Appendix C
Sub-catchment summaries

Upper Coxs River

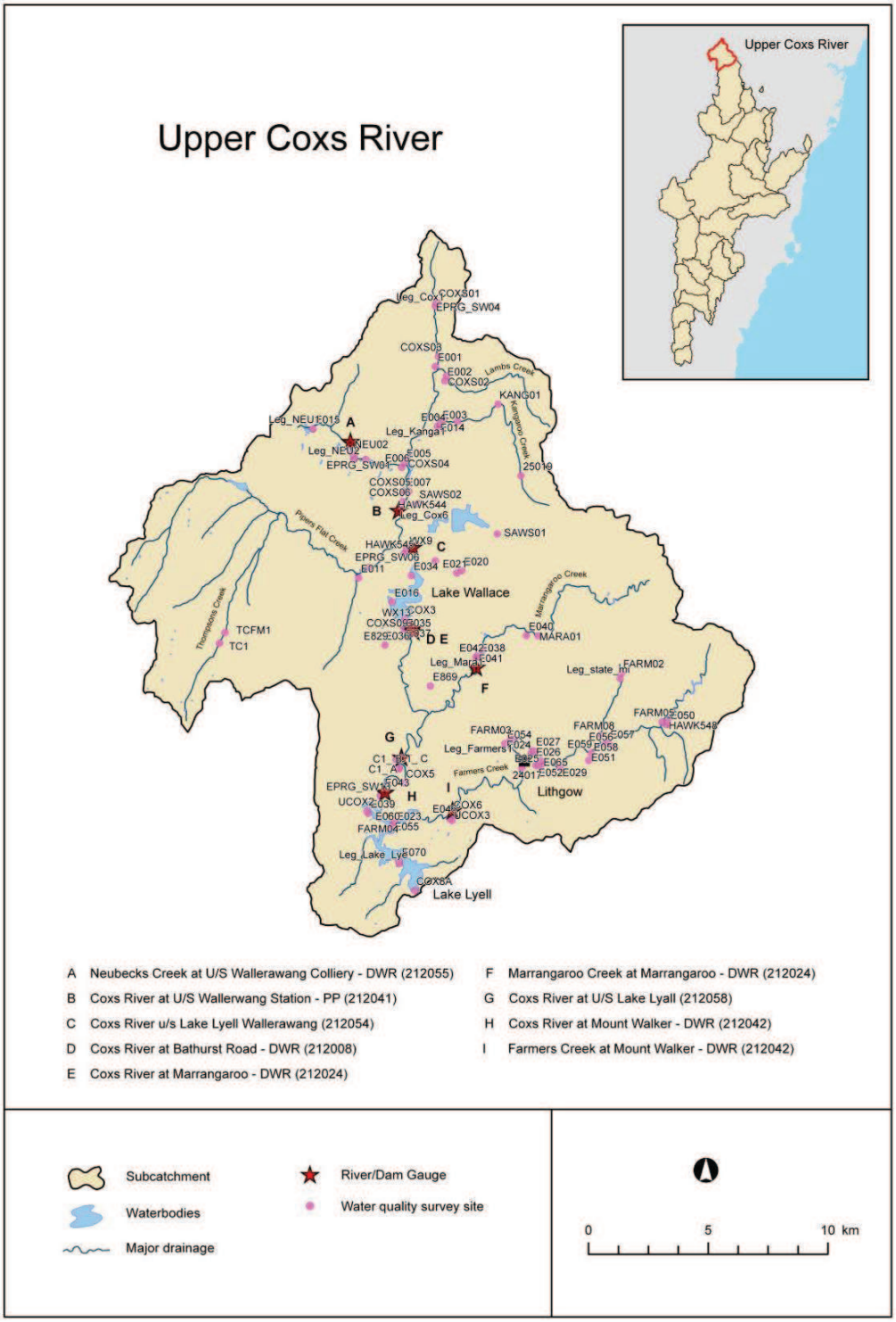

Figure C1: Location of existing and historical water quality monitoring sites and gauging stations in the Upper Coxs River sub-catchment

Note: Sites identified in Figure C1 is not a comprehensive list of all sites sampled in the Upper Coxs River sub-catchment.

