This Plan is the third edition, of the Condamine NRM Plan. The ongoing review and development of the Plan is based on a continuous improvement process, which provides optimal natural resource management direction for the catchment over the years to come.

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What is the Plan?

This Plan provides an integrated framework for improving the sustainability of management of natural resources in the Condamine catchment.

It achieves this by:

- Reviewing the current state of natural resources in the catchment, with consideration of socio-economic impacts
- Identifying and prioritising the issues
- Identifying the underlying processes causing the issues
- Ensuring stakeholder engagement in the Plan's development and future involvement in its implementation
- Identifying opportunities for better management of the issues
- Establishing a structure of targets and actions to guide the catchment community to better NRM outcomes for the future
- Providing a basis for strategic regional investment to guide future investment priorities for a range of NRM stakeholders
- Establishing a framework for assessment and review of the NRM plan, investment priorities and their outcomes
- Providing a living reference for catchment stakeholders to use as a compass: guiding collective action and regularly updated to keep us all on track

The Plan integrates people, water, land, wildlife and air conservation themes with a series of overarching principles to provide an integrated and inclusive approach to managing the catchment. It encourages all stakeholders across the catchment to work together to achieve a more sustainable and profitable future and to set a precedent for future generations to do the same.

How to use this Plan

Everyone has a role to play in protecting our catchment's natural resources

We all benefit from these resources through the goods and services they provide — from the water we drink and the food we eat, to the air we breathe and the birds we watch in our gardens.

We all use the resources, and we all have a role to play in protecting them.

This Plan provides guidance for our collective actions to ensure we can enjoy the benefits of these resources long into the future. It provides long term targets and priorities for the resources of People, Water, Land, Wildlife and Air of the catchment. It is up to each of us to take ownership of the natural resources we each manage or interact with and set appropriate goals and targets that are within our own sphere of influence and control, but that still align with the broader goals and targets outlined in the NRM Plan.

The targets and the priority maps are a great resource to use when planning where to focus your activities. They show us our goal, but everyone must map their own path towards it. Some targets will be more relevant to some people and organisations than others, but together we can achieve them all.

Checklists have been provided to show some of the most helpful ways people can contribute in their daily activities, depending on the type of catchment stakeholder you are. For some people several checklists may be relevant, for others only one.

Overarching principles

This Plan adopts the following overarching principles to ensure the appropriate, efficient and effective implementation of the Plan towards the community's vision for the catchment.

Coordination and Linkage

Implementation of this Plan will be done in coordination with appropriate agencies, government departments, community groups, industry and any other relevant stakeholders, including those in neighbouring catchments. Resulting plans and programs will be developed at relevant scale and link to and address relevant local, state, national and international requirements with coordinated involvement of relevant stakeholders for local issues.

Strategic Planning

NRM Plan targets will be incorporated into, and aligned with, appropriate local, state and national strategic planning documents through liaison with relevant government departments and industry organisations.

Sustainability

Actions undertaken during implementation of this Plan will promote the responsible use and equitable distribution of the catchment's natural resources to ensure the long-term sustainability and viability of the natural environment, industry, agriculture and livelihoods.

Climate Change

The impacts and effects of climate change will be a major consideration in implementation of all aspects of this Plan.

Cultural Heritage and Knowledge, both Indigenous and European

Actions undertaken during implementation of this Plan will ensure the conservation of Traditional knowledge, and the European and Indigenous Cultural Heritage of the Condamine catchment.

Community Capacity Building

Implementation of this Plan will involve the development of community capacity building and awareness programs to increase knowledge and implementation of best management practices. Implementation strategies, review/monitoring and continual improvement will be part of implementation programs. Programs will engage with relevant stakeholders from planning to delivery to maximise capacity growth and ownership of implementation.

Our Process

Why is the Plan being updated?

Stakeholders in the Condamine catchment are committed to continually improving practices across all aspects of natural resource management. The state of the catchment, similar to many areas in southern Queensland, is rapidly changing. These changes together with the availability of new data, information and technology mean that the 2010 Plan required updating. Additionally, issues affecting natural resource management (such as climate change and the booming mining and energy industries) are also facing the catchment compelling the region to embrace an adaptive approach to natural resource management to secure the catchment's long-term future.

How were the priorities identified?

It is important to create a Plan that captures the essence of managing the changing nature of the catchment. The process of developing this plan consisted of four phases based around the guidelines set by the Queensland Regional NRM Group's Collective and those set by the Australian Government.

Phase 1: Reviewed and researched new scientific development for the Plan which involved community consultation and input. Developed a conceptual model that maps system interaction and supports the identification of management objectives.

This phase involved the State of the Catchment report being reviewed by local experts using a broad range of sources which can be accessed in the NRM Library. A workshop with representatives from 14 key stakeholder groups (who formed the Advisory Team) was held to map out how the land, water and wildlife components of the catchment interact and determine the role that human activities have in these interactions. A review was conducted on each theme individually and then all of the themes were bought together to highlight how they interact and impact upon each other based on the conceptual map developed in the workshop. The State of the Catchment information and the concepts, scientific papers and reports identified in the workshop, were used as inputs to Phase 2. The updated State of the Catchment report was released online for community feedback and to identify any gaps.

Throughout this phase, the community had the opportunity to provide proactive ideas and information to support the activities that were conducted in this phase and to help the team understand the broad range of priorities and perspectives across the catchment. Any feedback that was received was considered by the Advisory team during their workshops.

Phase 2: Developed models of the catchment which incorporated the data that was available and identified and set geographic priorities and targets.

The conceptual model and scientific information that were identified on Phase 1 were used to build the first version of a model of the catchment using Bayesian Belief Networks. The model is split into six subcatchments to better represent the differences across the catchment, but links water, land and wildlife components within these subcatchments to better represent the relationship between them.

A second workshop was held with the Advisory Team to confirm the assumptions behind the model and make sure it mapped the catchment appropriately for target setting purposes. This workshop also included a scenario-building process that looked at what might possibly happen in the catchment over the next 15 to 20 years. The team developed three scenarios that were used to help understand what targets could be set for improving our catchment's health: best case, worst case and most likely case.

The revised model and the scenarios were used in a third workshop to support assessment of the achievability and possible outcomes of various targets in an iterative process to develop the draft targets for the plan.

Throughout this phase, the community continued to have the opportunity to provide proactive ideas and information to support the activities of this phase in order to help the team understand a broad range of priorities and perspectives across the catchment. Any feedback that was received was considered by the Advisory Team during their workshops.

Phase 3: Release of the draft of the NRM Plan 2015 for community feedback.

The draft Condamine Catchment Natural Resource Management Plan 2015 was reviewed by the public online (this website) in October and November 2014. This new online format allows components of the Plan to be updated more frequently so it can respond more quickly to changes affecting the catchment.

The community were engaged for feedback on the draft Plan during Phase 3 using a range of mechanisms. Some examples include:

Public exhibition - Six (6) week period in which all audiences could provide comment on the draft plan
Formal letter - Distribution of a formal letter to primary stakeholders inviting their feedback
Online forum - Comment box on the web page which allowed users to post comments and photos related to discussion
Feedback form - Feedback form was available online to collect formal email or postal submissions on the draft Plan
Special briefings - Conducted with stakeholder groups as requested
Stakeholder briefings - Three stakeholder and community briefing sessions (Toowoomba, Warwick and Dalby)

Phase 4: Review the feedback collected from the community from the draft plan for update of targets and priorities in preparation for the release of the final plan.

Feedback received on the draft Plan during Phase 3 was collated and analysed to identify where improvements could be applied by relevant experts. A summary of the feedback received during development and upon release of the draft Plan and the review actions taken in response to this feedback can be accessed and viewed in the community feedback section of the Plan. An analysis on the effectiveness of the community engagement approach and incorporation of feedback into the NRM Plan to draft Final stage was also undertaken and is summarised in the Community Feedback Analysis Report.

Letters or emails (as appropriate) have been sent to those who provided formal feedback on the draft, identifying the improvements made based on the collective feedback received. The website and plan content will continue to be updated during final consultation with catchment stakeholders in 2015-16. After a final review by the Australian government, the final Condamine Catchment Natural Resource Management Plan 2015 will be formally released in 2016.

Phase 5: Ongoing review and update.
The Condamine catchment and its community are constantly changing. In order to address emerging issues and changes in the pressures and issues facing our natural resources, this Plan needs to change in response to community and catchment needs.

The Advisory Team

One of the most important components of the development of this Plan has been the input of the Advisory Team. This team has provided expert advice, strong local knowledge and critical review and feedback throughout the planning process to ensure that this Plan is relevant, appropriate and focused. This team has given freely of their time and knowledge, without which the Plan could not have progressed.

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Wes Davidson Department of Environment and Heritage Protection

A Quality Process

The Queensland Regional NRM Planning Guidelines (RGC, 2012) were developed to provide a guiding set of principles and standards for writing community NRM plans. There are four planning principles that are highlighted in the guidelines:

1. The plan supports and promotes collaboration between community, government, industry and other stakeholders.
2. An adaptive planning process is used to develop and implement the plan and its regular review.
3. The plan is action-oriented, describing a collective regional vision and clear pathways to implementation.
4. The planning process uses the best available scientific, local, traditional and cultural knowledge

The standards for NRM planning were developed based on the four principles and form a comprehensive matrix which provides a set of attributes that are required for a high quality NRM plan. The attributes provide more detail for assessing activities and how well they meet the standards for NRM planning.

Community Feedback

Community feedback received during development and upon release of the draft Plan was reviewed in detail and incorporated as appropriate into the Plan during finalisation.

The Community Feedback Analysis Report describes the feedback received about the comprehensiveness and effectiveness of the Plan as a document. The report firstly assesses the effectiveness of the different engagement and feedback methods. The report then goes on to summarise the feedback received from the catchment community and describes how this feedback was addressed and incorporated into the Plan.

Each question or suggestion was individually evaluated and summarised and then like issues were categorised together. A summary of the review actions is outlined below.

Assets

The natural resource assets specifically mentioned in community feedback are listed below. Each asset was reviewed against the draft Plan to confirm which were already addressed and which required adding or amending. Those that were not already sufficiently well addressed in the State of the Catchment report, targets, checklists and/or priority maps were addressed in whichever of those were at the appropriate level of detail for the feedback submitted.

- Air quality
- Good quality agricultural land/fertile soils
- Groundwater - water quality, water levels, system connectivity
- Native ecosystems - especially groundwater dependent ecosystems and the Bunya mountains
- People's capacity for natural resource management
- Surface water - water quality, native fish, habitat, groundwater connectivity
- Threatened species and ecosystems - especially grasslands and those in small reserves

Threats

Each of the threats below were reviewed against the draft plan to confirm which were already addressed and which required adding or amending. Those that were not already sufficiently well addressed in the State of the Catchment report, targets, checklists and/or priority maps were addressed in whichever of those were at the appropriate level of detail for the feedback submitted.

People

- Changing land ownership and educating newcomers
- Disengagement when actions are believed to have no impact
- Knowledge gaps (including around land-wildlife interactions) across all stakeholders
- Legislation counter to community goals
- Loss of networks for collaboration across landscape (e.g. floodplain coordination)
- Lost knowledge
- Money and time are barriers to implementation

- Social issues when coal seam gas extraction enters decline
- Urban-rural divide distancing ownership of issues

Water

- Abandoned mines
- Chemical pollution of runoff
- Drainage modification
- Flood levees
- GW quality risk - Oakey Army base example, coal seam gas concerns
- New dams
- Over-allocation and extraction of surface water and groundwater
- Poor efficiency of water storages
- Poor prioritisation of water allocations to different uses
- Silting of waterways and storages
- Soil erosion (especially agricultural land and riparian zones)
- Urban sprawl and associated runoff

Land

- Agricultural intensification and food production target pressures
- Development above land capacity
- Loss of good quality agricultural land

Wildlife

- Infrastructure development causing fragmentation
- Knowledge gap around available biological controls for weeds and pests
- Large impacts of low priority weeds in small reserves
- Loss of native vegetation
- Research gap around impact of fragmentation of state forest by coal seam gas
- Weeds and pests

Air

- Coal dust and pollutants

Across-themes

- Baseline data availability (including extractive industry areas)
- Drought
- Increasing sand and gravel extraction for development
- Poor resource management
- Resource extraction (especially cumulative impacts)

Natural resource management actions

Each of the actions below were reviewed against the draft plan to confirm which were already addressed and which required adding or amending. Those that were not already sufficiently well addressed in the targets, checklists and/or priority maps were addressed in whichever of those were at the appropriate level of detail for the feedback submitted.

People

- Collaboration between groups and across levels (eg government and landholders)
- Communicate the natural resource management message simply (including report cards, use of media)
- Education tailored to stakeholder knowledge gaps
- Increase engagement and volunteerism (including retired individuals)
- Knowledge retention
- Knowledge sharing and education of newcomers
- Landscape scale planning (across neighbours and stakeholders) and issue ownership
- Make the celebration of successes mainstream
- Monitor and increase community resilience
- Monitor and promote the social outcomes of natural resource management action (including knowledge and skills; aboriginal employment and social benefits)
- Ongoing communications on educational resources and promotion of milestone achievements
- Promote connection to nature
- Provide evidence of return on investment in natural resource management activities to increase adoption (better information on cost and return)
- Researchers engage more with end users to better design projects

Water

- Irrigation offtake research for fish protection
- Mine rehabilitation and mine waste management (including abandoned mines)
- Regular waterway health data collection and public sharing
- Research to map instream habitat
- Water management plans for riparian rehabilitation and protection

Land

- Best practice soil management
- Promote diversity of agricultural production
- Soil conservation expertise
- Mine rehabilitation priorities

Wildlife

- Assess the cumulative impact of fragmentation of state forest by coal seam gas activities
- Inclusion of native grasslands in rehabilitation

Air

- Promote renewable energy projects
- Managing for climate variability and emissions reduction

Across-themes

- Capitalise on opportunities offered by new technology (e.g. water storage options)
- Modelling of development (especially resource extraction) for cumulative impact assessment
- Promote supply chain natural resource management ethos
- Identify new technological solutions to issues by working more closely with research and development scientists

Plan implementation process

The following feedback points were provided by the community to support the effective implementation of the Plan and should be considered by all contributors as appropriate to their activities. They are generally addressed in the Overarching principles and will be evaluated as outlined in Monitoring and updates.

- Engage at landscape level with broad representation for local priorities and action
- Engage with stakeholders from plan to grants to implementation
- Negotiate with stakeholders on their implementation contributions (with special mention of State government)
- Promote ownership and uptake

State of the Catchment

The State of the Catchment has been developed to give you a snapshot of the natural resources in the Condamine catchment – their current condition, use and management. It aims to raise awareness of the importance of these resources and help guide what we do to protect them.

This report is the result of extensive research and review of current science and knowledge focused on four central themes: People, Water, Land and Wildlife. Like our natural resources that are always changing, this resource will continue to be updated to reflect outcomes from the Plan review, environmental changes and current science and knowledge.

People

The Condamine catchment is a small yet diverse part of Australia. Its population of over 200 000 is growing due to expanding industries and immigration. Organisations, community groups and individuals are actively playing a part in managing our natural resources now and for the future. This section outlines information about the region's people and who's involved in taking care of our natural resources.

Our Community

There's a lot going on in our catchment. The Condamine catchment is home to approximately 233 000 people (ABS, 2012) and showcases a thriving agricultural region as well as a growing urban lifestyle.

In the next 15 years the population is expected to increase dramatically as a result of urban development and the expansion of extractive industries. Our growing community and industries means we can expect a lot more pressure on our natural resources. Many individuals and organisations are directly involved in planning and caring for our natural resources for a sustainable future.

Who are the people in our catchment?

The Traditional Custodians of the Condamine catchment are the Barrunggam, Jarowair, Bigambul, Giabul, Kambuwal and Githabul people.

Today the Condamine catchment is a popular settlement area for immigrants, with Toowoomba and surrounds boasting a strong multi-cultural network and diverse ethnic communities. Between 2001 and 2011, the number of people in the Condamine region who were born overseas increased by 49.7% (ABS, 2012). Australian born persons accounted for 84.8% of the population in the Condamine region in 2011 (ABS, 2012).
The Condamine catchment extends across three main local government areas: Toowoomba Regional Council, Southern Downs Regional Council and Western Downs Regional Council.

People: our most valuable resource

Our catchment is fortunate to have an abundance of natural resources and assets, such as wetlands, ecosystems, native flora and fauna, prime agricultural land and places of high scenic and natural amenity.

Individuals and organisations play an important part in planning for and taking care of these natural resources and assets now and for the future. These include local and state governments, community groups, not-for-profit organisations, Traditional Owners and land managers.

The Australian Bureau of Statistics has identified a gap in their data around how people look after the environment (ABS, 2014). They are continuing to investigate the best ways to measure this community involvement, as the information is of critical importance to understanding who is involved and how this changes over time.

Working Together

Community involvement is a crucial to delivering successful, long-lasting care and protection of our natural resources. The involvement of the catchment community in decision making and activities underpins the success and longevity of natural resource solutions.

How can you get involved in looking after our natural resources?

Why look after our natural resources?

People rely on natural resources in many aspects of their lives. We are connected to our environment every day, from our local park to the land we work on. This relationship means we all have a valuable contribution to make in the management of our natural resources.

A healthy environment means healthy communities. It’s easy to think economic growth is the best way to manage and address accessibility, amenity, health and infrastructure needs of the community. However, proper care, protection and management of the environment also plays an important part in meeting community needs and improving the health of the community.

Everyone should be involved

Successful management of our natural resources relies on involvement from industry, land managers, investors, institutions and community groups and members. It also relies on strengthening the adaptive capacity and improving the wellbeing of our people, encouraging a shared value system for the environment and fostering a ‘sense of place’.

The Condamine Catchment NRM Plan provides a great opportunity for you to contribute to future planning and management of our natural resources.

Your help doesn’t just have to be on the ground. Subscribe your local groups’, council or Condamine Alliance newsletters or follow them on social media. It’s a simple way to hear about what’s happening and how you can be involved in the future.

Opportunities for involvement

The Condamine catchment community are an active bunch. Nearly a quarter of us are participating in voluntary work for a variety of causes, including our environment. This is supported by active institutions and organisations that collaborate to manage and protect the natural resources and assets of the Condamine catchment, for the benefit of our people, water, land, wildlife and air.

These simple actions are helping our environment…

People power: citizen scientists and volunteer action

The efforts of citizen scientists gives us substantial data and insights into our environmental challenges. Our citizen scientists are part of the 22% of the population within the catchment that undertake voluntary work for a variety of causes (ABS, 2012). This is evidenced by the strong Landcare presence and number of volunteer conservation groups in the catchment.

