Appendix 4

Macroinvertebrate Sampling Program Operations Survey: Spring 2014

(No. of pages including blank pages = 20)

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

This page has intentionally been left blank

Report for
Donaldson Coal Pty Ltd

Donaldson Coal Mine

Macroinvertebrate Sampling Program Operations Survey: Spring 2014

15th October, 2014

RT & A Pty Ltd
Consultants in Environmental Science

6 The Comenarra Parkway
West Pymble NSW 2073
Ph: 02 9983 1511

Email: robyn@tuft.id.au

DONALDSON COAL MINE: OPERATIONS MACROINVERTEBRATE SURVEY

TABLE OF CONTENTS

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
4 rehabilitation phase 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 rehabilitation survey in Spring 2014. The stream was sampled in Spring (15th September, 2014) under dry weather conditions, although a total of 8 mm was recorded five days prior to sampling, 16 mm on 6th and 7th of September and 9 mm on 3rd September.

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 4km^2 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 km^2 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 approximately 8 km^2 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 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.

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, 0.5 to 3m in width and 0.1 to 0.5m in depth. Much of the substrate was bedrock, overlain with silt and detritus. The water level was moderate, with no flow. The water clarity was fair but with no odour.

Four Mile Creek downstream: was sampled in a shallow section of riffle and channel, 1 to 5m wide and 0.1 to 0.8m in depth. The water level was moderate and water clarity was good with no odour. Substrate was mainly pebble, bedrock and sand. 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 0.1 to 1.5 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 clay and silt with some sand. 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 pool, 0.5 to 3m wide and 0.1 to 0.5m deep. Water clarity was poor and the water level was moderate with no flow. There was a sulphurous odour present. The substrate was mostly sand and silt. Eucalypts provided moderate shading for the site and the understory 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 0.1 to 6m channel of 0.1 to 0.8m depth. The stream substrate was mostly bedrock and boulders with some detritus cover and submerged logs. The water level was moderate with no flow 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. The net forming alga, *Nitella* covered approximately 10% of the water surface.

Weakleys Flat Creek downstream: was sampled in a channel, 1 to 5m wide and 0.1 to 0.6m deep. The water level was moderate with no flow and the clarity poor. The substrate was sand, clay, pebble and cobble with submerged logs. There was a sulphur odour present. The site was moderately shaded from native trees such as eucalypts, with the understory 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 similar scores as compared to the autumn sampling .

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
	30/9/13	14	Good	11	Excellent	41	Good
	15/4/14	15	Good	11	Excellent	43	Good
	15/9/14	16	Good	9	Good	43	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
	30/9/13	14	Good	11	Good	40	Good
	15/4/14	17	Excellent	10	Good	41	Good
	15/9/14	17	Excellent	11	Good	45	Good

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
	30/9/13	15	Good	4	Very Poor	35	Fair
	15/4/14	17	Excellent	5	Poor	38	Good
	15/9/14	16	Good	4	Very 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	Good	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
	30/9/13	16	Good	11	Excellent	44	Good
	15/4/14	13	Good	6	Good	35	Fair
	15/9/14	14	Good	7	Fair	38	Good

Donaldson Post-operation Stage Macroinvertebrate Survey

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
	30/9/13	14	Good	9	Good	35	Fair
	15/4/14	15	Good	9	Good	37	Good
	15/9/14	15	Good	8	Fair	38	Good
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
	30/9/13	15	Good	9	Good	39	Good
	15/4/14	16	Good	6	Poor	37	Good
	15/9/14	17	Excellent	8	Fair	41	Good

4.3 AQUATIC ECOLOGY

Biological characteristics are summarised in Tables 6 and 7. The diversity of fauna had increased for all sites, apart from taxa numbers in the Weakleys Flat system which declined slightly. The SIGNAL index showed little change at all sites. All sites were populated by pollutant sensitive families such as shrimps, caddisfly and mayfly nymphs. SIGNAL indices were no different from upstream to downstream.

The exotic pest species of *Gambusia* was again found in the upstream site of Four Mile Creek.

Algal growth was low at all sites apart from Weakleys Flat upstream which had filamentous algae and the net alga, Nitella covering approximately 20% of the surface. 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.