Pressures

The Upper Coxs River sub-catchment is under a high level of stress (SCA 2007a). There are two sewage treatment plants (STPs) located at Lithgow and Wallerawang which impact locally on water quality. Flow is regulated by dams (Lake Wallace, Thompsons Reservoir and Lake Lyell) for power supply and there are seven barriers to fish passage. Farmers Creek Dam is used to supply drinking water to Lithgow. There is also geomorphical disturbance due to both current and historic mining operations. In addition, there are a number of areas currently affected by dryland salinity

The Upper Coxs River sub-catchment is under pressure from the extraction of surface and ground water, as a large volume of water is permitted to be extracted under water access licences by Delta Electricity, and there are also a moderate number of farm dams and groundwater bores in this sub-catchment (DECC 2007).

There is a large urban residential area at Lithgow in the sub-catchment. There were a small number of sites of pollution and potential contamination in the medium risk category, and a single mine in this sub-catchment. A few of these sites were located close to Lake Wallace and the Coxs River. There was a small area of land in this sub-catchment affected by gully erosion (DECC 2007).

The SCA's Catchment Decision Support System (CDSS) (SCA 2009a) identified Farmers Creek to be affected by Lithgow STP, urban stormwater and roads yielding a high to very high nutrient source rating, moderate suspended solids source rating and high pathogen source rating. Pipers Flat Creek was identified as being affected by Wallerawang STP, urban stormwater, grazing and roads, yielding a moderate suspended solids source rating and a high pathogen source rating.

In addition, Delta Electricity's licensed blowdown discharge discharges a relatively large volume of highly saline (>2000 µS/cm conductivity) water to the Upper Coxs River downstream of Lake Wallace. This discharge can also contain high levels of some heavy metals (e.g. copper). Other licensed discharges from coal mine operations in Kangaroo and Neubecks Creek also have issues with elevated salinity and heavy metal levels.

Potential future pressures arise from increased urban and rural residential development and associated infrastructure, including increased discharges from STPs (SCA 2007a).

State of the sub-catchment during the current audit period (1 July 2007 to 30 June 2010)

Land use

The major land-use categories in the Upper Coxs River sub-catchment are shown in Figure C2. The main land uses are forestry (33%), grazing or improved pastures (26%) and conservation or natural area purposes (24%).

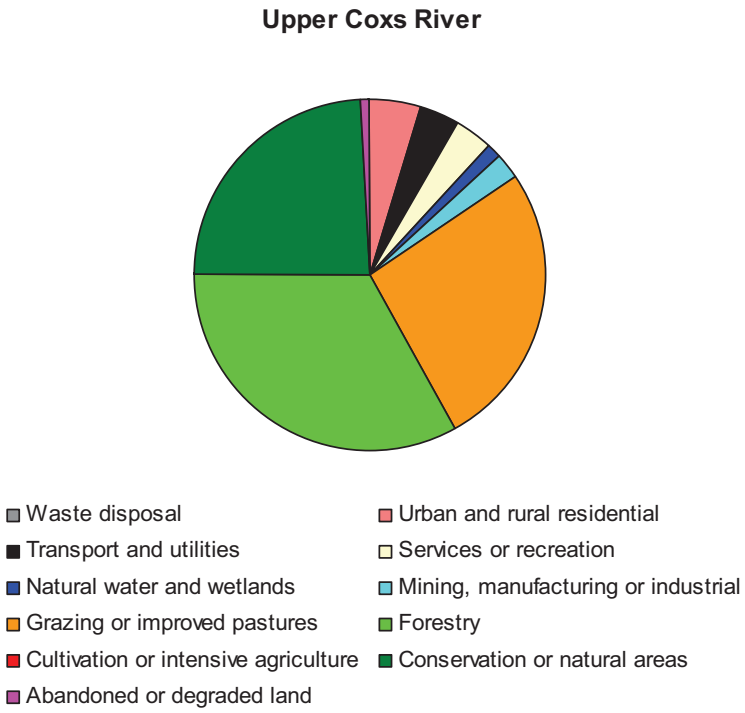

Figure C2: Land use in the Upper Coxs River sub-catchment

Source: Data from SCA (2010)

Water availability

Surface water flow

Recent flow data was available from 4 gauging stations in the Upper Coxs River sub-catchment (Table C1). Records during the current audit period generally indicated a lower median flow in the Coxs River than the long-term median, but the median flow was similar to, or slightly higher than, median flows in the previous 6 years. It is clear that where records exist prior to the construction and operation of the dams, median flows were historically much higher than their current values. In recent times, low flows are also more frequent than the long-term average (Appendix F), potentially due to environmental flow provisions in Delta Electricity's water management operating licence.