Our community has many active environmental groups working to protect our natural resources - such as Landcare groups, community groups, universities, research institutions, fish stocking associations, industry groups, businesses and volunteer organisations.

Landcare groups that operate in our catchment and who work with the smaller local groups include: Chinchilla District Landcare Group, Brigalow-Jimbour Floodplains Group, Central Downs Area Landcare Groups, Millmerran Landcare Group, Condamine Headwater Landcare Group, North East Downs Landcare Group and Toowoomba Landcare Group.

Other groups helping to manage and protect the natural resources of the catchment include:

- Condamine Balonne Water Committee
- Condamine Catchment Management Association
- Friends of Felton Inc.
- Friends of Franke Scrub
- Friends of Peacehaven Botanic Park Inc.
- Friends of the Escarpment Parks (Toowoomba) Inc.
- Granite Belt Wildlife Carers Inc.
- Householders' Options to Protect the Environment Inc.
- Irongate Reserve
- Scouts Australia
- Toowoomba Community Organic Gardens Association Inc.
- Toowoomba Field Naturalists Club Inc.
- Wildlife Welfare Carers Inc.

Little things add up at home

Incorporating ways to reduce environmental impacts into our daily lives are also important. Activities such as recycling, composting, efficient energy and water use, buying local produce or growing your own food, product choices and mode of transport at home and at work can reduce our ecological footprint and pressure on natural resources. Across the Condamine catchment, approximately 20% of the working population use environmentally friendly modes of transport, such as bus, bicycle or walking, to travel to work (ABS, 2012).

The next generation

Schools and youth groups across the catchment are incorporating environmental programs into their curriculum and activities to help create and promote local solutions to help protect the environment. Initiatives such as the Condamine Crusaders, the Dewfish Demonstration Reach and Nikki Long Cod Demonstration Reach, Adopt a Patch, weed spotting, habitat monitoring, tree planting and guest environmental presentations are actively embraced by many schools and youth groups in our catchment.

The benefits to community resilience

Resilience allows a community to deal with adversity. With the many changes expected across the catchment due to population expansion, new industries, and climate change, a resilient community will be much better able to respond. Involvement in natural resource management activities helps develop the resilience of both participants and the natural resources. All of the key components of community resilience (Berkes & Ross, 2013) can be built upon through collaborative regional natural resource management, including:

- engaged governance
- social networks
- values and beliefs
- knowledge, skills and learning
- leadership
- people-place relationships
- diverse and innovative economy
- community infrastructure
- positive outlook
- self-organisation
- agency

Threats to involvement

Being involved in helping the environment is a rewarding experience. However, it can seem difficult to know where to start or lend a hand. Various factors including financial constraints, resource availability and capacity can all play a part in helping or hindering community involvement in natural resource management.

What's stopping people getting involved in natural resource management?

Why not get involved?

Moving from environmental awareness to acknowledgement and action involves many factors. People may become disengaged or disempowered if they cannot understand or see the value of their involvement. The community may perceive a lack of acknowledgement or active support by organisations or government. This can undermine present and future community uptake and commitment to regional natural resource management processes.

Barriers to involvement

Within the Condamine catchment various factors can limit community involvement in natural resource management. Some of the barriers to community involvement could include:

- capacity, resourcing and coordinating efforts of groups and individuals
- understanding the role of the volunteer groups and what's involved
- an accurate understanding of how they may be involved
- commitment capacity: finding the time to be involved, conflicts with other commitments
- physical barriers for ageing population/volunteer group members
- access and inclusion for younger volunteers
- recognition of community members for their time, input and contributions
- skills, knowledge and technical capacity.

Future of involvement

Threats to involvement can be difficult to target and manage but are critical to address. It is often easier to focus on outputs such as landholder engagement and investment amounts than on outcomes in community attitude, behaviour and network strength. A range of different engagement strategies will be necessary to increase community involvement and recognition of their contributions towards achieving the Plan's targets.

More information on Our Community

- ABS 2012, 2011 Census, Online.
- ABS 2014, Protecting the environment, Online.
- Berkes, F and Ross, H 2013, Community Resilience: Toward and Integrated Approach, Society and Natural Resources, Vol 26(1), pp 5-20.
- Condamine Alliance 2013, Flood recovery report card: Final report June 2013, Condamine Alliance, Toowoomba.

Water

Water is the lifeblood of the land. At the headwaters of Australia's largest river system, it's easy to see that looking after our catchment has importance beyond our boundaries.

This section looks at the water resources and their uses and management in the Condamine catchment.

Our Water Resources

From groundwater to surface water, water is crucial to our communities and industries. As our catchment grows, so too do the demands and impacts on our water resources. Taking stock of our water resources can help us better understand and manage them now and into the future.

The Condamine River and its tributaries

The Condamine catchment is located at the headwaters of the Murray-Darling Basin in southern Queensland. The Condamine River is the major drainage system in the catchment.

The catchment extends from its source, which rises on Mount Superbus on the inland side of the Great Dividing Range and flows through to where it joins with Dogwood Creek west of the town of Condamine. Here the river changes its name to the Balonne River. The main channel is approximately 657 km long and is part of Australia's largest river system – the Murray-Darling.

Sub-catchments

There are nineteen sub-catchments (as adopted by Condamine Alliance) that exist within the Condamine catchment boundaries.

Subcatchment	Major Waterways
Dogwood Creek	Dogwood Creek
Upper Charleys Creek	Charleys Ck, Durah Ck, Burraburri Ck
Lower Charleys Creek	Charleys Creek, Canaga Ck, Branch Ck
Wambo and Wieambilla Creeks	Wambo Ck, Wieambilla Ck
Jingi Jingi Creek	Condamine River, Jingi Jingi Ck
Cooranga and Jandowae Creeks	Cooranga Ck, Jandowae Ck
Wilkie Creek	Wilkie Ck
Jimbour Creek	Jimbour Ck, Cattle Ck
Upper Myall Creek	Myall Ck, Moola Ck
Lower Myall Creek	Myall Ck
Lower Oakey Creek	Oakey Ck, Lagoon Ck
Upper Oakey Creek	Oakey Ck, Gowrie Ck, Westbrook Ck
Central Creeks	Condamine River

Subcatchment	Major Waterways
Kings and Hodgon Creeks	Kings Ck, Hodgon Ck
Western Creeks	Condamine River
Six Mile and Thane Creeks	Six Mile Ck, Thane Cks
Glengallan and Dalrymple Creeks	Glengallan Ck, Dalrymple Ck
Swan and Emu Creeks	Swan Ck, Emu Ck, Rosenthal Ck
Sandy Creek	Sandy Ck

The sub-catchments range in area from 235 km^2 to 3560 km^2 and flows vary across the sub-catchments from 4213 ML/yr to 101.567 ML/yr. The floodplains associated with the Condamine River and its tributaries cover about 26% (637 300 ha) of the catchment (Searle et al 2007).

Stream flow

Stream flow in the catchment is highly variable due to natural climate variability (DNR 2000; Searle et al. 2007). Dams, weirs, pumping infrastructure and land clearing for agriculture and grazing activities have heavily modified the hydrology of the watercourses in the catchment. The upland streams in the eastern ranges near Killarney are largely perennial streams that flow 90% of the time. This perennial nature is likely to result from a combination of higher rainfall and the contribution of base-flow from groundwater in the upper catchment. In the mid and lowland areas, stream flow occurs 80% of the time, becoming gradually more intermittent in the west of the catchment. Discharge from the catchment west of Chinchilla is approximately 490 000 ML/yr. CSIRO (2008b) estimated that about 8.5% of the total annual runoff in the Murray-Darling Basin is generated in the Condamine-Balonne catchment, with the average surface water availability estimated to be at 1305 GL/yr.

Flows in the Condamine below the Chinchilla weir are being supplemented by the discharge of water produced by coal seam gas operations that has been through a reverse osmosis process then reconstituted with sediment and often gypsum the return it to similar quality to the water in the river.

Dams and Weirs

There are a number of dams and weirs throughout the catchment that have various uses. They provide water supplies for irrigation and domestic use and recreational opportunities. The table below outlines the capacity of both major and minor in-stream storages within the catchment and average annual evaporation losses and releases are shown for major storages.

Two additional dams, Cressbrook Dam and Perseverance Dam, are located outside the catchment but supply water to Toowoomba. The capacity to further source additional water from Wivenhoe Dam (located further outside the catchment) to supply water to Toowoomba also exists.

STORAGE NAME	CAPACITY(ML) 1	AVERAGE ANNUAL INFLOW (ML)	AVERAGE ANNUAL YIELD (ML)	AVERAGE ANNUAL NET EVAPORATION (ML)
Major supply reservoirs				
Leslie Dam	106200	29600	16500	7700
Connolly Dam	2600	7700	2500	400
Cooby Dam	28650	5000	3500	1400

STORAGE NAME	CAPACITY(ML) 1	AVERAGE ANNUAL INFLOW (ML)	AVERAGE ANNUAL YIELD (ML)	AVERAGE ANNUAL NET EVAPORATION (ML)
Chinchilla Weir	9780	265600	2200	6500
Minor supply reservoirs				
Talgai Weir	640	-	-	-
Yarramalong Weir	390	-	-	-
Lemon Tree Weir	260	-	-	-
Cecil Plains Weir	700	-	-	-
Melrose Weir	160	-	-	-
Wando Weir	310	-	-	-
Nangwee Weir	80&	-	-	-
Loudoun Weir	590	-	-	-

Note: Total Storage Volume (including dead storage) rounded down for reporting purposes.
(Source: CSIRO, 2008b)

Three main flow-regulated reaches support the irrigation industry in the Condamine catchment (predominantly cotton). These are 196 km of the Condamine River between Leslie Dam (Sandy Creek) and the Cecil Plains Weir, 87 km along the Condamine north branch downstream of Pampas, and 88 km of the Condamine River below the Chinchilla Weir (Thoms and Parsons 2003; cited in Wilson and Adams 2004). Both stock and domestic water (eg Leslie Dam at Warwick) are also sourced from these watercourses. Industrial use of water is also significant, for intensive livestock production (piggeries, feedlots, dairying), abattoirs, mining and power generation and other light industries in the area (Wilson and Adams 2004). A summary of the legislation and regulations governing the management of the water resource can be found in the Legislation and Policy List.

Overland Flow

Stormwater runoff from urban catchments and across the floodplain (both local and river overbank flows) has been harvested for use since the 1960s. The capture and use of this water is an important asset on the Darling Downs floodplain. Water is captured using high-capacity pumps and stored in large off-stream storages (ring tanks). The Condamine catchment has about 350 000 ML of on-farm storages. Since August 2004, the Condamine and Balonne Water Resource Plan prevented any increase in the capacity (limiting both storage and pumping capacity) for the take of overland flow.

Groundwater

There are significant groundwater resources within the Condamine catchment. Fractured basaltic aquifers on the Darling Downs contain large volumes of high quality water. The Condamine tributaries (particularly in the uplands) and the Condamine plains through to Macalister, have large sand and gravel aquifers (Kenway, 1993). Bores in this area are 60-130 m deep, with those in tributaries less than 40 m deep. Recharge in these aquifers is limited due to the presence of layers of relatively impermeable clay. The groundwater resources historically provide 18% of total water used in the region as groundwater is used to supplement irrigation supplies and provide stock and town water. Estimated groundwater extraction from the Condamine alluvium is 55 000 ML/yr.

The major groundwater systems of the Condamine catchment are classified as:

1. Unconsolidated porous media (alluvium)
   - Condamine River floodplain (major aquifer)
   - Tributary stream flats
2. Fractured rocks (basalts and metamorphics)
   - Main range basalts (major aquifer)
   - Texas beds
3. Consolidated porous media
   - Shallow sandstones
   - Deeper Great Artesian Basin sandstones (major aquifer)

The Condamine alluvia groundwater system covers an area of approximately 8500 km^2, starting in the headwaters near Killarney and extending downstream to the Balonne River. The alluvium is approximately 30-60 m deep but is closer to 130 m deep in the central floodplain. On the eastern side, clay deposits overlie the alluvium making it semi-confined. Recharge is mainly from the Condamine River with some contribution from deep drainage from rainfall (mainly during periods of long fallow) and from irrigation (DNRM, 2008b).

Groundwater levels within the alluvium show almost no difference in water levels with depth. This means that although the system is made up of many discrete beds, there is significant inter-connectivity in profile within the alluvium and hydraulically the alluvium acts for the most part as a single aquifer system (KCB 2010).

The groundwater quality within the alluvium is generally good but tends to deteriorate and become more saline on the edges of the alluvium and in the down valley direction. The alluvium and tributaries have been extensively developed for irrigation, industrial, stock and domestic purposes and are characterised by overdevelopment and over allocation with respect to the productive yield of the system. Overdevelopment is a historic legacy from major irrigation growth in the 1960s.

The main range basalts have limited supplies of good quality water but are used for irrigation and to supplement urban water supplies. The water quality is good with generally low levels of salinity, although there are minor localised concerns of salinity emerging. These basalts are potentially at risk from contamination with nitrates from dairy operations and from failing septic systems. Water levels have been in decline but these aquifers demonstrate rapid recharge from rainfall events.

The Walloon Coal Measures underlie much of the Condamine alluvia. They are reported to be up to 650 m thick and contain sedimentary deposits including coal seams. They contain water but it is generally of very poor quality although they have been poorly monitored. The water in the Walloon Coal Measures is older water than in the Condamine Alluvia and is a result of limited local recharge and contains remnant salt (Hillier, 2010). The coal seams contain the most water and this water is brought to the surface during coal seam gas extraction.

Environmental values associated with the catchment's groundwater resources have been identified as part of the process for development of local water quality guidelines (Condamine Alliance, 2012c). A wide range of values from productive uses (irrigation, industrial use and stock watering) to domestic uses (including drinking water) and cultural and spiritual values were identified.

Wetlands

Wetlands are an important water resource as they provide a number of ecosystem services. These include improving water quality by filtering out sediment, nutrients and pesticides and providing critical habitat for waterbirds, native fish and other aquatic fauna such as macro invertebrates and reptiles (Wilson and Adams 2004).

Condamine catchment wetlands

Condamine catchment wetlands have been mapped and classified under the Wetland Classification and Mapping Method (EPA, 2005), which provides an accurate description of the extent and distribution of wetlands at the time of mapping.

Clayton et al. (2008) used this classified wetland mapping as a platform for undertaking an aquatic conservation assessment of the Condamine catchment. A total of 1750 wetlands were identified, occupying a total area of about 28 000 ha (about 1% of the total catchment area). Seventeen wetland management groups were identified (see table below). Of this total number, 768 wetlands were identified which had limited or no known modification to their 'natural' hydrological regimes and are considered to be unmodified, natural wetlands (known as H1 wetlands). This assessment also identified the 'top 30' wetlands in the catchment of highest conservation value.

Group	Wetland management group name	Mapped wetlands	
		NUMBER	AREA (Ha)
1	Permanent natural lakes &ndash with or without fringing palustrine components	4	322
1	Non-permanent natural Lakes - with or without fringing palustrine components	0	0
3	Permanent natural billabongs	22	146
4	Non-permanent natural billabongs and shallow wetlands	143	1386
5	Permanent natural waterholes	0	0
6	Non-permanent natural creeks and waterholes	94	1667
7	Permanent red-gum wetlands	52	408
8	Non-permanent wed-gum wetlands	453	13593
9	Grassland swamps	19	111
10	Phragmites swamps	2	81
11	Montane heaths and sedgelands	1	1
12	Sandstone springs	0	0
13	Alluvial/basalt springs	0	0
14	Modified natural wetlands - weirs, dams and impoundments	231	2999
15	Modified natural wetlands - non-riverine	39	265
16	Modified natural wetlands - non-riverine, 4-walled tanks and dams	58	763
17	Modified natural wetlands - canals and channels	0	0

Source: Clayton et al. (2008)

Nationally important wetland – Lake Broadwater

The Directory of Important Wetlands in Australia lists only one wetland within the Condamine catchment as being of national importance, which is Lake Broadwater (south-west of Dalby). Lake Broadwater is a good example of a semi-permanent freshwater lake in an area where these are rare (DEHP, 2011). Lake Broadwater provides habitat for migratory birds protected under Japan Australia Migratory Birds Agreement (JAMBA) and the China Australia Migratory Birds Agreement (CAMBA).

A recent environmental values report for the catchment (Condamine Alliance, 2012b) identified 101 drought refuges across the catchment (based on mapping to date). Furthermore, 27 other aquatic areas were identified as 'containing waters of high ecological value'. These areas cover approximately 467 200 ha of the catchment. A further 118 areas were identified as important, although containing "slightly disturbed waters". These more disturbed aquatic areas cover approximately 94 700 ha of the catchment.

Water resource health

Healthy water resources are crucial for a healthy community. From the surface water to groundwater, our current use and growing demand are having an impact on its health and viability. Understanding the condition of our water resources and our impacts on them can help us better plan for their use and management.

How do we measure the health of our water?

Surface Water Health

Key contaminants impacting on surface water health include salinity (measured as electrical conductivity) which impacts on soil health, human and animal health; sediments (measured as total suspended solids and turbidity) which impacts on aquatic health; nutrients (nitrogen and phosphorus) which impact on aquatic health, human and animal health; toxicants including chemicals, heavy metals, pesticides and herbicides which impact on aquatic health, human and animal health; and pathogens which impacts on aquatic health, human and animal health.

How does our surface water measure up?

Groundwater Health

Shallow groundwater depth (less than 5 m) in many areas of the Condamine catchment creates a potential risk for dryland salinity (Kelly and Merrick, 2007), particularly in areas where the shallow water table is rising (Biggs et al, 2010). There has been limited monitoring of groundwater quality. Water levels have been lowered in the Condamine alluvium over the past forty years from extraction being higher than its refilling rate. Declines of over 3 m have been common in the central Condamine area from 1990 to 2000. This can result in increasing salinity in the groundwater. In a number of areas, the groundwater salinity is currently above crop tolerance levels, for example, cones of depression (where extraction of water results in a potential for adjacent, often more saline water to flow in) are evident in the vicinity of Cecil Plains.

These areas with salinity concerns include (Kelly and Merrick, 2007):

- near Chinchilla

- in the central plains north of Pittsworth
- in the central plains west of Oakey
- in the eastern hills north of Toowoomba
- along the western margins north of Millmerran.

Shallow groundwaters also experience elevated nitrogen levels from dairy operations and/or septic systems. Although there is no ongoing monitoring for pesticides in the groundwater, experience from other catchments indicate that persistent pesticides are likely to be found in the groundwater of the catchment.

The impact of the catchment's many small abandoned mines upon our groundwater is relatively unknown. These mines were predominantly for coal, gold and tin extraction with smaller numbers also mining silver, copper, lead and other minerals.