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						
Spring 2014	29	29	25	22	19	16
Autumn, 2014	15	20	17	16	23	23
Spring, 2013	13	21	21	20	20	18
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 result	(30)	(36)	(39)	(32)	(44)	(39)
SIGNAL Index						
Spring 2014	5.7	5.7	5.6	5.5	5.3	5.8
Autumn, 2014	5.7	6.0	5.6	5.2	5.1	5.5
Spring, 2013	6.0	5.1	5.5	5.6	5.7	5.1
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)

Donaldson Post-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 **Autumn, 2014**	Leptophlebiidae (mayfly nymphs) Leptoceridae (caddisfly nymphs) Atyidae (shrimp) Chironomidae (fly larvae) Dytiscidae (beetle)	Leptophlebiidae (mayfly nymphs) Chironomidae (fly larvae) Megapodagrionidae (damselfly nymphs) Baetidae (mayfly nymphs) Leptoceridae (caddisfly nymphs)	Leptoceridae (caddisfly nymphs) Dytiscidae (beetle) Atyidae (shrimp) Leptophlebiidae (mayfly nymphs) Veliidae (surface bug)	Leptoceridae (caddisfly nymphs) Chironomidae (fly larvae) Veliidae (surface bug) Scirtidae (beetle larvae)	Chironomidae (fly larvae) Leptophlebiidae (mayfly nymphs) Dytiscidae (beetle) Gomphidae (dragonfly nymph) Veliidae (surface bug)	Leptoceridae (caddisfly nymphs) Veliidae (surface bug) Leptophlebiidae (mayfly nymphs) Chironomidae (fly larvae) Dytiscidae (beetles)

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	*Gambusia*	-	-	-		
Macrophytes	Coverage	-	-	-	-	50%	-
	Predominant types	-	-	-	-	*Phragmites Typha*	-
Algae	Coverage	-	-	-	-	20%	-
	Predominant types	-	-	-	-	*green filamentous*	-

5 CONCLUSIONS

The streams in the study area tended to show moderate diversity of fauna indicative of mildly impaired fauna and fair water quality. However all sites were populated by several pollutant sensitive families of invertebrates. RCE scores were similar to the autumn results. Therefore there was no evidence of changes in stream quality since autumn and since site rehabilitation commenced.

6 REFERENCES

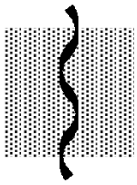
Australian and New Zealand Environment and Conservation Council (1992) Australian Water Quality Guidelines for Fresh and Marine Waters. National Water Quality Management Strategy November 1992.

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.

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

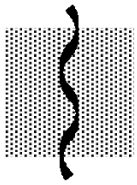
APPENDIX 1 – BIOLOGICAL DATA



ROBYN TUFT & ASSOCIATES RT152

SIGNAL INDEX SUMMARY

		SIGNAL Index
Weakleys Flat Ck, upstream	15 Sep 2014	5.3
Weakleys Flat Ck, downstream	15 Sep 2014	5.8
Scotch Dairy Ck, upstream	15 Sep 2014	5.6
Scotch Dairy Ck, downstream	15 Sep 2014	5.5
Four Mile Ck, upstream	15 Sep 2014	5.7
Four Mile Ck, downstream	15 Sep 2014	5.7



ROBYN TUFT & ASSOCIATES

MACROINVERTEBRATE SAMPLING RESULTS

Weakleys Flat Ck, upstream **15 Sep 2014**

Total Number of Taxa 19

Taxon ID	Number of Taxa	Abundance	Score
Ancylidae	1	1	7
Atyidae	1	2	12
Baetidae	1	2	14
Chironomidae	5	3	9
Coenagrionidae	1	2	4
Culicidae	1	1	6
Dugesiidae	1	1	3
Dytiscidae	2	2	4
Gomphidae	1	2	12
Leptophlebiidae	1	3	30
Lycosidae	1	1	0
Nepidae	1	1	5
Planorbidae	1	1	5
Veliidae	1	2	12