Upstream of Lake Lyell, median flow in the Coxs River was higher during the current audit period than in the previous periods (2001–2004 and 2004–2007). Flow monitoring at Station 212058 commenced in December 2000, so assessments of flows at this point relative to what existed prior to the construction of Lake Wallace can not be made from these data.

During the current audit period Neubecks Creek had a median flow that was similar to, but slightly lower than the long-term median. Flows in Neubecks Creek were similar to the 2004–2007 period, although 2004–2007 saw a relatively higher frequency of medium flows than those experienced during the current audit period (Appendix F). Median flow in the 2001–2004 period was slightly higher than median flow in the 2004–2007 period, but lower than the current audit period.

Table C1: Flow (in ML/day) at gauging stations in the Upper Coxs River sub-catchment

Station number	Site name	Date records commenced	Long-term median	2001–2004 median	2004–2007 median	2007–2010 median
212008	Coxs River at Bathurst Rd	09/02/1951	12.292	8.506	11.877	11.239
212058	Coxs River upstream of Lake Lyell	15/12/2000	16.571	14.229	20.08	25.75
212055	Neubecks Ck upstream of Walwang	07/12/1991	0.5	0.14	0.1	0.3
212042	Farmers Ck at Mt Walker	25/09/1980	15.959	10.914	8.195	12.578

During the current audit period, Farmers Creek had a median flow that was similar to the long-term median flow. While the audit period flow exceedance curve was similar for the lower percentiles, there was an obvious lack of higher flows (Appendix F). Median flow during the current audit period was higher than in the previous two periods (2001–2004 and 2004–2007).

Environmental flows

Delta Electricity's Water Licence is currently under review (NOW 2010). This review is likely to change the way in which environmental flows are released in the future in the Upper Coxs River catchment.

Ecosystem and raw water quality

River water quality

A variety of organisations have been, or are currently involved, in monitoring the Upper Coxs River sub-catchment (e.g. SCA, Sydney Water (and its predecessor organisations: Water Board and MWSDB), DECCW, Delta Electricity, various Streamwatch groups). Long-term water quality monitoring in the Upper Coxs River sub-catchment is, however, limited to only a few sites. The Upper Coxs River and its tributaries were therefore divided into sections and water quality results from multiple sites within these sections are used to infer water quality state and trend.

During the audit period:

- median total nitrogen (TN) levels were highest in Farmers Creek near Lake Lyell (median=1.9 mg/L), Coxs River downstream of the blowdown discharge to Marrangaroo Creek (median=1.4 mg/L), and Coxs River downstream of Sawyers Swamp Creek to Pipers Flat Creek (median=0.8 mg/L). In these sections, all TN levels measured were above the ANZECC guidelines (ANECC/ARMCANZ 2000) for upland rivers. Elevated TN levels (relative to ANZECC guidelines) were also recorded in the Coxs River downstream of Lake Wallace (median=0.74) and Coxs River downstream of Marrangaroo Creek (median=0.7). Lower levels of TN were recorded in Neubecks Creek (median=0.28 mg/L) and the Coxs River

upstream of Kangaroo Creek (median=0.335mg/l[1]). All median TN levels were above ANZECC guideline levels for upland rivers.

