>
Atyidae	1	2	12
Baetidae	1	2	14
Coenagrionidae	1	1	2
Dytiscidae	1	3	6
Hemicorduliidae	1	1	4
Hydrochidae	1	1	4
Hydrophilidae	1	1	4
Leptophlebiidae	1	4	40
Megapodagrionidae	1	2	12
Mesoveliidae	1	1	2
Oxidae	1	1	7
Veliidae	1	1	6

Scotch Dairy Ck, downstream

21 Mar 2013

Total Number of Taxa 16

<u>Taxon ID</u>	<u>Number of Taxa</u>	<u>Abundance</u>	<u>Score</u>
Atyidae	1	3	18
Culicidae	3	2	12
Dytiscidae	1	3	6
Gelastocoridae	1	1	6
Gerridae	1	1	7
Hydrochidae	1	1	4
Hydrophilidae	2	2	8
Leptoceridae	1	3	21
Leptophlebiidae	1	3	30
Moinidae	1	2	0
Notonectidae	1	1	6
Parastacidae	1	1	7
Veliidae	1	2	12