Opportunities for water resources

Our water resources are highly used, making water a scarce resource. Current usage is likely to be further challenged into the future due to increasing requirements for water from urban and industrial use and as rainfall patterns change under a changing climate.

With agriculture using the largest volume of water in the catchment (ABS, 2014), opportunities around water availability are limited and reside through improved water use efficiency, both within the existing cropping systems and in future cropping systems. There is likely to be a transition to crops which return a higher gross margin per megalitre, such as broadacre horticultural production.

Coal seam gas: opportunities for our water resources?

Produced water potential

The emergence of the coal seam gas (CSG) industry and the produced water resulting from these operations present significant opportunities for the catchment's water resources.

In its raw state, produced water is generally too saline for use in agricultural production but its quality can be significantly improved by reverse osmosis so that it is suitable for a range of uses. This water is currently being used on a minor scale for irrigation of crops and pastures and to augment urban water supplies. A number of beneficial reuse and disposal options have been considered for the CSG produced waters by the gas companies. Some of these options include application of saline water for dust suppression and direct reinjection of treated wastewater to suitable shallow and deep aquifers.

Water resource connectivity

Connectivity between the Condamine River, its tributaries and alluvial aquifers is both spatially and temporally variable (CSIRO, 2008b). Within the Condamine catchment, there are three main aquifer divisions, namely the Main Range Basalts, Walloon Coal Measures and the Condamine Alluvia.

The Condamine Alluvia are believed to be inter-connected as groundwater levels within the alluvium show almost no difference in water levels with depth. This means that although the system is made up of many discrete beds, there is significant inter-connectivity in profile within the alluvium and hydraulically the alluvium acts for the most part as a single aquifer system (Klohn Crippen Berger 2010b).

There is a hydraulic connection between the ground and surface water systems along the main channels in the upland area of the catchment (CBWC, 1999). Where stream baseflow is derived from groundwater the stream is classified as a gaining stream and conversely where stream flow is lost to the groundwater the stream is classified as a losing stream. The upland tributaries in the west, south and eastern ranges of the Condamine catchment are 'gaining' streams (Kelly & Merrick, 2007). That means groundwater aquifers get recharged during flood events. Upper Condamine River main channel is described as a 'losing' stream with less baseflow. The river upstream of Chinchilla Weir is described as a losing stream (high-to-medium) and downstream of Chinchilla Weir as a gaining stream (low-medium) (CSIRO, 2008b).

How does coal seam gas affect water connectivity?

Coal seam gas and water quality
Coal seam gas (CSG) activities can have a direct impact on surface water flow due to change in water movement in the surrounding aquifers. This may also alter the aquifer connectivity.

In 2007, a total of 12.5 GL (equivalent to 12 500 ML) was produced in Queensland (AGNWC, 2010). The biproduct of this process is called 'produced water' with annual production projected to reach 79 000 ML by 2030 (Kelly & Merrick, 2007).

The coal seams from which the CSG is obtained contain both water and natural gas. For CSG to be released, the water must be pumped from the coal seams to reduce pressure - thereby releasing gas that is trapped in the coal. The quality of CSG produced water quality varies greatly. CSG water can vary from fresh water (water with very few other elements) to salty or highly turbid.

Coal seam gas water from the Surat Basin typically has the following characteristics: pH of approximately 7 to 11; salinity generally ranging from 3000 to 8000 mg/L (ie brackish) and total dissolved solids including sodium salts, bicarbonate salts, chlorides and others; suspended solids from the well that will usually settle out over time; other ions including calcium, magnesium, potassium, fluoride, bromine, silicon and sulphate (as SO_4); trace metals and low levels of nutrients.
Coal seam gas is extracted economically from a depth of 200-1000 m via CSG wells drilled into the coal seams.

Water resource management

As demand increases managing our water resources has never been so important. The Condamine Alluvium and tributaries have been extensively developed for irrigation, industrial, stock and domestic purposes. They are characterised by overdevelopment and over allocation with respect to the productive yield of the system.

Overdevelopment is a historic legacy from major irrigation growth in the 1960s. Since 1970, the cumulative impact on this resource has been recognised. Measures have been taken since then to manage this resource more effectively.

How do we manage our water?

A history of overdevelopment and overallocation
Metered groundwater extraction in the Condamine-Balonne during 2004 - 2005 was 160 GL/yr, with 97% of that occurring in the Upper Condamine (CSIRO, 2008b). A model study indicates that in Upper Condamine areas, in 90% of years, the groundwater extraction has exceeded the recharge by 38% (CSIRO, 2008b). This figure had increased to 61% during dry periods.

Since 2004, the state government and the Central Downs Irrigators have been collaborating to manage the declining groundwater levels. This initially resulted in an agreement to voluntarily reduce the annual entitlement on take in sections of the Central Condamine Alluvium. In 2006, a review of system performance identified the aquifer was still in decline despite the measures implemented to reduce use. The management area was expanded at this time to form the Central Condamine Alluvium. This approach was formalised in a moratorium to limit development of groundwater in this area, which was published in June 2008 for the alluvium and the basalts in the Upper Condamine catchment.

Legislation and plans

Water resource management falls under the Water Act 2000. Under this act, the Condamine and Balonne Water Resource Plan 2004 has been developed, which identifies the Upper Condamine Alluvium groundwater systems as two sub-units: the central Condamine alluvium and its tributaries. A process to address over allocation by amending the Condamine and Balonne Water Resource Plan began in 2009, with preliminary involvement of groundwater users to discuss potential cuts of 60% to entitlements to bring the use of groundwater back to sustainable levels.

In 2010, the Murray–Darling Basin Authority released the Guide to the Basin Plan. The moratorium was amended to further restrict new take of groundwater in the system. Currently entitlement holders in the Central Condamine Alluvium are restricted to 50% of their nominal entitlement and those in the tributaries to 30%.

The final Basin Plan (MDBA, 2012) also converted area based entitlements (a given area of land being irrigated) to volumetric allocations (a given amount of water being used for irrigation) and proposed the allowance of water sharing.

Sustainable diversion levels versus current levels

The table below identifies figures for sustainable diversion levels and current levels of use of the Central Condamine Alluvium and tributaries. These figures are taken from the draft Basin Plan and they identify that the level of groundwater use in the system is 40.4 GL more than the sustainable level. The Commonwealth required an interim water resource plan before they would commence any buyback of groundwater entitlements. The water management plan released on 10 August 2012 is an interim water resource plan that meets the Commonwealth's requirement.

	Upper Condamine Alluvium (UCA)		
	Central Condamine Alluvium (GS67a) (GL)	Tributaries (GS67b) (GL)	
	Total Entitlement volume	86.1	42.0
Stock and domestic estimated use	6.0	3.5	
Current levels of use	81.4	45.5	
Sustainable diversion levels	46.0	40.5	
Gap (Commonwealth water recovery)	35.4	5.0	

Table source: Condamine-Balonne Water Resource Plan 2004

The Commonwealth has undertaken to purchase groundwater entitlements in the Upper Condamine Alluviums to align current levels of use with sustainable diversion levels and have been investing in improved water use efficiency infrastructure to assist in achieving sustainable water extraction.

Threats to our water resources

Water is a resource that is increasingly in demand and affected by human activities. Understanding what factors affect the condition and management of our water resources can help us develop ways to sustainably use (and even reuse) this valuable resource. Information on the threats to our water resources and impacts are detailed in the sections below.

Climate Change

It is acknowledged that climate prediction is a somewhat inexact, albeit an improving science. The 2010 report Condamine Region Climate Change Modelling (Stone et al, 2010) utilises five climate change/global circulation models and, compared to a baseline period (1960 – 1990) and predicting to 2010 – 2030 and 2040 – 2069, suggests that these periods (for the majority of models):

Climate variable impacted on	Period	
	2010 – 2030	2040 – 2069
Mean annual rainfall	Decrease by 60 – 180 mm	Decrease by 60 – 180 mm
Summer rainfall	Increase	Increase
Autumn/ winter/ spring rainfall	Considerable decrease	Considerable decrease
Annual surface/ sub-surface runoff – upper catchment	Decrease by 30 mm	Decrease by 60 mm
Annual surface/ sub-surface runoff – lower catchment	Increase by 30 mm	Increase by 60 mm
Summer surface/ sub-surface runoff	Increase	Increase
Autumn/ winter/ spring surface/ sub-surface runoff	Considerable decrease	Considerable decrease

Table source: Condamine Region Climate Change Modelling (Stone et al, 2010)

More recent climate change projections for Australia and the eastern Darling Downs region in particular, include a decline in rainfall, with increasing temperature and evaporation in conjunction with more extreme climate events with tropical cyclones likely to become more intense and shift southwards (Queensland Government, 2011a, IPCC, 2012). Extreme rainfall intensity is also projected to increase, indicating that, despite projections showing that total rainfall will decrease, the projected increase in rainfall intensity could result in more flooding and erosion events, potentially also increasing sediment, pesticide and nutrient transfer.

Under these scenarios, runoff could be expected to increase albeit, more episodically. Similarly, flooding could increase overall, particularly in summer but may be more likely in the lower reaches of the catchment. This may support enhanced groundwater recharge but conversely challenge surface water storage refills (both dams and on farm storages).

Land use change

Land use change will be significantly driven by economic considerations but potentially includes increased soil cover through expanding adoption of zero/reduced tillage systems and controlled traffic farming, which reduce the amount of soil lost in runoff water.

Cropping on marginal lands is increasingly likely to be converted to pasture systems, either ley pastures or permanent pastures. These systems reduce runoff and reduce sediment load. The opportunity to convert irrigated cropping systems to higher return per megalitre produce such as horticulture, are likely to increase runoff and sediment load through reduced soil cover.

Overall, it is expected that land use changes and improved land management practices will generally result in an increase in water entering the river system with lower loads of sediment, pesticides and nutrients.

Land uses also threaten other natural resources with activities such as land clearing impacting on wildlife, and changes to land use for agriculture leading to reduced soil productivity. Read more about threats to Land and Wildlife.

Wetlands

Wetlands are challenged by declining water quantity and quality, habitat degradation and incursions of exotic species. Reduced water quantity impacts on the survival and breeding of riverine plants and animals. Water quality factors such as salinity, nutrients and pesticides also impact on the flora and fauna of the wetlands.

Riparian health is being challenged by clearing or thinning of vegetation, excessive and often uncontrolled grazing pressure and damage by pest species such as feral pigs. There has been significant decline of riparian canopy tree health in some areas of upper Condamine. It is believed that a number of contributing factors such as vegetation clearing, lippia invasion, hydrological change and persistent drought have resulted in reduction in tree cover. It is also thought that the dropping of groundwater levels is another factor of tree death in the catchment (Reardon-Smith & Le Brocque 2012). The cotton industry's Best Management Practice has a specific module that provides management information to monitor and manage riparian health.

Exotic pest fish species also challenge the wetlands through adverse impact on native fish populations and through increased turbidity. Tilapia has not been recorded as being found in the Condamine catchment. However, recent post-flooding surveys have recorded tilapia in the Upper Burnett River, which is within 3 km of the Condamine catchment, and the catchments may coalesce in periods of extreme flooding. Instances exist in other catchments of examples where it is believed that tilapia have been deliberately introduced. Modelling suggests that tilapia may be able to occupy up to 50% of the Murray–Darling Basin if they successfully invade.

Dam leakage and tailwater

Leakage from dams and loss of tailwater from irrigation operations pose potential risks to groundwater and surface water. Seepage from on farm storages results in deep drainage that may increase the salinity level in groundwater.

Tailwater may contain nutrients (particularly nitrogen) and persistent pesticides that can potentially affect the quality of groundwater (deep drainage) and surface water (runoff). The cotton industry's Best Management Practice has a specific module that provides management information to monitor and manage these problems. The cotton industry's inclusion of these issues in their Best Management Practice is an example of how industry is helping to monitor and manage these issues.

Nutrients, pesticides and heavy metals

Current land use and changing land use increase the risk of contamination and consequent decline in water quality. Nutrients from agriculture (cropping and intensive livestock production) continue to be a source of nutrient contamination and are expected to increase into the future. This issue is compounded by the degradation of septic systems (due to age and lack of maintenance) across the catchment.

Pesticides are similarly a threat, particularly from runoff. Pesticides in ground water are notcurrently monitored but loss to the groundwater though deep drainage and the hostile conditions in subsoils that preclude the survival of soil biota degrading pesticides suggest this is a present and increasing threat.

Heavy metals from intensive livestock production and potentially from the coal seam gas industry are also poorly monitored. As industry grows, these contaminants are also expected to increase into the future.

Groundwater and surface water interaction

Groundwater use has exceeded recharge in the lower sections of the floodplain for decades. The current Condamine and Balonne Water Resource Plan has addressed this with imposed moratoria on further irrigation development, restricted current entitlements to 50% of their nominal entitlement in the Condamine catchment Alluviums and those in the tributaries to 30%, and proposed a 40.5 GL reduction in water take to be realised through water buy back and improved infrastructure to improve water use efficiency (with a consequent return of water savings). Preliminary data suggests that a majority of monitored bores in the catchment has stabilised or are rising since 2010 due to two flooding events and a reduced take from the aquifers (DNRM, personal communication).

The development of the coal seam gas industry will result in some loss of water from the Condamine Alluviums to the Walloon Coal Measures but modelling suggests this will be about 1100 ML/yr over the next hundred years. This will result in lowering of groundwater levels but modelling suggests this will be below the threshold levels (5 m for consolidated aquifers (such as sandstone) and 2 m for unconsolidated aquifers (such as sands). The predicted maximum impact on water levels in the Condamine Alluvium is approximately 1.2 m on the western edge of the alluvium with an average of approximately 0.5 m for most of the area. This will place increased pressure on the availability of groundwater and raises the increased potential for saline water intrusions on the periphery of the alluvium. Saline water intrusion from the Walloon Coal Measures into the Condamine Alluviums already occurs at the edges of the alluvium and progressively down valley. The use of saline water for irrigation and human consumption increases costs and raises the potential for salinisation of important cropping lands.

Coal seam gas produced water

Coal seam gas (CSG) development can have potential impacts on surface and groundwater quality and quantity. These can happen during exploration, construction, operation, maintenance and decommissioning phases. An Arrow Energy baseline study indicated that the electrical conductivity (EC) of CSG wastewater is ranged from 1160 to 30 900 µS/cm in their project locations in the Surat

Basin region (Arrow Energy, 2012). Apart from EC, CSG produced waters found to have elevated pH, turbidity, sulfate, chloride, ammonia and heavy metals.

Unplanned and uncontrolled discharge of untreated water to watercourse during heavy rain events could impact the water quality in the sub-catchments. The potential direct impact of release of coal seam gas wastewater to waterways in the sub-catchments would cause degradation of environmental values due to increase in concentration of salts, sediments, suspended solids, chlorides and other contaminants. In all but exceptional circumstances, evaporation dams have been banned for CSG water, and existing dams will be either converted to other uses or decommissioned.

In the case of groundwater, the potential direct impact of CSG development on groundwater systems include reduced groundwater level as well as reduced flow directions in the Walloon Coal Measures during coal seam gas production (Arrow Energy, 2012). The groundwater extraction due to coal seam gas development has the potential to cause indirect impacts on groundwater levels in aquifer systems above and below the Walloon Coal Measures. This could cause potentiometric surface drawdown in the Walloon Coal Measures, which in turn can reduce the flow to groundwater streams and springs hence, reduce the groundwater supply to existing or future ground water users who extract groundwater from Walloon Coal Measures. Furthermore, there is a potential to cause cross-contamination between groundwater systems and subsequent impact on groundwater users and the ecosystems that dependent on the groundwater.

Competition for water

Population growth and the expansion of industrial requirements for water will continue to place increased demands for access to the water resources of the catchment. Toowoomba, the largest urban centre, has accessed additional supplies of water from Wivenhoe Dam. Competition for water by industry may be offset by a usually lower requirement for quality water; for example, Acland Mine uses water from the Wetalla treatment plant.

Our competition for water can also have an impact on our land and wildlife. Read more about threats to Land and Wildlife.

More information on our water resources

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Land

Food, fibre, energy, home… our land supports many aspects in our lives. Our increasing use of our land resources has impacted on its availability, condition and productivity. Around Australia and the world there is considerable effort from farmers, land management organisations, conservation groups and individuals to address issues affecting our land resources through improved management practices - so that we can maintain and improve its condition and productivity.

Our land resources

Understanding our land resources is key to helping us plan for its management. This means knowing about its capabilities and being able to identify opportunities, prevent conflicts, minimise harmful effects and degradation.

This section details more information on the land resources in the Condamine catchment.

Geology

Below the surface of our landscape, the Condamine catchment has an ancient story to tell. The movement and changes overtime have left us with the valuable land resource weenjoy today. A basic look at the geology of the Condamine catchment shows it consists of basement rocks overlain by deep sediments sloping to the west with volcanic outcrops.

During the Jurassic (about 145-200 million years ago) and Cretaceous (about 65-145 million years ago) periods, basement metamorphic and granite rocks were uplifted to produce large mountain blocks to the north, east and south forming a large basin to the west. Streams flowing towards the west from those mountains deposited thick sedimentary quartzose sandstones layers which grade from coarse (at depth) to finer. The sediments include the Great Artesian Basin layers such as the Marburg Formation, the Walloon Coal Measures and the Kumbarilla beds. Remnants of the granite rocks outcrop near Stanthorpe, Leyburn and Crows Nest/Cooyar.

These sediments continually subsided and compacted along with further uplift in the east and north associated with tertiary volcanic activity that poured volcanic rocks (mainly basalt) over parts of the landscape. Much of this basalt was eroded during this time exposing the sedimentary rocks. Erosion of both these rock types has resulted in the formation of a deep blanket of clay-rich colluvium and alluvium, including the brigalow clay sheet and alluvial plains of the Condamine River and tributaries. Remnants of the basalts including the Cooyar, Blackbutt and Great Dividing Ranges and basaltic uplands remain. Some of these basaltic remnants were laterised (chemically altered) giving soils rich in iron and aluminium (the red clay soils).

Soil resources

The level of detail for soil surveys of the Condamine catchment varies considerably (Biggs et al, 2012). The broad soil types of the Condamine catchment as classified under the Australian Soil Classification System (Isbell, 2002).

For the Condamine catchment, soils derived from basalt are usually dark, cracking, wellstructured, self-mulching fertile clays (vertosols) or deep well structured red clay soils (ferrosols) like those around Toowoomba.

Those formed from sediments vary depending on the nature of the sediment. The coarser sediments such as the Marburg Formations and the Kumbarilla Beds generally produce hard setting texture-contrast sandy coarse soils (sodosols, chromosols, kurosols and kandosols), often with dispersive layers that tend to dissolve when wet. The finer sediments such as the Walloon Coal Measures produce uniform dark cracking and non cracking clay soils, often with gilgais (vertosols, ferrosols and dermosols). Texture contrast soils (chromosols, sodosols and kurosols) and shallow sandy soils (tenosols) are common on sandstones and granites, and mixed origin alluviums. Alluvial sands (rudosols and tenosols) formed on alluvial and colluvial deposits are found along sandy alluvial plains.