- median total phosphorus (TP) levels were highest in the Coxs River downstream of the blowdown discharge to Marrangaroo Creek (median=0.4 mg/L), Farmers Creek near Lake Lyell (median=0.115 mg/L), Coxs River downstream of Sawyers Swamp Creek to Pipers Flat Creek (median=0.09 mg/L) and Coxs River downstream of Marrangaroo Creek (median=0.06 mg/L). In these sections, almost all TP levels measured were above the ANZECC guideline levels for upland rivers. Elevated TP levels (relative to ANZECC guidelines) were also recorded in Pipers Flat Creek (median=0.03 mg/L). Low levels of TP were recorded in the Coxs River upstream of Kangaroo Creek (median=0.019mg/L).
- median conductivity levels were highest in the Coxs River downstream of the blowdown discharge to Marrangaroo Creek (median=1.6 mS/cm), Coxs River downstream of Marrangaroo Creek (median=1.081 mS/cm), Coxs River downstream of Lake Wallace (median=0.751 mS/cm), Coxs River downstream of Sawyers Swamp Creek to Pipers Flat Creek (median=0.676 mS/cm) and Pipers Flat Creek (median=0.464 mS/cm). In these sections, all conductivity levels measured were above the ANZECC guideline levels for upland rivers. Elevated conductivity levels (relative to ANZECC guidelines) were also recorded in Neubecks Creek (median=0.445 mS/cm). Low levels of conductivity were recorded in the Coxs River upstream of Kangaroo Creek (median=0.04 mS/cm) and Marrangaroo Creek (median=0.05 mS/cm).

Lake water quality

During the audit period:

- median TN levels were highest in Lake Lyell (1.89 mg/L). Elevated TN levels (relative to ANZECC guidelines) were also recorded in Lake Wallace (0.7 mg/L) and Thompsons Creek Dam (0.65 mg/L). In Lake Wallace and Lake Lyell, all TN levels measured were above the ANZECC guidelines for freshwater lakes and reservoirs. In Thompsons Creek Dam, the median TN level measured was above the ANZECC guidelines for freshwater lakes and reservoirs.
- median TP levels were highest in Lake Lyell (0.1 mg/L). Elevated TP levels (relative to ANZECC guidelines) were also recorded in Lake Wallace (0.08 mg/L) and Thompsons Creek Dam (0.02 mg/L). In Lake Wallace and Lake Lyell, all TP levels measured were above the ANZECC guidelines for freshwater lakes and reservoirs. In Thompsons Creek Dam, the 25th percentile TP level was above the ANZECC guidelines for freshwater lakes and reservoirs.
- median chlorophyll a levels were moderate in Lake Wallace (2 µg/L), Lake Lyell (3.6 µg/L) and Thompsons Creek Dam (2 µg/L). Relatively high chlorophyll a levels were recorded in Lake Wallace in December 2007 (20 µg/L) and May 2008 (56 µg/L). Relatively high chlorophyll a levels were recorded in Lake Lyell in September and November 2007 (68.5 and 49 µg/L respectively), August 2008 (41 µg/L) and February 2009 (63.2 µg/L).
- median conductivity levels were relatively high for freshwater lakes and reservoirs. Median levels were highest in Lake Wallace (0.779 mS/cm), followed by Thompsons Creek Dam (0.59 mS/cm) and then Lake Lyell (0.52 mS/cm).

[1] Sample sizes for nutrient data during the audit period were small for the Coxs River upstream of Kangaroo Creek (n=4).

Biodiversity and habitats

Macroinvertebrates

Data on macroinvertebrates in the Upper Coxs River sub-catchment were available from thirty eight (38) sites over the last decade (Figure C3 and Table C2). Macroinvertebrate data were primarily sourced from the SCA, DECCW and Delta Electricity monitoring programs.

Four of these sites (10.5%) had their most recent AusRivAs health rating as 'Similar to Reference' (Band A).

Ten of these sites (26.3%) had their most recent AusRivAs health rating as 'Significantly Impaired' (Band B).

Eighteen of these sites (47.4%) had their most recent AusRivAs rating as 'Severely Impaired' (Band C).

Two of these sites (5.3%) had their most recent AusRivAs health rating as 'Extremely Impaired' (Band D).

Four of these sites were found to be outside the experience of the model (OEM).

Macroinvertebrate data were also available at a number of sites from earlier periods (pre-2001) and these have been included in Table C2. There may be additional macroinvertebrate monitoring sites in the sub-catchment which have not been reported on here.

Only one SCA core site, A16 (edge habitat), has been assessed each year since 2001. AusRivAs scores at this site generally fluctuated between Band A (Similar to Reference) and Band B (Significantly Impaired). The latest AusRivAs rating at this site (2009) was Band B.

Wetlands

A variety of wetland types occur in the Upper Coxs River sub-catchment (Figure C4). There is, however, limited information available on their overall condition. Some swamps have been impacted by longwall mining, mine water discharges and water transfers to the Farmers Creek Dam water supply.