Weakleys Flat Ck, downstream **15 Sep 2014**

Total Number of Taxa 16

Taxon ID	Number of Taxa	Abundance	Score
Chironomidae	3	2	6
Copepoda	1	2	0
Hydracarina	1	2	10
Leptoceridae	2	4	28
Leptophlebiidae	1	2	20
Megapodagrionidae	1	2	12
Moinidae	1	2	0
Naididae	1	1	4
Notonectidae	1	1	6
Pleidae	1	1	4

Printed 21 Sep 2014 Page 1

ROBYN TUFT & ASSOCIATES

MACROINVERTEBRATE SAMPLING RESULTS

Scirtidae	1	1	6
Tubificidae	1	1	2
Veliidae	1	3	18

Scotch Dairy Ck, upstream **15 Sep 2014**

Total Number of Taxa 25

Taxon ID	Number of Taxa	Abundance	Score
Atyidae	1	3	18
Chaoboridae	1	1	0
Chironomidae	2	3	9
Culicidae	1	1	6
Dugesiidae	1	1	3
Dytiscidae	1	3	6
Gelastocoridae	1	1	6
Gerridae	1	2	14
Hemicorduliidae	1	1	4
Hydracarina	1	3	15
Hydrophilidae	2	2	8
Leptoceridae	3	4	28
Leptophlebiidae	1	3	30
Megapodagrionidae	1	1	6
Moinidae	1	2	0
Notonectidae	2	2	12
Ostracoda	1	2	0
Parastacidae	1	2	14
Scirtidae	1	1	6
Veliidae	1	3	18

Scotch Dairy Ck, downstream **15 Sep 2014**

Total Number of Taxa 22

Taxon ID	Number of Taxa	Abundance	Score
Ancylidae	1	1	7
Atyidae	1	1	6
Chaoboridae	1	1	0

ROBYN TUFT & ASSOCIATES

MACROINVERTEBRATE SAMPLING RESULTS

Chironomidae	2	3	9
Culicidae	1	1	6
Dytiscidae	2	2	4
Gerridae	1	1	7
Hydracarina	3	3	15
Hydrometridae	1	1	5
Leptoceridae	1	4	28
Leptophlebiidae	1	2	20
Lycosidae	1	1	0
Megapodagrionidae	1	2	12
Mesoveliidae	1	2	4
Notonectidae	1	2	12
Scirtidae	2	3	18
Veliidae	1	3	18

Four Mile Ck, upstream **15 Sep 2014**

Total Number of Taxa 19

Taxon ID	Number of Taxa	Abundance	Score
Atyidae	1	2	12
Calamoceratidae	1	1	9
Chironomidae	2	2	6
Copepoda	1	2	0
Corixidae	1	1	3
Dytiscidae	1	2	4
Hydracarina	1	2	10
Hydrochidae	1	1	4
Hydrometridae	1	1	5
Hydrophilidae	1	1	4
Leptoceridae	1	3	21
Leptophlebiidae	2	3	30
Notonectidae	1	1	6
Parastacidae	1	2	14
Scirtidae	1	2	12
Tubificidae	1	1	2
Veliidae	1	2	12

ROBYN TUFT & ASSOCIATES

MACROINVERTEBRATE SAMPLING RESULTS

Four Mile Ck, downstream **15 Sep 2014**

Total Number of Taxa 29

Taxon ID	Number of Taxa	Abundance	Score
Aeschnidae	1	1	7
Atyidae	1	1	6
Baetidae	1	2	14
Calamoceratidae	1	1	9
Chironomidae	2	3	9
Copepoda	1	2	0
Corydalidae	1	1	7
Culicidae	1	1	6
Dugesiidae	1	1	3
Dytiscidae	1	2	4
Gerridae	1	1	7
Gordiidae	1	1	7
Hemicorduliidae	1	2	8
Hydrometridae	1	1	5
Isostictidae	1	1	6
Leptoceridae	1	2	14
Leptophlebiidae	1	3	30
Lycosidae	1	1	0
Megapodagrionidae	1	3	18
Notonectidae	1	1	6
Philopotamidae	1	1	10
Physidae	1	2	2
Scirtidae	1	2	12
Simuliidae	1	2	10
Telephlebiidae	1	1	7
Tetragnathidae	1	1	0
Tubificidae	1	1	2
Veliidae	1	2	12