Residual sands and sandy loams (rudosols, tenosols and kandosols) are formed from quartzose sandstone usually found on eroded edges of the plains and in the uplands. Skeletal, rocky or gravelly soils (rudosols and tenosols) generally occur beside rock outcrops in upland areas.

Land resource areas

Land Resource Areas (LRA) are areas of land each with a group of related soils, developed on a common geology and, mostly, have a common vegetation community. The Condamine catchment has 12 LRAs.

Land capability

Climatic, landscape, soil and agronomic factors should be taken into account when assessing the capability of a piece of land for a particular use. Historically land has often been used beyond its capability the world over, and the Condamine catchment is no exception. Today the region has about 76 000 ha of land converted for pastures to improve its condition following extensive cropping in the 1950s (Biggs, 2007).

Rosser et al. (1974) modified the USDA Soil Conservation Services land capability classification system (Klingebiel & Montgomery, 1961) for use for agricultural purposes in Queensland. That land capability classification system groups soils primarily on the basis of their capability to produce common cultivated crops and pasture plants without deteriorating over a long period of time. The eight classes of that system (detailed in the table below) indicate progressively greater limitations and narrower choices available. Rosser et al. (1974) also provided a table listing limiting factors and the degree of limitation caused by each factor. The most severe limiting factor sets the class of the land.

Whilst the assessment of the capability of individual parcels of land in the Condamine catchment has usually been carried out individually as required, Hannigan and Webb (1993) successfully mapped land capability for the Linthorpe Valley (around 30 km west of Toowoomba) using a computer-based Land Information System.

Class	Suitability	Limitation
1	All agricultural and pastoral uses	Nil.
2	All agricultural uses but with slight restrictions to use for cultivation	Some limitation to choice of crops, some impediment to the use of cultivation machinery, requires simple soil conservation practices.
3	All agricultural uses but with moderate restrictions	Moderate limitation to choice of crops, moderate impediment to the use of cultivation machinery, requires intense soil conservation practices.

Class	Suitability	Limitation
4	Primarily suited to pastoral use but which may be safely used for occasional cultivation with careful management	Severe limitation to choice of crops, severe impediments to the use of cultivation machinery, cannot be used safely for permanent cultivation and, if cropped, a pasture phase must be the major component in the cropping program.
5	Land which in all other characteristics would be arable but has limitations which, unless removed, make cultivation impractical and/or uneconomic	Limitations which, unless removed, make cultivation impractical and/or uneconomic.
6	Not suitable for cultivation but is well suited to pastoral use	The use of machinery to improve and establish pasture is practicable.
7	Not suitable for cultivation and pastoral use is possible only with careful management.	The use of machinery to improve and establish pasture is not practicable.
8	Unsuited for either cultivation or grazing	Numerous.

Source: Rosser et al. (1974)

Soil suitability

A thorough knowledge of both the soil's properties and the needs of the use is required to be able to assess the suitability of soil for a specific use. When growing a crop for example, a soil's suitability is dependent on how well that soil meets the crop's requirements. Taking into account properties such as soil depth, soil texture, soil drainage, plant available waterholding capacity, soil nutrient levels (base saturation and cation exchange capacity) and soil organic matter.

Soils can be grouped in terms of their suitability for a particular use with further subdivision of these groups (or classes) based on the degree of limitation for each property. There is limited information on the current suitability of soils for use across the Condamine catchment.

Land availability and use

As social and economic demands change across the Condamine catchment, so do the land uses. Land use decisions (including legislative and policy controls) are made by different individuals and organisations at different scales, including internationally (eg World Heritage Areas), nationally (eg nationally significant wetlands under international agreements like RAMSAR), by state governments (eg mining development approvals), by local governments (eg planning schemes), and by individual property owners (eg choices for siting buildings, and grazing versus cropping use).

Land uses

Land Use	Area (km^2)	Area (%)
Nature conservation	239	1.0
Minimal use	495	2.0

Land Use	Area (km^2)	Area (%)
Grazing native vegetation	11 977	49.0
Production forestry	2232	9.1
Plantation forestry	11	0.0
Grazing modified pastures	2	0.0
Dryland cropping	6240	25.5
Dryland horticulture	16	0.1
Irrigated cropping	1645	6.7
Irrigated horticulture	37	0.2
Intensive animal and plant production	869	3.6
Intensive uses (mainly urban)	187	0.8
Rural residential	403	1.6
Mining and waste	9	0.0
Water	95	0.4
Total	24 456	100.0

Source: Bureau of Rural Sciences, Catchment Scale Land Use Mapping for Australia, Update May 2009 dataset

Agriculture

The dominant land uses in the Condamine catchment are grazing of native vegetation (49%) and dryland cropping (26%). The catchment's range of climates and soils allow a variety of cereal, pulse and fibre crops to be grown both dryland and irrigated including wheat, barley, oats and chick peas in winter; sorghum, sunflower, maize and cotton in summer; horticultural crops (fruit and vegetables); and some viticulture. Other significant land uses include forestry, intensive animal production, nature conservation and urban.

Vegetation cover

The Queensland government's Statewide Landcover and Trees Study regularly updates data on landcover change at the broad scale. For 20011-12, the woody vegetation clearing rate for the Condamine catchment almost tripled, compared to the previous year (from 1769 ha/yr up to 4935 ha/yr). This is the highest clearing rate since 2005-06. The clearing of remnant woody vegeation formed 28% of this, totalling 1390 ha/yr. Most of the total cleared area (74%) was replaced by pasture, but clearing for infrastructure rose to 823 ha/yr (17% of all clearing), which was the highest recorded rate since records began in 1988 (SLATS, 2014). With natural areas (conservation and grazing of natural environments in the table above) totalling 122 160 ha across the catchment, the locations and patterns of clearing pose significant threat to the long term survival of these ecosystems.

Urban and infrastructure development

Land use in the Condamine catchment has changed recently. Peri-urban development of small lots and urban sub-division has occurred predominantly in the area of Toowoomba Regional Council area

(Preston et al. 2007). Clearing of woody vegetation for urban uses (settlement) was slightly lower in 2011-12 than the previous year (3 ha compared with 5 ha), however clearing for infrastructure development (823 ha/yr in 2011-12 up from 53 ha/year in 2010-11) and for mining (225 ha/yr in 2011-12 up from 104 ha/year in 2010-11) both increased significantly (SLATS, 2014).

Coal seam gas industry

Along with production wells, a network of roadways and pipelines is being put in place as part of the coal seam gas (CSG) extraction and generation activities particularly in the western parts of the Condamine catchment (Arnold, 2010). Experience indicates that, with typical 65 ha production well spacing, a production well and associated infrastructure will disturb 2–3% of land. Production wells require land for drilling and the installation of wellhead infrastructure. For centralised processing, land is required for pipelines for field compression facilities, central gas processing facilities and for integrated processing facilities (Arrow Energy, 2013). It is not yet clear what will be the implications for wildlife of the fragmentation of remnant vegetation by the well infrastructure network, but research is being undertaken by multiple organisations (including the University of Queensland) to understand the social and economic implications for farmers impacted by these networks.

Land resource health

We all benefit from healthy land resources. Our lifestyles, businesses and health depend on the condition of our land and its productivity.

A healthy soil results from balanced chemical fertility, optimal water infiltration, storage and supply and enhanced soil biological function (Lawrence, 2008). Large numbers of soil properties, all of them varying with time and location, influence these properties and processes, for example pH, organic matter levels, salinity/sodicity levels, nutrient levels, physical structure, erosion rate and presence/absence of diseases and toxins.

Soil chemical fertility

Queensland's cropping soils contain only half of the Carbon (C), Nitrogen (N,) Phosphorous (P) and Potassium (K) of adjacent uncropped reference sites (Bell et al., 2010). Since a soil's natural fertility depends largely its parent material, the soils of the Condamine catchment have a wide range of inherent chemical fertilities – those derived from basalt are much more fertile than those developed on sandy sediments. However, even for the most fertile soils, such as the vertosols, nutrient levels have been depleted in harvested products, soil erosion, leaching and burning of plant material to the point where productivity is reduced (Dalal & Mayer, 1986). To maintain or increase productivity these nutrients have to be replaced.

Some of these nutrients are replaced during rainfall but amounts are low and highly variable. The usual management response to nutrient removal or loss is to apply fertiliser but often too little is added (Dalal & Probert, 1997; Bell, et al, 2012). Using ABS data on the amounts of N, P, K, and Sulphur (S) applied as fertilisers and removed in agricultural commodities, Edis et al. (2013) found a net input of N but a net loss of P, K and S for the Condamine catchment, however, results for individual farms would be different.

Surveys of the Upper Condamine indicate that few landholders base their fertiliser application on soil analysis and/or nutrient budgeting - only 20% undertook nutrient testing and management, and few knew their soil nutrient levels (Clifton et al, 2007). There is also a mindset of some that there is no economic justification for applying fertiliser products simply to return to the soil the quantities of nutrients removed by crops or livestock – rather, fertiliser is applied at rates which provide profitable yield increases (Kenway, 1993).

Soil biology

With limited data available on the soils of the Condamine catchment it is difficult to make an overarching statement about its health. We do know that soils generally are like diverse communities containing a variety of living things known as biota. Active soil biota are essential to healthy soils and productivity.

The major groups of soil biota, based on their body size, include:

- microflora (bacteria, fungi, algae and actinomycetes)
- macroflora (plant roots)
- microfauna (protozoa, nematodes)
- mesofauna (collembola, mites)
- macrofauna (spiders, earthworms, beetles, termites).

The diversity and numbers of biota present can be enormous. For example, it is estimated that in a gram of soil there are millions of bacteria. A diverse, balanced and active soil biota can help provide soil conditions necessary for sustainable crop production, with very little negative environmental effect, through:

- increasing microbial activity, carbon turnover and nutrient supply
- preventing aggressive plant pathogens taking hold
- supporting populations of plant beneficial microorganisms
- reducing the loss of inorganic fertilisers from erosion and leaching
- improving / stabilising soil structure
- reducing reliance on agrochemicals and persistence of pesticides.

In our catchment the biological status of the vertosols in the northern grains region is poor (Silburn et al, 2007). The quantity, activity, and constituents of the soil biota vary with land use and farming system, specifically:

- cropping consistently reduced all measures of general microbial biomass or microbial activity compared with other land uses
- the combination of stubble retention and reduced tillage where soil Carbon content builds up in the top 5 cm had a relatively small impact
- long bare fallows and skip row planting had negative effects on soil microbial communities
- soil biota generally responded positively to ley pastures
- soil moisture is often the limiting factor - most of the biota are concentrated in a thin layer of surface soil (estimated that 70% of populations are in the top 10 cm) which is prone to environmental extremes moisture and temperatures.

There are many beneficial effects of soil biota, for example, earthworm burrowing together with termite and ant galleries has lead to higher infiltration, drainage and salt leaching (draining away) rates improved infiltration and better subsoil aeration (Friend and Chan 1995, Hulugalle et al, 2001; Holt et al, 1993; Radford et al, 1995; Wildermuth et al, 1997).

Soil biota can also have negative effects. They can be a source of human, animals and plant pathogens and pests including fungal and bacterial infections, nematodes, cutworms, spiders and termites. Further details relevant to our region is available following research on specific components of the soil biota - particularly on soil-borne diseases - plant-parasitic nematodes and on the importance of mycorrhizae in the cropping system (Wildermuth et al, 1997; McLaughlin & Mineau, 1995). Relevant industries proactively develop programs and advice for management of these problems such as the Queensland Department of Agriculture, Fisheries and Forestry (DAFF, 2013b) for barley crops.

Soil physical properties

Soil physical properties are the framework in which plant roots and organisms live. They influence things like the soil's drainage, water holding capacity, workability, strength to support plants, aeration, root growth, and nutrient holding and availability. The physical properties of soils, in order of decreasing importance to plants, are texture, structure, density, porosity, consistency, temperature and resistivity.

In the Condamine catchment land management practices have altered the structure of some soils (Connolly et al, 1997). Compaction is the main soil structural issue common to cropping and grazing lands. Compaction alters a soil's structure - arrangement of pores and fissures (porosity) within a matrix of aggregates (clumps of soil particles and organic matter) – and leads to reduced crop growth, lower rainfall infiltration, lower soil plant available water holding capacity, lower crop yields, increased wear and tear on machinery, and increased runoff and soil erosion (McGarry et al, 2003; Hamza & Anderson, 2005; Bridge & Bell, 1994). Indicators of damaged soil structure include: rill and sheet erosion, surface crusts, cloddiness (bricklike clumps), presence of specific plants known to be linked with poor soils, ponding, hard surface, poor infiltration, reduced organic matter (evident when a soil is paler and more brittle than a healthier example of the same soil) (Hazelton et al, 2007).

Soil compaction occurs when a pressure exerted by machinery tyres, tines or livestock compresses the soil - maximum pressures generated by horses and cows range from 0.16-0.39 Mpa, for sheep and humans 0.06-0.1 MPa and for tractors (small) 0.03-0.10 MPa and (large) 0.1-0.2 MPa (Dexter & Tanner, 1973). The worst compaction occurs when field operations are performed when soils are wet with clay soils being the most susceptible as they hold more water for a longer period than sandy or loamy soils.

Compaction of soil is unavoidable during any farming operations — the main priority is to restrict it as much as possible (McKenzie, 1998). Some practical techniques have emerged on how to avoid, delay or prevent soil compaction (Hazma & Anderson, 2005; Silburn, 2011) including:

- reduce soil pressure by decreasing axle load and/or increasing the wheel-soil contact area – tracked tractors have similar compaction loads to wheeled tractors but over a smaller area
- working soil and allowing grazing at optimal soil moisture
- reduce the number of farm machinery passes and the intensity and frequency of grazing
- confine traffic to certain areas of the field (controlled traffic farming)
- increase soil organic matter through retention of crop and pasture stubble
- deep rip (dry) soil
- use soil conditioners such as manures and gypsum
- use crop rotations that include plants with deep, strong taproots
- supply complete crop nutrition requirements
- use permanent pasture or pasture-ley systems
- encourage natural cracking in self-mulching soils.

Land systems and connectivity

The landscape of the Condamine catchment has developed through the (largely) water driven processes of soil development, erosion, transport and deposition. Runoff moves sediment from hillsides into and down watercourses, and when the channels surcharge, onto the floodplains as episodic pulses dependent on flood size. These processes were in balance until major land use and management changes occurred with European settlement.

How has altered land use and management changed our landscape?
Clearing and cultivation led to higher runoff and increased soil erosion rates. There is evidence that much of the resultant sediment is temporarily stored in valley floors as it moves down the catchment (eg East 1986). This has altered the flow dynamics of those streams, and that, along with reduced riparian vegetation, has led to higher stream erosion rates. Along with this, flow patterns between main channels and floodplains have been changed by construction of levees, dams, transport infrastructure and the like. These factors have all led to changes in factors such as nutrient movement, floodplain productivity and pollutant transport.

This altered land use has impacted on groundwater movement with unintended consequences. In some upland areas, clearing has increased groundwater movement resulting in secondary salinity outbreaks (Biggs and Power, 2003). In other areas, over-extraction of groundwater for irrigation has been shown to be a major contributor to dieback in riparian woodlands along the Condamine River (Reardon-Smith, 2011) and has affected poplar box (*Eucalyptus populnea*) woodland condition (Fritz, 2012).

Water has a major role in these processes – rainfall intensity affects erosion rates, runoff rates affect sediment transport, groundwater movement affects secondary salinity and so on. As climate change projections for the Condamine catchment include a decline in rainfall but with more extreme events (Stone et al, 2010; IPCC, 2012) further changes in the movement of soil (and associated nutrients, pollutants etc) through the landscape are to be expected.

Opportunities for our land resources

The health, productivity and resilience of the Condamine catchment landscapes and soils can only improve by changing land use and management practices. It is also important to recognise that catchment processes operate beyond property boundaries. The saying 'think globally, act locally' becomes increasingly relevant when trying to bring about effective change in land resource health.

Greenhouse gas reduction

One area where such activity may become viable is greenhouse gas reduction – agriculture contributes about 15% of Australia's net emissions of greenhouse gases (and most of the methane) (Department of Climate Change, 2008) and carbon sequestration. Greenhouse gases include water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3) and chlorofluorocarbons (CFCs).

Cattle fodder changes will be required to reduce methane emissions (read more about methane research in Australia here). The main sources of nitrous oxide are animal urine, nitrogen fertiliser and legumes with judicious use of nitrogen fertiliser being the main control mechanism.

Alternate management practices

Undertaking alternate management practices for cropland (rotations, no-till and/or stubble retention) and pasture (fertilisation, irrigation and using more productive varieties) may slow carbon loss from soils.

Time series data show that soils under improved cropping systems often still show significantly low soil organic carbon stocks – a likely result of these soils still responding to the initial cultivation of the native soil. As an example, soil organic carbon content in the 0-10cm layer of a clay soil at Brigalow research Station was 1.37% after 20 years of aggressive cultivation compared to 1.61% for zero till (Radford, pers comm.). As well, this slowing of soil organic carbon loss rates has been found to diminish over time - largest gains are generally found within the first 5 to 10 years, with any effect diminishing to nearly zero after 40 years (Sanderman et al, 2010; Page et al, 2013; Dalal et al, 2011; Collard & Zammit, 2006). This means that Australian soils under no-till or similar cropping systems may only be mitigating losses and not actually sequestering additional atmospheric carbon. Areas where this decline could be targeted are shown in the soil carbon sequestration opportunities map.

For Queensland, the best opportunities where agriculture can make a contribution to carbon sequestration for greenhouse gas reductions seem to be forestry related biologically diverse native species plantings, commercial forest plantations, and reduced land clearing/managed regeneration. Even scattered trees assist - Ghaderi et al. (2010), in a five year study in the traprock country found that remnant trees in grazing lands exponentially stored carbon over time. Whether such activities are economical is a moot point – Maraseni (2007) found that, although spotted gum forestry gave an annual soil organic carbon gain of 1.4%, the profitability of alternate land use strategies is dependent on the price of carbon. Refer to the treed carbon sequestration opportunities map.

Research is currently being undertaken at the University of Southern Queensland to identify the best options for carbon sequestration within the Condamine catchment (for more information visit the Australian Government's Climate science website or the University of Southern Queensland's Project website).