One of the largest swamps in this area is Long Swamp in the Upper Reaches of the Coxs River. Long Swamp has been impacted by mine water discharges and 4WD tracks and is potentially threatened by longwall mining altering groundwater levels adjacent to the swamp (Aurecon 2009). Many areas of Long Swamp are still in good condition and giant dragonflies (*Petalura gigantea*) have been recorded in its upper reaches. Some areas of Long Swamp are experiencing increased desiccation for an unknown reason.

Kangaroo Creek Swamp in the upper reaches of Kangaroo Creek has recently been impacted by longwall mining. Piezometer levels suggest that the perched aquifer in the swamp has been lost post mining, with piezometric levels now quickly falling to the base of the piezometer after rain (Centennial Coal 2009).

Farmers Creek Swamp is classified as a Newnes Plateau Shrub Swamp (Endangered Ecologiocal Community) and is located at the top of the Farmers Creek catchment. The Clarence Water Transfer Scheme transfers water from the Clarence Colliery Dam to settling ponds above Farmers Creek Swamp where the water then flows by gravity through an outlet pipe located at the top of Farmers Creek Swamp. It appears likely that channelling and erosion in Farmers Creek Swamp downstream of the outlet pipe is related to relatively recent and above average historical flows into the swamp and the flows from the Clarence transfer scheme are likely to have been

a major contributor to the gullying in the upper part of the swamp (DECCW 2010a). Proposals to address erosion issues in the transfer of water through the swamp are currently underway. This swamp is likely to be able to regenerate naturally if water transfers are piped around the swamp (DECCW 2010a).