Soil fertility

If agricultural productivity levels are to be maintained or increased, then soil chemical fertility has to be increased. Use of inorganic fertilisers (at the right level) is one way. Individual soil tests are one option for determining the amount of nutrients required. An option to overcome the reluctance of landholders to undertake soil tests identified by Kenway (1993) is the use of databases such as the Better Fertiliser Decisions for Crops National Database (Gourley et al, 2007) and paper based calculators such as Fertfact (Incitec Pivot, 2015).

Organic amendments

Legume-based ley pastures can also be use to maintain or restore soil fertility, particularly for mixed grain and livestock enterprises (Weston et al, 2000). The use of this management practice is only slowly increasing. Possible reasons for this slow rate of adoption include the lower profitability of rotations involving livestock, management complexity of leys, reluctance to change, looking to easier options, availability of non-degraded lands and bloat fears with temperate legumes.

Use of organic wastes is also an option. These wastes are generated as by-products from intensive agricultural production such as piggeries, cattle feedlots, dairies, poultry, abattoirs, sawmills and cotton gins in large amounts – estimated in 2005 to be 363 000 t of solid waste and 7400 ML of effluent containing 11 500 t of nitrogen, 4200 t of phosphorus and 13 200 t of potassium (Condamine Alliance, 2010b). These wastes can, and are, being used as fertiliser either directly or composted to combat chemical fertility rundown and add organic matter to soils. There are advantages to using manures as fertiliser (eg lower cost nutrient replacement and added organic matter) but some problems remain – such as higher up-front costs (particularly transport), uneven distribution from spreaders, weed seeds and compaction from spreading (Wylie, 2007).

Controlled traffic farming

Controlled traffic farming has been shown to minimise soil compaction impacts on cropping land. Adoption began around 1990 with use of 'permanent beds' by rowcrop farmers, particularly in irrigated cotton production (Hume et al., 1996; Tullberg et al, 2003; ACTFA, 2013). Since then there has been a steady rate of adoption now that issues such as deep eroding wheel tracks (Neale, 2013) have been addressed and tractor guidance systems have reduced in price.

Grazing management

Grazing of cropland on mixed crop-livestock farms can result in soil compaction particularly of recently tilled or wet soil (Greenwood & Kenzie, 2001). Careful grazing management (dry soil and no rainfall during grazing) has been shown to have little/no effect on subsequent crop yields (Connelly & Freebairn, 1998; Agostini et al, 2012; Bell et al, 2011; Radford et al, 2008). Ley pasture phases improve the structure of clay soils in cereal cropping areas but those benefits however are quickly lost (within a few years) under conventional tillage practices (Bell et al, 2007).

Time controlled rotational grazing has been promoted by some to benefit soil properties over continuous grazing management practices. In one of the few scientific studies carried out in the region, Sanjari et al. (2009) found that continuous sheep grazing in the Traprock hills resulted in soil compaction but time controlled grazing did not.

Soil biota numbers can be built up using land management practices such as conservation tillage farming and pasture leys (Roper & Gupta, 1995; Watt et al, 2005; Bell et al, 2006) and lucerne (*Medicago sativa L.*) strips (in cotton fields) (Roper & Gupta, 1995; Brussaard et al, 2007) and addition of animal wastes (McLaughlin & Mineau, 1995).

Threats to our land resources

Our growing region means the demand on our land resources is growing too. Threats to our land resources are not always limited to impacts from within our regional boundary. Many threats our land is facing are national and global issues.

This section has information detailing the threats that are impacting on our natural resources. These threats are not often limited to this theme and can impact water and wildlife as well.

Chemical fertility decline

The cropping soils of the Condamine catchment are in a state of soil fertility decline suggesting that current land management practices are not sustainable. Cropping soils contain only half of the carbon (C), nitrogen (N), phosphorous (P) and potassium (K) of adjacent uncropped reference sites (Bell et al, 2010).

Soil nutrient levels have been depleted in harvested products, soil erosion, leaching and burning of plant material to the point where productivity is reduced (Dalal & Mayer, 1986; Clifton et al, 2007). A major rethink of management practices may be necessary to reverse this decline. For example, the practices of retaining crop residue (stubble) and adding nitrogen fertiliser increased total soil nitrogen levels in the short term only (Dalal et al, 2011).

Soil erosion

Soil erosion due to water (mainly) and wind is a threat to the soils of the Condamine catchment (Alcock, 1980) Preserving our precious soil has involved many efforts over the years, however further soil conservation measures are needed to stem future losses. Current dryland agricultural practices in the catchment are not considered to be environmentally sustainable — for example, average soil loss exceeds the rate of formation (Clifton et al, 2007), with about 70% of the cultivated soils and much of the grazing and forestry land having a high erosion hazard (Brownlea & Van der Zee, 1977).

In the upland areas, the types of soil erosion present include sheet, rill (where small channels up to 30 cm deep develop), gully and tunnel (especially in soils with dispersible subsoil) on hillslopes, scour and slumping on stream banks, and mass movement, especially in the steep headwaters, as soil creep and land slides.

Soil management on the floodplain

In the Condamine River floodplain the shape of the landscape influences the occurrence and extent of erosion. Where creeks flowing out of upland areas spread out on the floodplain, sheet, rill and gully erosion can occur. On the floodplain closer to the Condamine River the land is often so flat that, unless flows are concentrated by infrastructure, erosion risk is low. Most (94%) of the river and creek banks have some erosion but only 11% are unstable (Ngaire & Moller, 1995).

Soil conservation measures include matching land use with land capability (prevention), runoff management and soil surface management. Most (but not all) of the runoff control structures required on hillslopes have been constructed in the past with assistance from the Queensland Government (Carey et al, 2004). On the floodplains, measures to spread flows such as strip cropping, removal of fences that are no longer of use and land levelling have proven to be effective in reducing soil erosion levels.

Suitable soil surface management practices are being adopted and the yield advantages, field efficiencies, lower per acre costs gained from controlled traffic farming will continue to drive this change (Freebairn & Wockner, 1986; Freebairn & King, 2003; Thomas et al, 2007; Condamine Alliance, 2006, 2007a, 2008d, 2009, 2010a; Barson, 2012; ACTFA, 2013).

Some levees on the floodplain have been associated with increased soil erosion. Following recommendations from the Queensland Floods Commission of Inquiry (2012), the Queensland Government developed regulations applying to the construction and modification of levees (DNRM, 2014a). As well, liability under common law actions of nuisance or negligence may be incurred if a levee alters the natural flow of water resulting in proven damage downstream (Donaldson, 2013)

A lack of soil conservation technical expertise is an issue in the catchment. Currently there are few practicing soil conservationists in the catchment and very limited training opportunities. There appears little likelihood of this situation changing in the near future.

Wind erosion

Some of the soils of the Condamine catchment are susceptible to wind erosion (Mullins, 1978). Higher vegetative cover reduces this threat and less soil surface disturbance resulting from conservative and flexible stocking rates in grazing land (Sanjari et al, 2009; Silburn et al, 2011; Aubault et al, 2012) and reduced/zero tillage systems for crop production.

Property developers and other construction industry members have a responsibility under the Environmental Protection (Water) Policy 2009 to implement erosion and sediment control measures on construction sites. The nature of the soils and infrastructure associated with the coal seam gas and other mining industries means that care in locating and constructing that infrastructure along with a maintenance program is required. Guidelines and design manuals such as Witheridge (2012) and DEHP (2014) are available to assist in this regard.

Soil biota

Pesticide impacts on soil biota range from negative to beneficial (Lines-Kelly, 2004). Generally, fungicides, fumigants, and insecticides have greater influence on soil biota because of their higher rates of application and toxicity than herbicides (Kookana et al, 1998). However, despite using pesticides according to recommendations, trace levels of pesticide residues have been detected in soil, water, and air with major ecological effects off-site and in-situ even after long time periods (Roper & Gupta, 1995; McLaughlin & Mineau, 1995; Bünemann et al, 2006; Kookana et al, 1998).

Specific chemical impacts include:

- paraquat, simazine and atrazine are deleterious to fungi
- algal populations are depressed by the triazines, MCPA, MCPB, diuron and trifluralin
- glyphosate and paraquat decrease crop residue decomposition but increase rates of nutrient loss from litter by altering microbial and arthropod activity
- organophosphates decrease soil populations of bacteria and fungi, reduce collembolan densities and decrease earthworm reproduction
- organochlorines reduce microbial activity and biomass and soil enzyme activity
- copper based fungicides reduce earthworm populations and microbial biomass.

Fertilisation enhances crop productivity but with different impacts on soil biota. Mostly, fertilisers enhance soil biological activity (Bünemann et al, 2006) with organic fertilisers usually having a greater beneficial impact than mineral fertilisers, which may decrease soil pH (Lines-Kelly, 2004). Nitrogen fertilisers increase plant residue decomposition but often at the expense of decreased nitrogen fixation (Roper & Gupta, 1995) while anhydrous ammonia has a short term negative effect on soil microbial biomass/activity (Bell et al, 2006).

Soil organic carbon living (about 15%) and dead organisms, provides energy, nutrients and habitat for organisms living in the soil, improves soil structure and enhances its water holding capacity. Cultivation has led to a substantial loss of soil organic carbon, (Dalal & Mayer, 1986; Dalal & Chan, 2001; Dalal et al, 2003) but may be slowed using reduced or no till and application of nitrogen (Marley & Littler, 1990; Sanderman et al, 2010; Dalal et al, 2003).

Soil acidification

Soil acidification, where soil pH decreases over time, is caused by removal of produce from the farm, leaching (draining away) of nitrogen, over use of nitrogen fertilisers, and build up in organic matter. If not corrected by application of lime, acidification can result in aluminium and manganese toxicities and calcium and molybdenum deficiencies.

Soil acidification is not common across the Condamine catchment as most soils have an inherent high buffering (resistance to change) capacity. Soils within the catchment most at risk are the shallow sandy soils (tenosols) and red ferrosols.

Acid sulphate soils form when sulfate-rich water mixes with land sediments containing iron oxides and organic matter in a waterlogged situation, i.e. in the absence of oxygen. Acid sulphate soils have been found in effluent ponds and in several north-draining streams and wetlands just north of the Granite Belt. Although isolated areas of acid sulphate soils have been identified in this region, the level of risk has not been quantified (Baldwin, 2011).

Soil salinisation

Salt lakes or pans are a common expression of primary salinity naturally occurring in the Australian landscape. Land use and management changes can lead to the development of secondary salinity, which impacts (negatively) on biodiversity, agricultural production, groundwater and/or stream water quality and infrastructure.

Secondary salinity expressions have been found on the eastern uplands and around the granite and sandstone landscapes in the south of the catchment (Condamine Alliance, 2012a). Most of the expressions are small, less than 1 ha and many reduced in area or retreated significantly during the recent prolonged dry period.

Since the average annual streamflow salt export for the Queensland Murray-Darling Basin is generally much less than salt input, its natural status is one of salt accumulation (Biggs et al, 2010). This has resulted in secondary salinity outbreaks in the Condamine catchment. Searle et al. (2007) assessed those salinity expressions (2230 ha) and further risk areas. The risk areas, derived using conceptual models, occur in the areas where the different geology types meet the basalt/sandstone/alluvium interface (Searle et al, 2007; Biggs et al, 2010).

In order to manage secondary salinity threats, land must be used within its capability. It is essential to understand the soil, surface water and groundwater interactions before deciding on how to manage salinity at a site. Searle et al. (2007) lists some salinity management options and provide guidance to assist land managers in deciding which option(s) will be most appropriate for them based on landscape units, land use and intent (prevent or remediate any salinity outbreak). They found that tree plantings were the main management option used in the Condamine catchment but trees planted in the middle of discharge areas have not survived well. Long fallowing of vertosols has moved salt below the cropping root zone, hence increasing the soils plant available water capacity, but the mobilisation of the salt is seen as a potential secondary salinity hazard (French et al, 2006). Refer to the catchment's salinity risk map.

The expansion of the coal seam gas industry in the Condamine catchment is resulting in the production of increasing quantities of coal seam gas waste water. This water is generally of poor quality with significant salt concentrations, high total dissolved solids levels, high sodium adsorption ratios and other contaminants. Coal seam gaswater has the potential to cause environmental harm - including soil structural damage due to sodicity and salinity — if released inappropriately (Biggs et al, 2013).

Biggs et al. (2013) found that overall salt status of the Condamine catchment is one of salt accumulation with average annual streamflow salt export generally much less than salt input (from groundwater and the atmosphere).

Peri-urbanisation

There has been a steady increase in the conversion of agricultural land for urban uses around the regional centres of the Condamine catchment. There are conflicting reports as to whether this peri-urbanisation has contributed to loss of agricultural production or if it benefits or harms the environment.

Houston (2005) suggests that peri-urban regions in the five mainland Australian states produce almost 25% of Australia's total gross value of agricultural production. Others say land management issues such as the interruption and thinning of biodiversity corridors, introduction and decreased management of pest species, decreased understanding and management of flood and fire regimes, decreased runoff water quality and increased surface and groundwater usage result (Mackenzie et al, 2006; Kearney & MacLeod, 2006). A side issue is the possible increases in property values making it more attractive for farmers to sell or inhibiting new farm investment leading to further alienation of agricultural land.

Conflicts between residents often occur where residential land is adjacent to farmland and major land use changes are rapid. An example is the use of agricultural chemicals and farm activities generating noise, dust or odour affecting nearby residents (DNRW, 2006). Such conflicts have already had significant impact on the egg industry in the Condamine, with those growers previously not concerned with impacts on neighbours now affected (QEFA, 2006).

This urban creep will most likely continue as there are limited options to exclude growth into agricultural areas in the Condamine catchment (DAFF, 2013a). However, this is not unchecked – local government planning schemes must comply with criteria given in the State Planning Policy of December 2013 (DSDIP, 2013b).

Municipal Waste Disposal

The threat of contamination to land and water from improperly managed waste disposal facilities in the Condamine catchment has been reduced by the closure of many landfill sites and waste and consolidation of recycling centres. This is a result of the Queensland Government's initiative in introducing strategies to reduce waste generation and landfill disposal and encourage recycling (Queensland Government, 2011c; DEHP, 2013). The *Waste Reduction and Recycling Act 2011* establishes a new framework to modernise waste management and resource recovery practices via three key provisions:

- Queensland Government agencies and local governments must prepare waste management plans
- waste products that are identified as a problem for landfill must have product stewardship arrangements in place
- littering and illegal dumping offences are strengthened.

Excess nutrients in waterbodies were factors in the development of a series of blue-green algae blooms in the catchments' waterbodies during the 1980s that necessitated the installation of mechanical destratifiers in Toowoomba's reservoirs (Achmad, 2009). Gutteridge et al. (1992) identified that point and diffuse sources contributed to these nutrient levels - point sources (mainly sewage treatment plants with Toowoomba being the largest source) dominated the supply of nutrients in dry years, diffuse sources provide the bulk during wet years. The Toowoomba Regional Council has commenced an overhaul of their sewerage system to alleviate this problem.

Large areas of the catchment rely on septic systems. There is evidence that outflow from septic tanks has led to elevated nitrate concentrations in basalt aquifers in the Toowoomba area (Bolger & Stevens, 1999). Similarly, Pakrou et al. (1997) identified that preferential flow in basalts is a key mechanism for nitrate contamination of groundwater at cattle feedlots near Toowoomba.

Climate change

Climate change projections for the eastern Darling Downs region include a decline in rainfall, increasing temperatures and evaporation in conjunction with more extreme climate events with tropical cyclones likely to become more intense and shift southwards (QCCCE, 2010; IPCC, 2012; Stone et al, 2010). These changes are likely to have significant impacts on all of the catchments resources (read more about this threat to our water and wildlife). DEHP (2011) and Hamilton (2010) provide summaries of the impacts these predictions may have on agriculture.

As far as soils are concerned, the projected increase in amounts and intensity of individual rainfall events could result in increased flooding, waterlogging and soil erosion. As well, future productivity growth may also be affected through higher temperatures decreasing vegetative cover.
Organic carbon and nitrogen found in soils are subject to a range of biological processes capable of generating or consuming greenhouse gases such as CO_2, N_2O and CH_4 (Baldock, 2012; Dalal & Chan, 2001). Since biological processes are sensitive to soil temperature and water content a changing climate may alter the rates of soil greenhouse gas emission or uptake.

Cropping areas in the Queensland Murray-Darling Basin have the precursors for secondary salinity development—high salt loads and an increase in drainage after clearing (Tolmie et al, 2011). Climate affects the extent of deep drainage — key factors being the amount and timing (seasonality) of rainfall and potential evaporation, and the relationship between the two (Tolmie et al, 2011). Deep drainage is highly variable over time and episodic in nature and relates to coincidences of larger rainfall events on near-full soil profiles - for example, more than 50% of total drainage may occur in only 10% of years (Yee Yet & Silburn, 2003). Given that more extreme rainfall events are projected, care needs to be taken to minimise the likelihood of secondary salinisation outbreaks due to deep drainage increases.

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Wildlife

You could say that wildlife make up nature's 'neighbourhoods'. Wildlife includes all native animals, plants and other organisms, which grow or live in an area. These communities of organisms (biodiversity) is well recognised as a critical value that provides long term environmental, cultural and economic benefits. The Condamine catchment area is no exception and contains a significant proportion of Queensland's native plant and animal species.

This section covers information on our wildlife, including our uses of, impacts on, and management of them.

Our Wildlife

The Condamine catchment contains a wealth of native flora and fauna species associated with a range of ecosystem types. Understanding and keeping track of them has been made easier with the use of technology in the field and electronic/online resources. Despite these advances, there is still a lot more to learn and discover.

What's living in our backyard?

The table below provides a summary of animal and their conservation status (level of threat) in the Condamine Catchment.

Kingdom	Native Species	Introduced Species	Threatened - Qld	Threatened - Australia
Mammals	107	14	10 (+3NT, 1PE)*	13 (+1EX)*
Birds	402	10	15 (+17NT, 1PE)*	11 (+1EX)*
Reptiles	150	0	7 (+8NT)*	7
Amphibians (Frogs)	49	1	4 (+3NT)*	0
Fish	23	5	0	2
Insects	113	0	3	0
Vascular Plants	2,639	521 (incl. 67 agricultural sp.)	46 (+31NT)	47

* NT = Near Threatened, PE = Presumed Extinct, EX = Extinct

Source: Queensland Government, WildNet data 13/11/2013

Wildlife Populations and their Importance

The mix of native organisms in any landscape, often referred to as its biodiversity, is well recognised as a critical value that provides long term environmental, cultural and economic benefits. The Condamine catchment area is no exception and contains a significant proportion of Queensland's native plant and animal species.

Environmental and economic benefits of wildlife

A very high percentage of the catchment's biodiversity occurs on private land and co-exists with potentially conflicting land uses. Yet, it is now being realised that many of these land uses can co-occur in harmony and incorporate measures that conserve our unique biodiversity. Moreover, many studies now suggest that the conservation of biodiversity can have flow-on effects that enhance our economic returns from well managed land.

For example, Dorrough et al. (2008) and Revell (2007) have both found that native pastures, which are well adapted to their specific habitat, can survive with less fertiliser and maintain the soil biota better than introduced species. With better soil quality and less cost for fertilisers, these pastures can deliver enhanced farm profitability. Because fertiliser levels are low, die-back in eucalypt shade trees can be avoided (Cogger et al, 2003), and so grazing animals are less stressed by high temperatures and harsh environmental conditions (Reid, 2013). This also results in an economic gain as stock are able to put on condition more rapidly. The maintenance of paddock trees can have additional benefits to that of shade. They also act as refuges for birds and small insect-eating bats which can reduce insect numbers and provide essential ecosystem services (Seabrook et al, 2008).

Native species benefits

On the merits of establishing locally native (indigenous plants) - including regeneration and plantings Costermons (1991) and Marriott (1996) write that the benefits include:

- relatively lower input to be established and maintained
- tolerance of local environmental conditions
- maintenance of the ecology and biodiversity of an area
- a balanced and suitable habitat for native fauna
- contributions to the productivity of farm enterprises
- maintenance of the unique character of the landscape.

They also report that indigenous plants can provide many environmental benefits as well as fulfil farm purposes such as the provision of shelter, wind breaks, soil erosion control and salinity control and provide timber for fence posts and firewood.

The Prime Minister's Science, Engineering, and Technology Council (2002) found that environmentally healthy catchments and farming land can be estimated to increase farm productivity nationally by over $1 billion per annum. This represents a 5% increase in the total value of agricultural production.

No doubt there are many more instances where biodiversity can be harnessed to provide a more economically and environmentally sustainable future. We still have a great deal to research and understand to fully appreciate this potential.

Wildlife Health and Habitat Condition

Unfortunately past land uses, the introduction of exotic plants and animals and other human-induced changes to the catchment have been to the detriment of our biodiversity and we now have many species that are threatened with extinction. Some of these species may have always been uncommon and so were pushed to edge by very minor changes to the landscape. Others were quite common but were highly susceptible to some of the changes that have occurred.

Threatened species

The table below shows the number of threatened species that are now listed under state (Nature Conservation Act 1992) and Commonwealth (Environment Protection and Biodiversity Conservation Act 1999) legislation.

Kingdom	Native Species	Introduced Species	Qld Status	Commonwealth status
Mammals	107	14	10 (+3NT, 1PE)*	13 (+1EX)*
Birds	402	10	15 (+17NT, 1PE)*	11 (+1EX)*
Reptiles	150	0	7 (+8NT)*	7
Amphibians (Frogs)	49	1	4 (+3NT)*	0
Fish	23	5	0	2
Insects	113	0	3	0
Vascular Plants	2,639	521 (incl. 67 agricultural sp.)	46 (+31NT)	47

* NT = Near Threatened, PE = Presumed Extinct, EX = Extinct

Source: Qld Govt. WildNet data 13/11/2013

For the purposes of future environmental planning, this represents the current situation that we have to work with - the biodiversity that we need to maintain and enhance for the enjoyment and economic benefit of future generations that will live and work in the Condamine catchment.

Habitat provision

A review of available data on habitat extent (based on satellite imagery) for the catchment was undertaken by Condamine Alliance. The catchment's wildlife recieved a 'B' rating, indicating that more work is required to provide habitat and movement access for wildlife across the landscape. Visit the wildlife report card for more information.

Habitat Connectivity

Connected landscapes are critical for maintaining healthy and resilient biodiversity. Depending on the species, degree of mobility and whether the species is a specialist or generalist, clearing of native vegetation is the most serious threat to connectivity and remains so considering recent changes to the Queensland Vegetation Management Act 1999 which has removed the legislative protection from priority regrowth on freehold land.

A study undertaken by Natural Solutions (2007), identified key corridors that could be enhanced to support habitat movement across the catchment (refer to the bioregional corridors map for details). In such a heavily developed landscape, obtaining land for treed habitat is difficult. Further research is necessary to better understand how wildlife move through landscapes to help develop alternative ways to provide connectivity across a range of land uses in the catchment.

Wildlife and Habitat Management

There is very little quantitative data available that considers the range of factors responsible for the loss of biodiversity across all animal and plant groups, both common and rare. We do however, have summary data for threatened species from the background information and submissions that were prepared when their listings were proposed to the relevant scientific committee.

One such source is the Australian government's Species Profiles and Threates (SPRAT) Database. It is reasonable to assume that the threatening processes listed here are also relevant to more common species, but to a lesser degree and for whatever reason, they have been better able to cope with these problems.

Snapshot of our catchment’s threats

To compile a list of threats and their relative importance, all of the Environment Protection and Biodiversity Conservation Act 1999 listed species from the catchment were checked against the above database and the four highest priority threats were noted.

The results for vertebrates are shown below in Figure 1 and results for plants are in Figure 2.

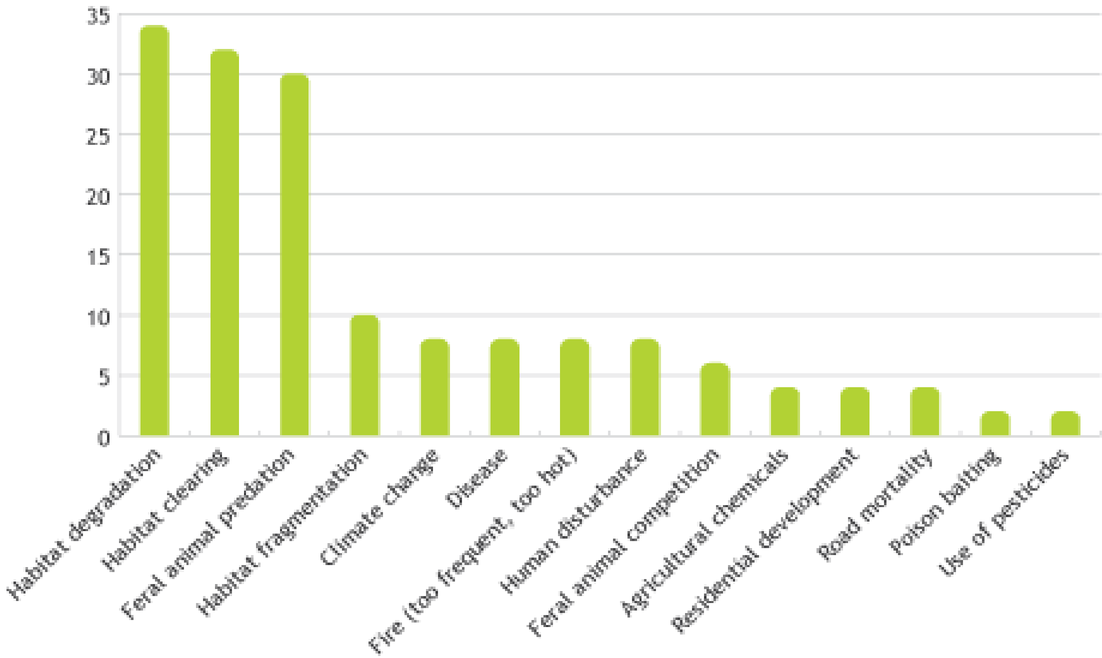

Figure 1 Major threats to fauna, summarised from the SPRAT Database for species identified as occurring in the Condamine catchment.

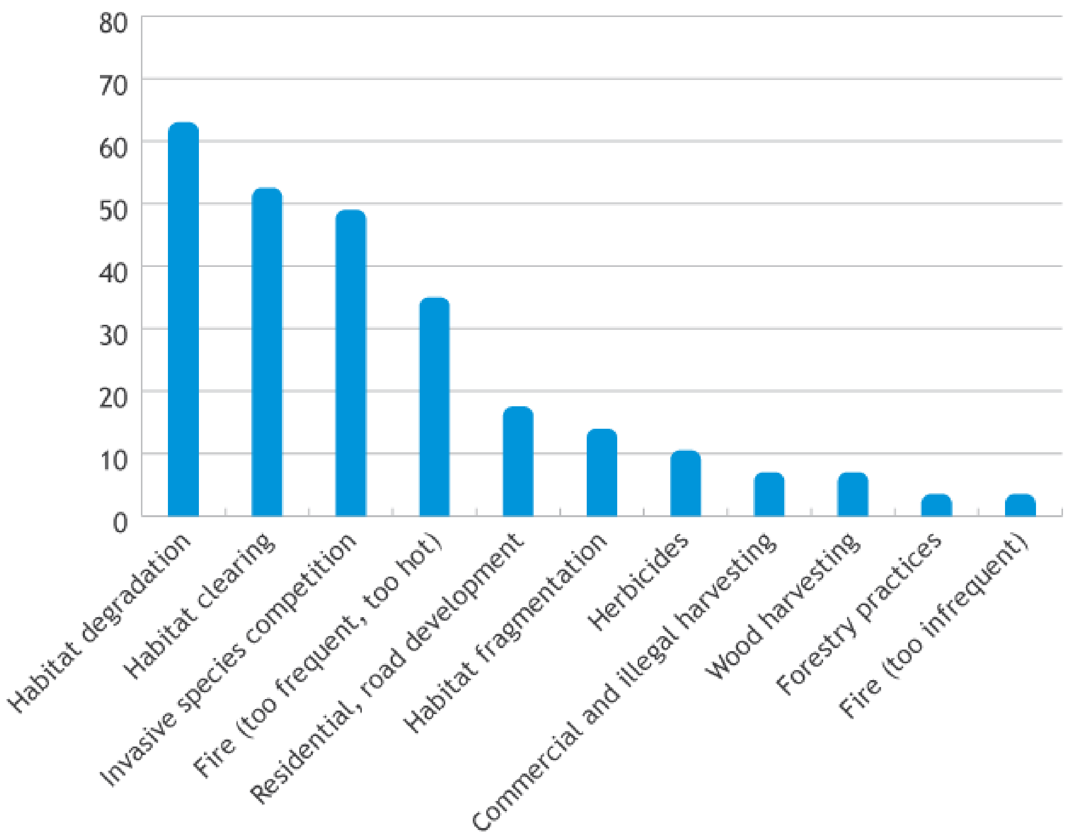

Figure 2 Major threats to flora, summarised from the SPRAT Database for species identified as occurring in the Condamine catchment.

The kinds of activities that help maintain native plants and animals are often those that manage the threats to these species, such as habitat degradation, habitat clearing, habitat fragmentation, invasive or feral species, and fire (see Wildlife threats). The national Land Management and Farming in Australia survey (ABS, 2013) found that approximately 53% of farms in the Condamine catchment containing areas of native vegetation reported undertaking activities aimed at protecting those areas.

It also found that 23% of the catchment's farms with native vegetation excluded stock from these areas and 55% controlled stock access. 60% of them managed weeds and 40% managed pest animals, and 56% undertook revegetation activities in their native vegetation patches.

Opportunities for our Wildlife

There is a wide range of opportunities for people to consider biodiversity conservation as part of everyday living. As community and business development occurs across the Condamine catchment actions can be taken to protect our wildlife and their habitats. This action is usually associated with decisions by governments, private business and individuals. These actions can include:

- prevent weed spread by vehicles
- make balanced development decisions to protect critical vegetation for habitat, air quality etc
- maintain urban green spaces and promote native species where possible (eg Grow Me Instead initiatives)
- understand pest species and what to do about them
- consider design changes to your products that can promote pervious surfaces in developments and refits
- keep harmful chemicals out of the waterways where it can damage species downstream
- support responsible pet ownership
- growing more vegetation
- invest in maintaining and increasing vegetation in key locations such as wildlife corridors.

Threats to our Wildlife

Some of the key threats identified in the summary of data from the SPRAT Database are detailed further in this section. Many of the threats are closely related or inter-dependent. For example, habitat degradation may be caused by invasive species, herbicides or fire; residential and road development may fragment habitats.

To allow clear focus on each as a specific issue, the individual headings are maintained to explore in the following sections.

Habitat degradation

Interestingly, this threat is recognised more frequently for threatened species in the SPRAT Database than habitat clearing; strongly indicating that the maintenance of existing remnant vegetation is a major concern.

The most often cited issue for remnants is the loss or alteration of the understorey by grazing or deliberate clearing. This can remove cover for many species of small mammals, reptiles and birds. It is also specifically recognised as a precursor to invasion and massive population increases in noisy miners (*Manorina melanocephala*). Noisy miners are a native but highly opportunistic and aggressive species that drives other bird species from otherwise suitable habitats, a behaviour that has led to them being classified as a threatening process for woodland birds (Howes & Maron, 2008).

The removal of the woodland understorey vegetation can also lead to invasion by weeds, including lantana, or replacement with invasive grasses such as buffel grass (*Cenchrus ciliaris*) and green panic (*Megathyrsus maximus*). These grasses can lead to massively increased fire fuel loads that can in turn, lead to the death of fire susceptible native species and permanent alteration and degradation of remnant areas (McAlpine et al, 2012). This is a particular problem for brigalow (*Acacia harpophylla*) woodlands which are listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 as a threatened ecological community and under the Queensland Vegetation Management Act 1999 as an endangered regional ecosystem.

The removal of the understorey can also facilitate predation by the introduced fox, a species that may be a key predator for many small ground-dwelling birds and mammals in the catchment area.

Habitat Clearing

The clearing of native vegetation is a rather obvious threat for species that rely upon unaltered landscapes for their survival. The Queensland government's Statewide Landcover and Trees Study regularly updates data on landcover change at the broad scale. For 20011-12, the woody vegetation clearing rate for the Condamine catchment almost tripled, compared to the previous year (from 1769 ha/yr up to 4935 ha/yr). This is the highest clearing rate since 2005-06. The clearing of remnant woody vegeation formed 28% of this, totalling 1390 ha/yr. Most of the total cleared area (74%) was replaced by pasture, but clearing for infrastructure rose to 823 ha/yr (17% of all clearing), which was the highest recorded rate since records began in 1988 (SLATS, 2014). With natural areas (conservation and grazing of natural environments in the table above) totaling 122 160 ha across the catchment, the locations and patterns of clearing pose significant threat to the long term survival of these ecosystems.

With the recent relaxation of vegetation clearing laws in Queensland (Vegetation Management Act 1999) and associated legislation in 2013), the rate of clearing may well increase again. The development of new industries, including the recent expansion of the coal seam gas industry, has also led to an increase in the rate of clearing of woody vegetation in the western parts of the catchment leading to fragmentation of habitat by the resulting network of access tracks and pipelines.

Habitat fragmentation

Habitat fragmentation is a threatening factor that is strongly related to habitat clearing. Apart from the actual loss of habitat through clearing, natural populations that remain may be separated from other populations by barriers of cleared land. The resulting isolated populations are then more prone to local extinction through predation, fire or disease, and reduced gene flow between populations may lead to a loss of genetic diversity and ultimately a loss of vigour and decline or extinction.

The degree of fragmentation required in order to create a barrier, varies from species to species. Some of the most easily affected might be leaf litter-dependant reptiles where even a narrow road or track may create an impassable barrier (Seabrook et al, 2008).

Invasive or feral species

Invasive species are plants and animals that can spread in ways that adversely affect the habitats they invade. They can be native (such as the noisy miner bird) or non-native (introduced) species (like the lantana bush, which is native to the Americas and Africa, brought to Australia for use in gardens).

Feral animals are those that have spread into the wild where they live and reproduce, having been originally introduced for domestic purposes (like house cats now grown into feral cat populations) The SPRAT Database identifies competition with invasive species as a major threat for flora and predation and competition by invasive (feral) species as two of the major threats for fauna.

It is to be expected that introduced species, each with their specific life strategies, may take advantage of new environments, exploiting other native species that are not equipped to cope with these new strategies. Several main areas of concern for the Condamine catchment are:

- The introduction and spread of weeds such as lantana in the eastern catchment and buffel grass and green panic in the central and western areas. These species are able to alter the structural dynamics of the habitats that they invade and pre-dispose these areas and component species to other threatening processes.
- Predation of fauna by foxes, cats and to a lesser extent, feral pigs. In some cases, these predators are known to be highly efficient and can cause local extinctions of native species such as ground-dwelling birds and medium-sized mammals.
- Habitat degradation by feral pigs.

Fire

Historically, much of the catchment consisted of a mosaic of eucalypt forests and woodlands with large expanses of brigalow woodland. Both brigalow and semi-evergreen vine thicket are naturally fire suppressant communities (Butler, 2007). They most probably limited the extent of wildfires across the region where they occurred in eucalypt communities, which are for the most part, naturally fire supporting.

With the removal of brigalow and the replacement of these communities with grasslands that are highly combustible, and with changes in the way in which humans manage the landscape, fire patterning in the region has changed. Present day fire regimes involve hot fires that burn extensively across large tracts of land. These are a major threat to fauna species that have sedentary lifestyles and are unable to escape a broad-ranging, hot fire (for example, the death adder). ANU (2009) also highlights possible changes to fire intensity and frequency as a result of climate change, further exacerbating the negative aspects of frequent, hot fires.

On the other hand, the SPRAT Database identifies a limited number of plants that may be under threat due to lack of fire in their habitats. These are cases where fire is required to initiate germination or seed set.

Clearly, fire regimes are important and must be designed specifically to suit the historic patterning and frequency of fires to which species are adapted.

Climate Change

A rapid alteration of the Earth's climate has been predicted as likely to occur, based on a number of factors. The most important of which is the escalating increase in atmospheric carbon dioxide (CO_2) and other greenhouse gases. Although the basis for climate change predictions is clear and unambiguous, the actual change is masked by short term fluctuations in temperature and rainfall which cause many land managers to be rather sceptical about the validity of the process. Nevertheless, there is sound scientific argument to support the climate change model. All of the catchment's resources are expected to be impacted by these changes.

The key predicted changes to the climate of the Condamine catchment (Ford, 2010) are as follows:

- Increased average temperatures, with the greatest rate of increase in winter;
- Decreased mean annual rainfall, particularly in the upper catchment;
- Decreased runoff (both surface and sub-surface) in the upper catchment, but increased runoff in the lower catchment;
- For both rainfall and runoff, seasonal reductions during autumn, winter and spring but increases during summer and possibly also in April;
- Decreased soil moisture content; and
- Increased surface-level solar radiation, which may enhance plant photosynthetic capacity and extend plant growing periods.

Possibly the greatest concern to land managers in this prediction, is the increased level of variability in temperature and rainfall which may drive species extinctions due to increased aridity and heat, but also due to extreme wet periods and flooding. Obviously this will also be a major concern for primary industries. Dexter et al. (1995) list six vertebrate species that may be at risk due to climate change but there may indeed be many more (Low, 2011).