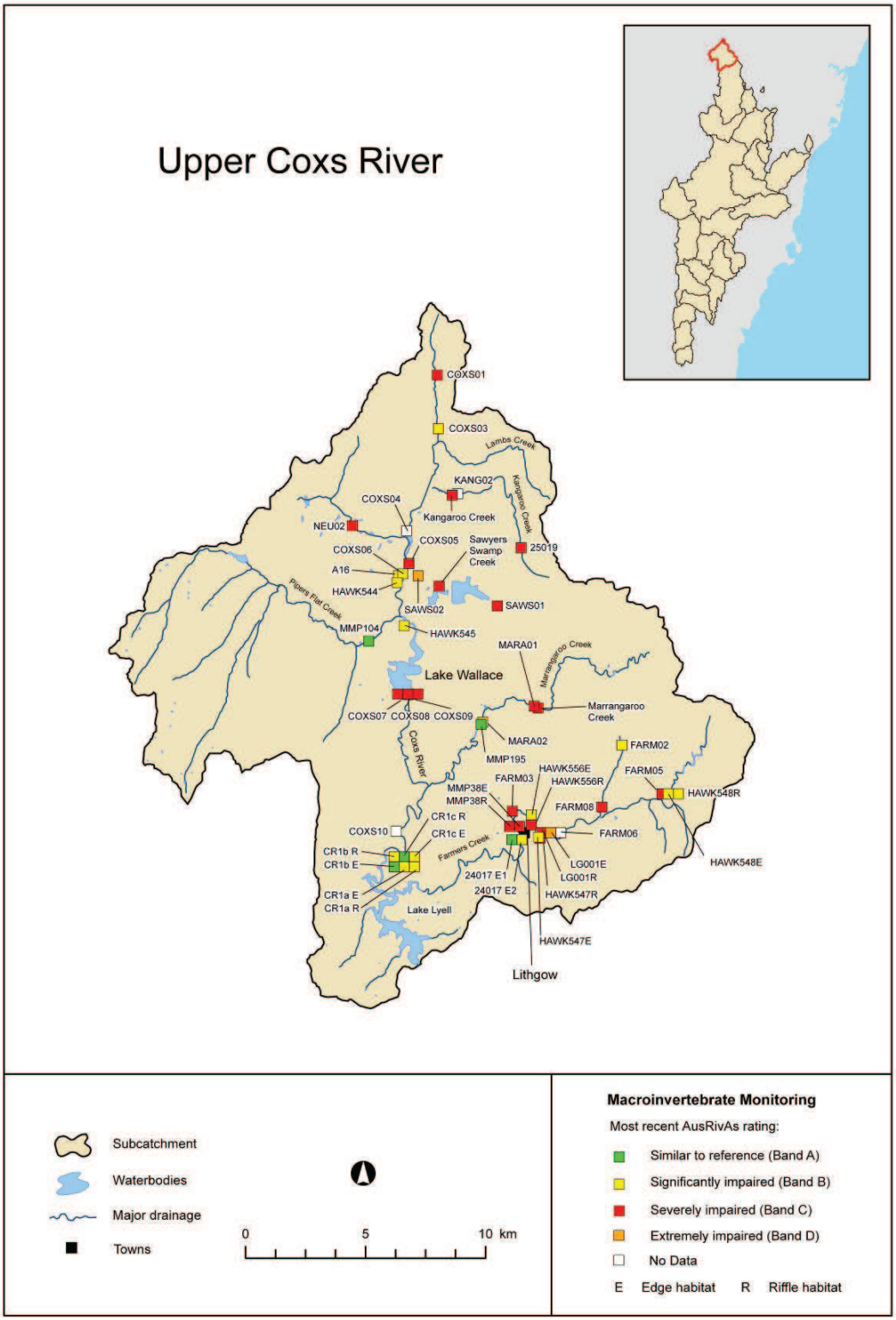

Figure C3: Location and AusRivAs ranking of macroinvertebrate monitoring sites in the Upper Coxs River sub-catchment

Note: This figure is not a comprehensive list of all the sites that have been sampled in the Upper Coxs River sub-catchment. Each site is represented by its most recent AusRivAs rating.

Table C2: AusRivAs ranking of macroinvertebrate monitoring sites in the Upper Coxs River sub-catchment

Site code	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009
24017 (edge)	-33.480970	150.129930								A		
24017 (edge)	-33.480970	150.129930								B		
25019	-33.371460	150.133160										C
A16	-33.380590	150.077980		A	X	A	A	B	A	B	A	B
COXS01	-33.305730	150.097810										C
COXS03	-33.325920	150.097620										B
COXS04	-33.363920	150.082160										OEM
COXS05	-33.376200	150.082760										C
COXS06	-33.379990	150.079980										B
COXS07	-33.425300	150.080126										C
COXS08	-33.425431	150.080713										C
COXS09	-33.425310	150.081350										C
COXS10	-33.476560	150.073690										OEM
CR1a (edge)	-33.486168	150.076972			B	B	B					
CR1a (riffle)	-33.486168	150.076972			B	B	B					
CR1b (edge)	-33.486168	150.076972			B	A	A					
CR1b (riffle)	-33.486168	150.076972			B	A	B					
CR1c (edge)	-33.486168	150.076972			B	A	B					
CR1c (riffle)	-33.486168	150.076972			B	B	A					
FARM02	-33.446560	150.175870										B
FARM03	-33.470280	150.125960										C
FARM05	-33.465270	150.193270										C
FARM06	-33.478620	150.138360										OEM
FARM08	-33.469590	150.166140										C
HAWK544 (edge)	-33.383200	150.077200	B									
HAWK545 (edge)	-33.399500	150.079800	B									
HAWK547 (edge)	-33.480200	150.137400	B									
HAWK547 (riffle)	-33.480700	150.138000	C									

Site code	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009
HAWK548 (edge)	-33.465300	150.196000	B									
HAWK548 (riffle)	-33.465300	150.196000	B									
HAWK556 (edge)	-33.475600	150.134300	B									
HAWK556 (riffle)	-33.475600	150.134300	C									
KANG02	-33.350560	150.105440										OEM
Kangaroo Creek (edge)	-33.351000	150.103000								C		
Kangaroo Creek (edge)	-33.351000	150.103000								A		
LG001 (edge)	-33.478570	150.139160									D	
LG001 (riffle)	-33.478570	150.139160									C	
MARA01	-33.431740	150.138800										C
MARA02	-33.436490	150.113870										B
Marrangaroo Creek (edge)	-33.431000	150.137000								C		
Marrangaroo Creek (edge)	-33.431000	150.137000								B		
MMP104	-33.404910	150.063860					A					
MMP195	-33.437310	150.113070							A			
MMP38 (edge)	-33.475940	150.129060			C					C	C	
MMP38 (riffle)	-33.475940	150.129060								C	C	
NEU02	-33.361430	150.058000										C
SAWS01	-33.393080	150.121840										C
SAWS02	-33.380900	150.086725										D
Sawyers Swamp Creek (edge)	-33.385000	150.096000								C		
Sawyers Swamp Creek (edge)	-33.385000	150.096000								C		

Note: Riffle and edge are specified where both habitats were sampled, otherwise it should be assumed that only edge habitat was sampled.