From a biodiversity perspective, the more robust and diverse our natural systems are, the better placed they will be to buffer the effects of climate change. Over many millions of years, our biota has adapted and evolved to meet climatic changes that have been far greater than those proposed by current climate change models. However these changes have occurred over many millions of years. It’s not the extent of the change that presents us with the greatest challenge, but the unprecedented rate of change that is predicted. Our natural, farming, agricultural and economic systems are unlikely to meet this challenge successfully without a good deal of proactive management.

One possible measure that landholders can take to combat climate change is to grow more native vegetation. Trees sequester carbon as they grow and some species are better at this than others. Brigalow for example, is a high biomass species, meaning that it stores a lot of carbon compared to other species from a similar climate. Brigalow regrowth therefore has considerable potential to be used as carbon sinks. As initiatives are taken to address climate change, these plant communities may well become valuable economic resources (McAlpine et al, 2011).

Some key impacts of climate change on our catchment’s biodiversity may include:

- Increasing soil temperatures and reduced soil moisture may have a negative impact on species that burrow, shelter and forage in soil, particularly the cracking black soils of the floodplains.
- Woodland habitats are likely to become more open, reducing suitability to some woodland bird species and increasing susceptibility to invasion by aggressive birds like noisy miners.
- Some invasive species will benefit (e.g. buffel grass and green panic; and also cane toads), while others are likely to reduce (e.g. blackberry).
- Increasing drought, poor rainfall reliability, compositional change to vegetation communities and the retreat of temperate woodlands will combine to reduce the availability and reliability of nectar supply for nectar-dependent species, increase the fire fuel load (e.g. through increased invasive grasses) and will increase the frequency and intensity of fires.

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Air

Air is critical to all life. Part of the global atmosphere, air in the Condamine catchment has importance well beyond our boundaries.
This section looks at air quality and its management in the Condamine catchment.

Our Air

From the worms in the soil to the workers at their desks, air is crucial to our survival. As our catchment grows, so too do the ways we impact on our air. Taking stock of our air quality can help us better understand and manage these impacts, now and into the future.

In Queensland, the main sources of air pollutants are transport and industrial activities, but rural and domestic activities also play a role (Queensland Government 2013). Air quality is influenced by many different factors from climate and natural disasters, to land use and resource management. This complexity requires management at many scales, including local, state and national measures. This complexity also makes it difficult to understand how well our control measures are working.

Monitoring our air quality

The National Pollutant Inventory (NPI) tracks air, water and land pollution across Australia, and provides this information to the community for 93 substances (across air, water and land) that have been identified as important due to their possible effect on human health and the environment. The data is provided by the facilities (eg mines, power stations and factories) for their point source emissions, and estimated by the government agencies for diffuse emissions from households and other broader sources (eg motor vehicles).

Facility emissions

As the population and land uses change across the catchment, the number and type of emitters also changes. The graphs below show how the number and density of emitting facilities has changed in the catchment, with emitter locations growing from only 19 localities in 1998-99 to 122 localities in 2012-13.

Figure 1. Number of emitting facilities registered, by regional council area

Source: **NPI, 2014**

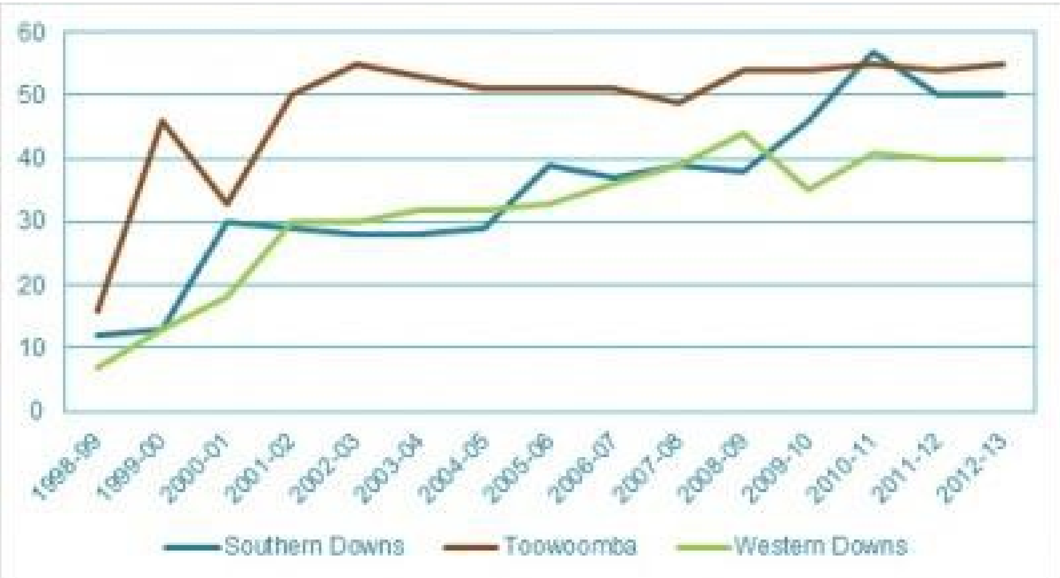
Polluting substances
The most commonly reported industry and diffuse emissions in 2012-13 for each regional council area are listed in Table 1 (NPI 2014).

Table 1. Industry and diffuse emissions

Region	Industry emissions	Diffuse emissions
Southern Downs	• Ammonia (total) • Mercury & compounds • Benzene • Chloroform (trichloromethane) • Dichloromethane	• Total Nitrogen • Total Phosphorus • Total Volatile Organic Compounds • Toluene (methylbenzene) • Benzene
Toowoomba	• Total Volatile Organic Compounds • Carbon monoxide • Oxides of Nitrogen • Particulate Matter 10.0 um • Sulfur dioxide	• Total Nitrogen • Total Phosphorus • Total Volatile Organic Compounds • Toluene (methylbenzene) • Benzene
Western Downs	• Total Volatile Organic Compounds • Carbon monoxide • Oxides of Nitrogen • Particulate Matter 10.0 um • Sulfur dioxide	• Total Nitrogen • Total Phosphorus

The number of substances emitted by facilities within each regional council area are presented in Figure 2. All three council areas are approaching similar numbers of emissions types, even while the number of emitters are much lower in the Southern Downs region (refer to Figure 1 in Facility emissions).

Figure 2. Number of substances emitted, by regional council area



Source: NPI, 2014

Monitoring Programs

The only regular Queensland government air quality monitoring in the Condamine catchment is undertaken at stations in Jondaryan and Toowoomba. Both stations record dust measures (total suspended particulates or TSP), and the Jondaryan site also records particulate measures by size (particles not more than 10 micronsin diameter, and not more than 2.5 microns in diameter).

The National Environment Protection (Ambient Air Quality) Measure (NEPM) standards for ambient air quality parameters measured in the catchment are:

- Total suspended particulates (TSP): Annual average no higher than 90 µg/m^3
- Particles no more than 10 microns in diameter (PM_{10}): 24 hour average higher than 50 µg/m^3 on no more than 5 days/year
- Particles no more than 2.5 microns in diameter ($PM_{2.5}$): 24 hour average no higher than 25 µg/m^3
- Particles no more than 2.5 microns in diameter ($PM_{2.5}$): Annual average no higher than 8 µg/m^3
- Dustfall: no more than 133 mg/m^2/day

Monitoring sites

Jondaryan

The Jondaryan site measurements form part of a specific monitoring campaign being undertaken to assess the impact of coal dust from the Jondaryan Rail Loading Facility. Monitoring started in March 2014 and are planned to continue for at least 12 months. Live air data for this site is available on the Environment and Heritage Protection department's air quality website.

Toowoomba

A campaign was undertaken in north Toowoomba between July 2003 and December 2010, that identified no ongoing requirement for air quality monitoring for most parameters in Toowoomba. The monitoring data recorded for the site satisfied the requirements of the National Environment Protection (Ambient Air Quality) Measure (NEPM) Technical Paper No. 4, "Screening Procedures", indicating that pollutant levels could be reasonably expected to be consistently lower than the required NEPM standards. Results of the campaign found (Neale & Tooker, 2013):

- Carbon monoxide concentrations were consistently less than 30 per cent of the standard
- Nitrogen dioxide concentrations were consistently less than 50 per cent of the standard
- Ozone concentrations were consistently less than 75 per cent of the standards
- All exceedences of the 24-hour PM10 standard were found to be associated with bushfire smoke or widespread windblown dust events
- There was no evidence that commercial and domestic PM10 emissions on their own were sufficient to lead to exceedences of the standard

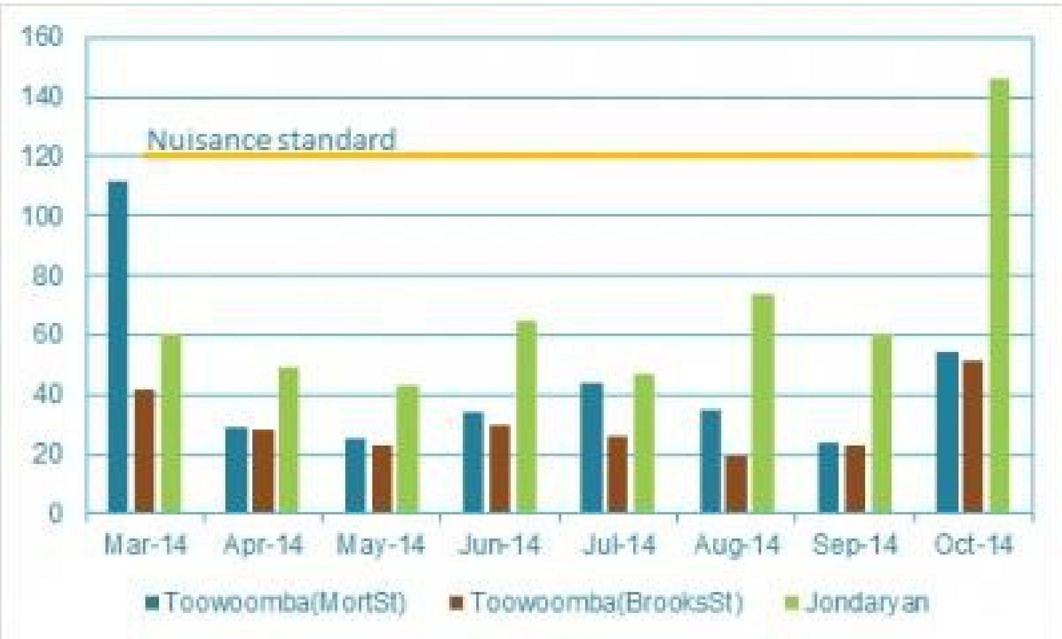
Monitoring results

While no formal analysis report is yet available for the Jondaryan site, monthly bulletins are released for all South East Queensland monitoring sites and includes results from both the Jondaryan and Toowoomba monitoring. The air quality measured at these sites are graphed against the NEPM standards in the figures below.

Figure 4. Jondaryan ambient air quality

Source: [Queensland Goverment, 2014]

Figure 5. Dust measures at Jondaryan and Toowoomba

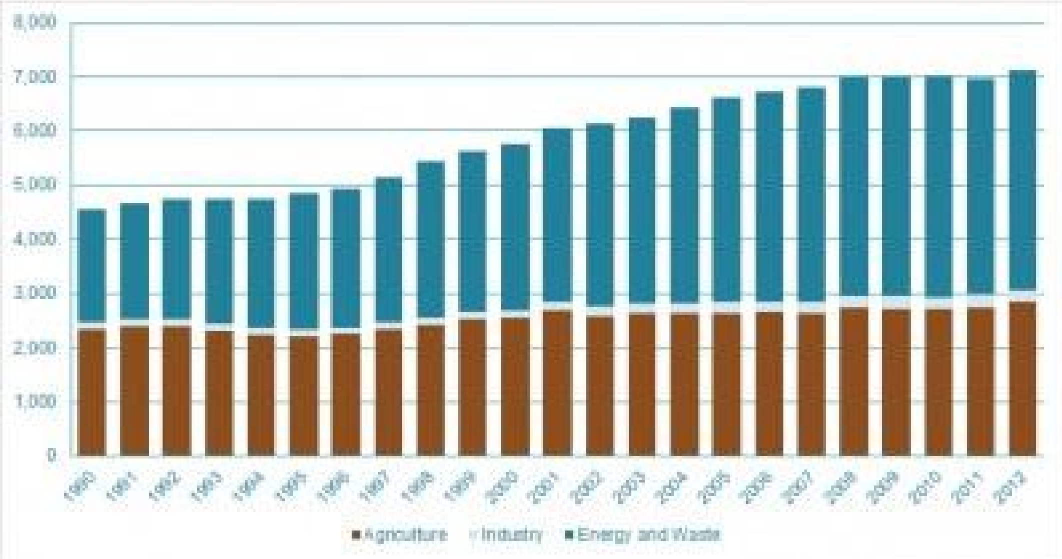


Source: [Queensland Goverment, 2014]

Greenhouse gas estimation

Greenhouse gas emissions are not included in the NPI substance reporting requirements and monitoring data on these gases is not available for the Condamine catchment at regional scale. Estimates have been made of greenhouse gas emissions for Australia and its states and territories by the Australian Department of Environment and are reported in the National Greenhouse Gas Inventory. To scale these down to estimates for the Condamine catchment, the catchment proportion of Queensland employment in each sector was applied to the State's emissions estimate. The results are shown in Figure 3 below. As the 2011 census employment figures for energy and waste (ABS 2012) combined both sectors, the Queensland emissions values for these sectors were combined prior to calculating catchment contributions.

Figure 3. Condamine catchment estimated net CO_2-e emissions (Gigagrams)



Note: Estimates based on catchment proportion of 2011 Queensland employment in each sector (ABS 2012)

Proposed changes to the standards

On 29 April 2014, changes were proposed to the standards for particles in air under the NEPM, based on improved understanding of their associated health risks. A more stringent reporting standard for particle pollution ($PM_{2.5}$ and PM_{10}) has been proposed. To support evaluation of the proposed changes, an impact statement and draft new measure were developed and reviewed by the public. Information on the changes and the submissions received during the consultation period are available on the Department of Environment website.

The main changes proposed include no removal or reduction of existing standards, but inclusion of:

- Addition of an annual mean standard for PM10
- Metrics other than PM10 and PM2.5, such as PM0.1, particle number
- Limits for specific PM components
- Secondary standards (as in the United States) for non-health impacts.

Maximising Carbon Capture

The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC 2013) concludes that changes to the global climate system is most likely a result of a marked increase in greenhouse gas emissions, brought about by human activities. These climate changes are evident in Australia in the form of increasing temperatures, shifting rainfall patterns and rising oceans (Ekstrom et al, 2015), which can have significant impacts to the management of Australia's natural resources. In recognition of the impact of climate change on the management of Australia's natural resources, the Australian Government has funded significant research into the impact of the future climate on Australia's natural resources. These natural resources have been grouped across broad-scale climate and biophysical regions of Australia (called 'clusters') for assessment. The Condamine catchment and its natural resources has been grouped into the Central Slopes cluster.

Tailored climate change projections, as well as adaptation opportunities for protecting and managing our land, soil, water and wildlife, for the Central Slopes cluster and Condamine catchment is available in the Central Slopes Cluster Report. The data, tools and information provided by this research has been used to develop maps of priority landscapes for improving carbon sequestration for both tree biomass carbon and soil carbon sequestration opportunities for the Condamine catchment.

By increasing the amount of carbon stored in our plants and soils, we can help reduce the amount of carbon dioxide in the atmosphere and thus help reduce greenhouse gas impacts and climate change. There are many opportunities in the Condamine catchment to increase carbon sequestration (capture), but changes in the system always need to be well considered to ensure there aren't unexpected and unmitigated side-effects. These evaluations need to be done on a site specific basis, as every situation is different.

This section provides information on where the biggest opportunities are for increasing carbon capture in our soil and in trees, and also highlights some key considerations around what disbenefits (negative side-effects) might occur.

Carbon capture in soil

Soil organic carbon plays an important role in improving the condition and productivity of agricultural land and is an excellent indicator of soil health. Soil organic carbon is part of the soil organic matter which is made up of decaying plant and animal materials and other important nutrients such as nitrogen, phosphorus and trace elements.

Agricultural production reduces soil organic carbon levels over time but this can be improved by optimising crop and pasture production, rotating crops, using manures and composts, maintaining groundcover, avoiding overstocking and planting trees.

An analysis of the carbon status of our catchment's soils was undertaken to determine which areas could be expected to offer the greatest additional storage potential. Areas where the soils have the greatest carbon storage potential were identified based on those with a high clay content in areas of greatest potential for rundown due to long-term landuse or poor temporal ground cover.

Carbon capture in trees

The Condamine catchment is classed as a highly developed catchment because agriculture and urban areas have been in place for many decades, with a significant proportion of the native vegetation having been cleared over time to make way for these developments.

With such high value productive soils across the floodplain, and urban areas already significantly well established, there is little land available where large volumes of trees would be suitable, practical, and viable to establish and maintain for the periods required to capture significant amounts of carbon.

Working within these constraints, priority areas of the catchment were identified where native ecosystems could be partly or fully re-established for improved wildlife habitat and also provide the added benefit of carbon capture.

These areas primarily include the following four zones:

- Riparian zone - areas along the banks of rivers and creeks where such plantings could contribute to wildlife and water priorities and carbon capture, but not detract from land targets
- Fencing zone - along farm fence lines where plantings could contribute to wildlife and land priorities and carbon capture
- Pasture zone - within grazing lands where plantings could contribute to wildlife and land priorities and carbon capture
- Patch edge zone - along the edges of existing remnant vegetation patches where plantings could contribute to wildlife priorities and carbon capture

An analysis of the carbon capture potential of our catchment's native ecosystems was undertaken to determine which ecosystems could capture the most carbon in dry times. Areas where these high performing ecosystems occur within the four potential capture zones listed above were identified based on performance expectation in dry times to match future climate expectations for the catchment.

What might go wrong

Natural resources across the catchment are, by their very nature, connected in a complicated system of interactions. Changes to one part of the system inevitably affect other parts of the system. Even when we try to do good, there can sometimes be negative impacts. It is important to consider what the impacts of change might be across the whole system before we make significant changes.

Some of the key aspects of the system that can be affected by activities of varying scales that increase carbon capture include:

- changes to water flow paths leading to erosion
- changes in rainfall patterns leading to changes in runoff and stream flow
- changes in the mix of, and accessibility of an area for native and pest animals and plants
- changes to soil structure and chemistry that require a change in management approach
- changes in the amount of wind, rain and sunlight received by neighbouring areas leading to changes in growth patterns

More Information

- Ekstrom, M et al, 2015 'Central Slopes Cluster Report' Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports, eds. Ekstrom M, etal, CSIRO and Bureau of Meteorology, Australia
- The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC 2013)
- National Environment Protection (Ambient Air Quality) Measure (NEPM)
- National Greenhouse Gas Inventory
- Neale, D. and Tooker, R. 2013, Queensland air monitoring report 2012, Queensland Government: Brisbane.
- Queensland Government's Managing Air Quality website

Our priorities

Regional Vision

The Condamine catchment community wishes to see viable communities (both economically and socially), improved ecosystem and biological diversity and improved water quality across the catchment, with productive industries that value and protect the natural resource assets in the Condamine catchment. The community also values culturally significant knowledge, heritage and sites.