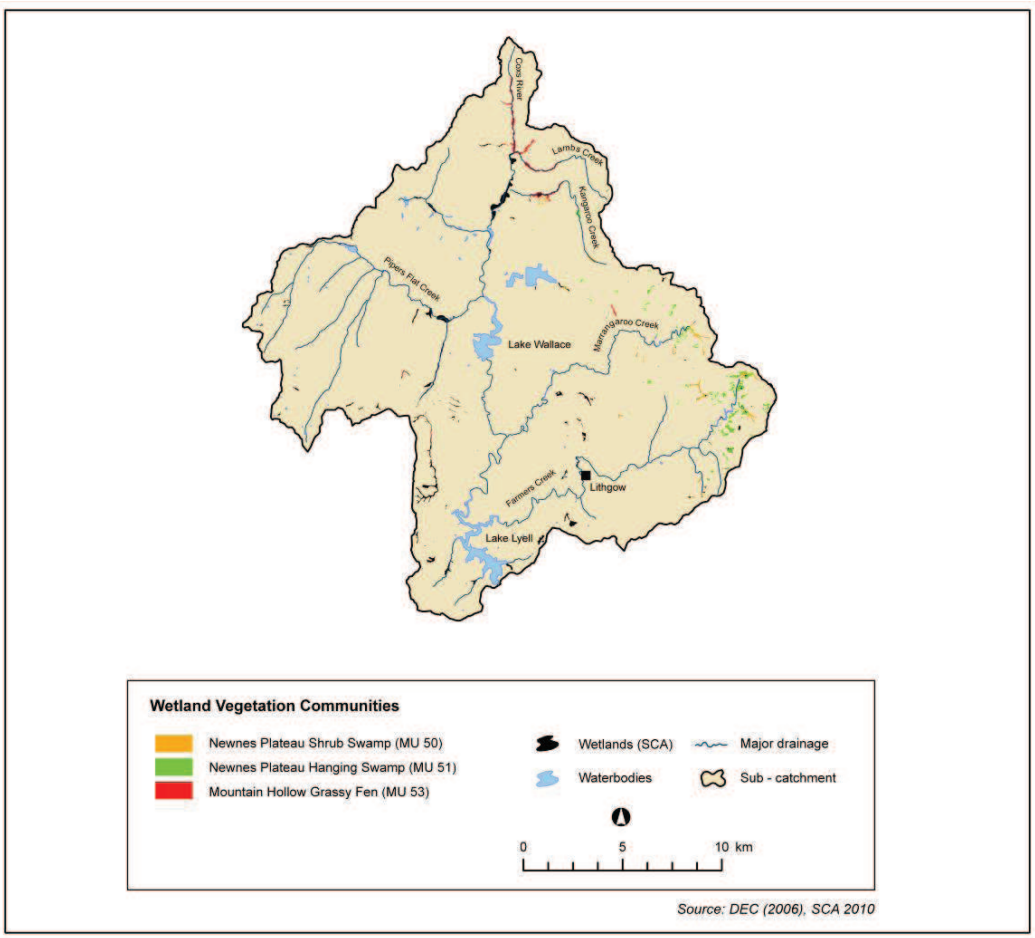

Figure C4: Wetlands in the Upper Coxs River sub-catchment

Source: DEC (2006) and SCA (2010a).

Physical form

The Upper Coxs River sub-catchment contains the largest range of river channel types of any Hawkesbury–Nepean sub-catchment, ranging from Chain of Ponds to fully concrete lined urban channels. A number of river reaches are in very good condition with a management focus on conservation. These are typically the headwater reaches of the rivers. However, the majority of river reaches in this sub-catchment are highly degraded. The land has been extensively cleared for industry, agriculture and grazing, and some creeks are highly modified by urban developments. An extremely rare example of a Chain of Ponds river channel type in good condition with a high recovery potential is located in the upper reaches of the Coxs River. This is a unique aspect of the sub-catchment and should be a priority for management to protect it from degradation (HNCMA 2008a).