Aspirational targets

People - The Condamine catchment community's culture and capacity for managing its natural resources will ensure coordinated and balance approaches that maintain the long term sustainability of these resources for the benefit of current and future generations.

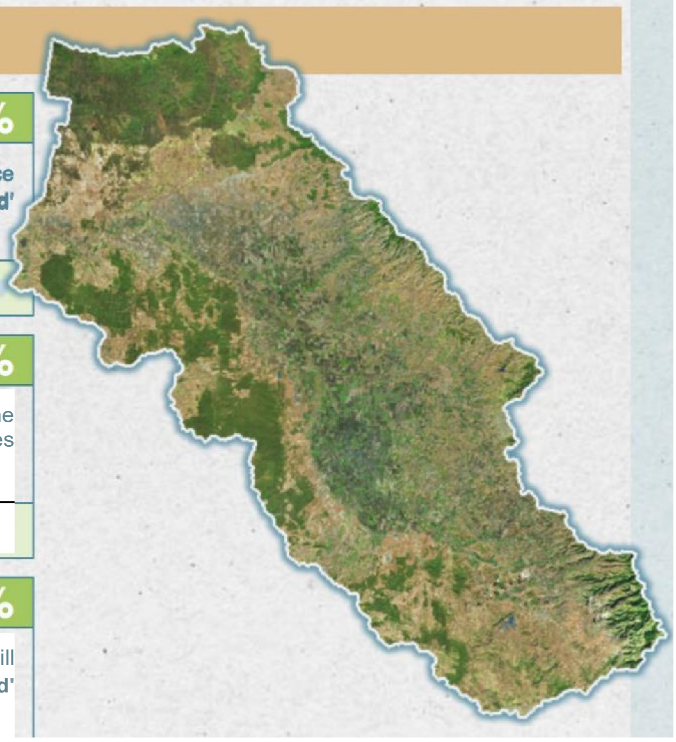
Water - The Condamine catchment community will effectively and sustainably manage its surface water and groundwater assets to ensure the long term environmental, recreational and economic viability of the catchment's water resources. The Condamine catchment community will lead best practice in water resource management by combining sustainable water use with productive rural and industry growth, while improving the long term environmental value of natural aquatic ecosystems.

Land - The Condamine catchment community will develop and implement land management strategies that permit sustainable and balanced use of land resources by industry and agriculture, while providing opportunities for urban growth and environmental conservation.

Wildlife - The Condamine catchment community will manage, rehabilitate and protect its natural fauna and flora assets so that the region and its ecosystems are not as vulnerable to threatening and degrading processes. Instilling the community with a culture of value and pride in the region's natural assets will ensure that the Condamine catchment's environmental heritage is treasured for generations to come.

Air - The Condamine catchment community will control emissions to the air and increase the sequestration of carbon from the air to reduce greenhouse gases and maintain high quality air for all.

People Priorities



QUALITY TARGETS

0%

By 2030 there will be an improvement in the skills and knowledge of catchment resource managers so that 70% of all resource management practices are classified as 'O good' across all land use management categories

PLANNING | RESEARCH | ACTIVITIES

QUANTITY TARGETS

0%

Increase in the number of people recognizing their involvement and responsibility in the resource management community resulting in 70% of all resource management practices being classified as '6 good' across all land use management categories

PLANNING | RESEARCH | ACTIVITIES

CONNECTIVITY TARGETS

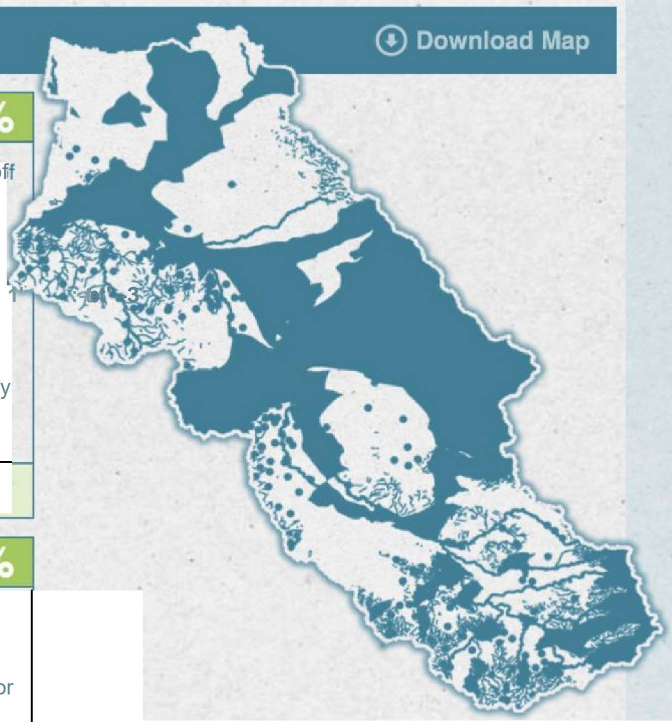
0%

By 2030, natural resource management collaboration, integration, and co-learning will increase so that 70% of all resource management practices are classified as 'O good' across all land use management categories

PLANNING | RESEARCH | ACTIVITIES

Water Priorities

Download Map



QUALITY TARGETS

0%

By 2030, there will be an improvementin wetland health over 60% (91 000 ha) or more of the catchment's wetlands (instream and offstrea m), including:

- Improvement to6' **good'** condition of at least 15% (1800 km) of instream habitat
- Improvements in water quality across at least 15% (1800 km) of catchment waterways to6 **levels accepted** for different water types.
- Make sure that over 75% of the shallow bores in the catchment have less than 1O milligramsper litre total nitrogen and less than 1 milligram per litre total phosphorus, by monitoring and corrective actions

PLANNING | RESEARCH | ACTIVITIES

QUANTITY TARGETS

0%

By 2030, the proportion of streams with median annual stream flow improving towards natural conditions will increase by 20% (2400 km) or more

By 2030, the groundwater levels at more than 50% of the catchment will be maintained or improved to previous or recommended water levels

PLANNING | RESEARCH | ACTIVITIES

CONNECTIVITY TARGETS

0%

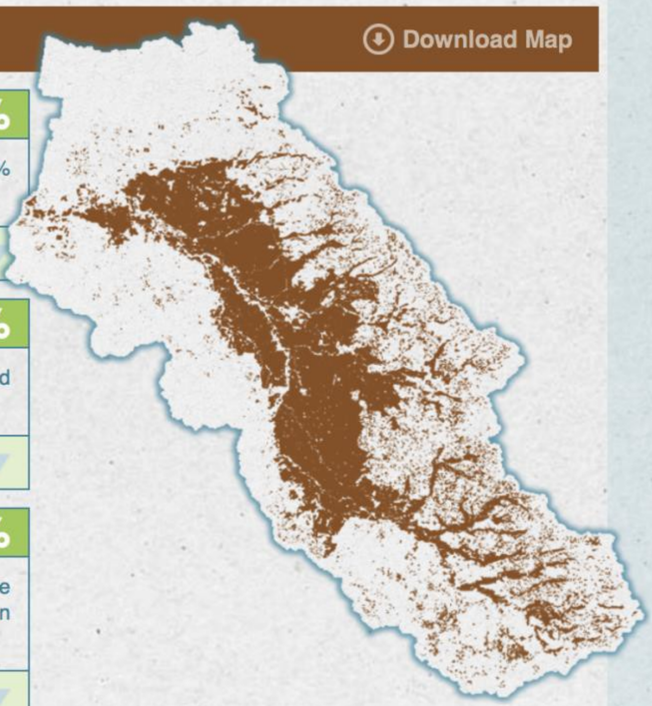
By 2030, there will be clear fish passages on the majority of flows in the Condamine River with no major instream barriers

By 2030, there will be a continuous riparian habitat corridor for the length of the Condamine River (approximately 500 km)

PLANNING | RESEARCH | ACTIVITIES

Land Priorities

Download Map



QUALITY TARGETS — 0%

By 2030, the area of soil in '**good**' condition will improve by more than 30% (763 000 ha), including soil fertility, soil structure and soil health, across all land uses

PLANNING | RESEARCH | ACTIVITIES

QUANTITY TARGETS — 0%

By 2030, the amount of **good** quality soil retained for productive purposes (food and fibre) will be protected at 83% (1 336 000 ha)

PLANNING | RESEARCH | ACTIVITIES

CONNECTIVITY TARGETS — 0%

By 2030, there will be an improvement in land use connectivity (beneficial coexistence and colocation, thresholds for effective management, and soil formation and distribution process functionality) across at least 75% (1 908 000 ha) of the catchment

PLANNING | RESEARCH | ACTIVITIES

Wildlife Priorities

Download Map

QUALITY TARGETS — 0%

In 2030 there will be an improvement in **health** over more than 35% (309 500 ha) of the catchment's habitat types, including:

- A **low presence** of weeds and pests across at least an extra 30% (217 500 ha) of th catchment

PLANNING | RESEARCH | ACTIVITIES

QUANTITY TARGETS — 0%

By 2030, the number of **mapped vegetation patches** will increase by 40% (3300 patches) -- excluding fragmentation effects where patches become dissected rather than added

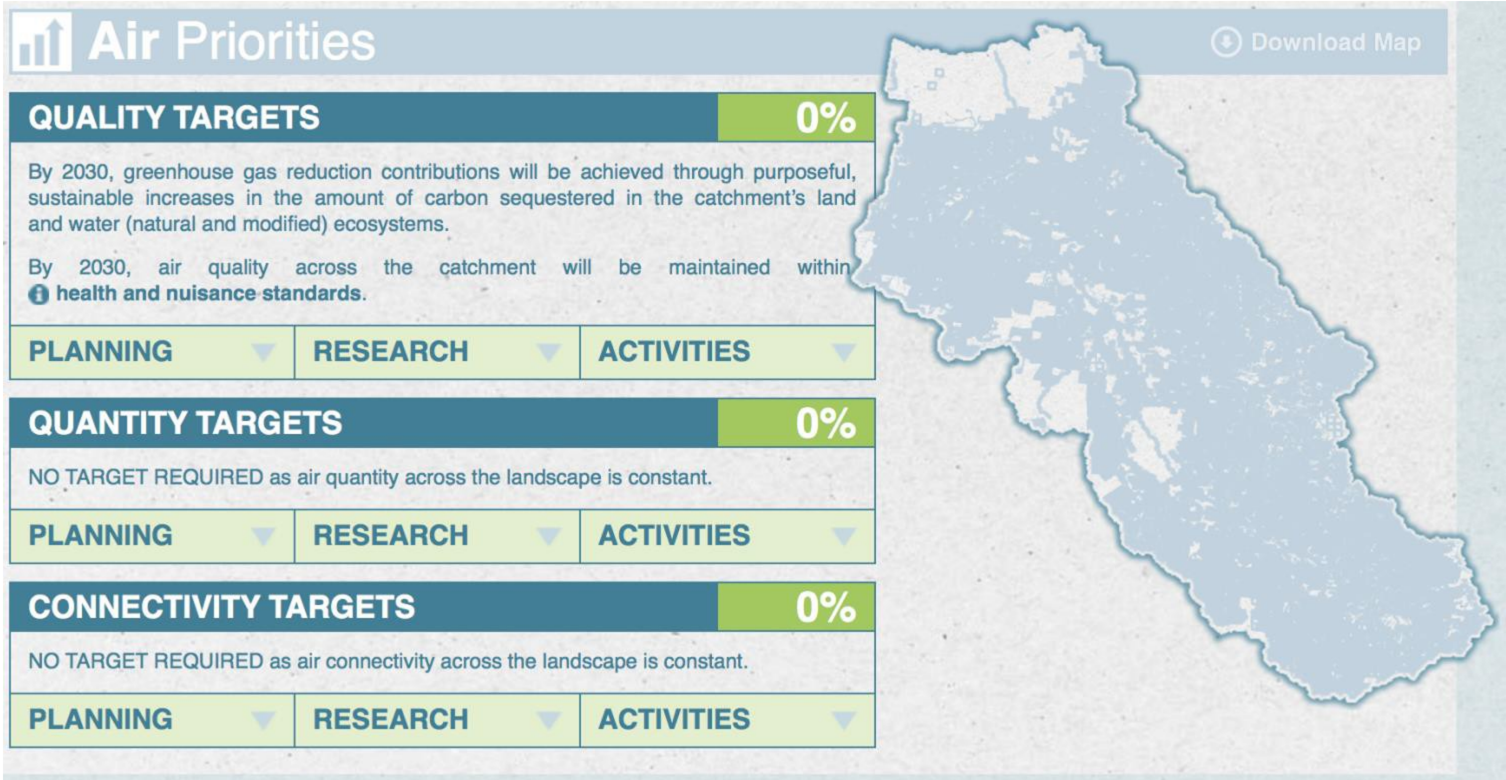
PLANNING | RESEARCH | ACTIVITIES

CONNECTIVITY TARGETS — 0%

By 2030 native vegetation **connectivity** will improve for patches across 30% (763 000 ha) of the catchment, including:

- A **continuous natural riparian corridor** for the length of the Condamine River (approximately 500 km)

PLANNING | RESEARCH | ACTIVITIES



Strategic alignment

How do these priorities fit with other strategic documents?

The legislated acts relevant to natural resource management are outlined in the State of the Catchment section's legislation and policy list, and their relevance to each of the natural resource management themes highlighted.

Key strategic directions provided by other levels of planning relevant to the Condamine catchment include:

- Queensland Government plans and strategies
- National, state and local research strategies of government and research institutions
- Regional Council planning schemes and community plans
- Neighbouring regional natural resource management plans
- Industry group plans and strategies
- Local community group plans and strategies

A review of these many strategic documents identified many alignments that provide opportunity for collaboration and cobenefit. A summary of the key documents and alignments for the broader catchment scale is provided below. Each of these strategies will evolve over time as will this NRM plan. Liaison and engagement by each group with the others will be necessary to maximise the ongoing alignment of these strategies.

Strategic planning alignments

- Australia's Biodiversity Conservation Strategy 2010-2030 (Australian Government, 2010)
  Includes goals regarding promoting participation in biodiversity conservation among Australians and organisations; increasing the employment of Indigenous people in biodiversity conservation; promote the market value of ecosystem services; increase the protection of habitat and promote connectivity.
- Australia's Native Vegetation Framework (COAG Standing Council on Environment and Water, 2012)
  Includes goals regarding national extent and connectivity of native vegetation; condition and function of native vegetation; benefits of ecosystem service markets; capacity to understand, value, and manage native vegetation; and engagement and inclusion of Indigenous peoples in management of native vegetation.
- Australian Pest Animal Strategy (Commonwealth of Australia 2007)
  Includes goals regarding leadership and coordination of pest animal management; prevention of establishment of new pest animals; and management of impacts of established pest animals.
- Australian Weeds Strategy (Commonwealth of Australia, 2007)
  Includes goals regarding the prevention of new weed problems; impacts of existing priority weeds; and capacity and commitment to solve weed problems.
- Basin Plan (Murray-Darling Basin Authority, 2012)
  Includes goals regarding improving water security; using water from the Basin in a way that sustains social, economic and environmental outcomes; provide objectives for water quality and salinity; establishment of sustainable limits for surface and ground water use.
- Building Nature's Resilience: A Draft Biodiversity Strategy for Queensland (Queensland Government, 2010)
  Includes goals regarding to reversing the decline of biodiversity; increasing the resilience of species, ecosystems and processes' identifying climate change adaptation strategies in conjunction with new and accepted science; employing science and scientific knowledge in decision making; coordinating cooperation among all levels of government; fostering stronger partnerships between government and key stakeholders.
- Darling Downs Regional Plan (Queensland Government, 2013)
  Includes goals regarding co-existence of resource extraction with agriculture and with towns; community infrastructure development; land release for development; liveability of communities; priority agricultural land protection; priority Living Areas for town growth; and water infrastructure security and supply.
- Foundations for the Future (Australian Government, 2013)
  Includes goals regarding coordination, collaboration and leadership in ecosystem science; maximising data resource accessibility; ecosystem surveillance; empowering the public; long-term research investment; maximising research impact through collaboration between researchers and knowledge users.
- Heathy Waters Management Plan for the Upper and Middle Reaches of the Condamine River (Condamine Alliance, 2013)
  Includes goals regarding improving water quality; protecting environmental values; improving management of water resource and connectivity of systems.
- National Food Plan - Our food future (Australian Government, Department of Agriculture, Fisheries and Forestry, 2013)
  Includes goals regarding biosecurity and food safety management systems; increase yields; support the development and adoption of industry innovations; industry based capacity building and knowledge transfer; raise community awareness around food supply chain and

food safety; support sustainable agriculture and natural resource management; reduce food waste; mitigate climate change and impacts.

- National Landcare Programme (Australian Government, 2014)
  Includes both Regional and National streams focused on improving collaboration and action toward natural resource management outcomes, particularly in the areas of pest animal and wee management, biosecurity incursion management, local river and waterway restoration, and tree planting.
- National Plan for Environmental Information (Australian Government, 2010)
  Aims to improve the quality and accessibility of environmental information through development of environmental information systems, environmental information standards, products and services, and tools for improved data access and discovery; supported by legislation, advisory groups, and whole of government direction and priorities.
- National Soil Research, Development and Extension Strategy (Australian Government, Department of Agriculture, Fisheries and Forestry, 2014)
  Includes goals regarding improved access to quality soil data and information; improved communication and sharing of soil knowledge; industry based capacity building and knowledge transfer; research collaboration; improve soil planning, monitoring and management; improve understanding of soil based ecosystem services.
- National Strategic Rural Research and Development Investment Plan (Australian Government, Department of Agriculture, Fisheries and Forestry, 2011)
  Includes goals regarding investment in improved natural resource integration and management; increase industry-based capacity building, training and knowledge transfer; develop resilient rural systems and develop adaptation practices for climate change; reduce impact and reliance on natural resources; improve resilience of rural communities; develop and promote new technologies to mitigate impact of change; leverage innovation and growth in rural production themes.
- Northern Rivers Catchment Action Plan 2013-2023 (Northern Rivers Catchment Management Authority, 2013)
  This plan is currently under review and includes boundary realignments under the new Local Land Services.
- Our Plan for a Cleaner Environment (Australian Government, 2010)
  Includes programs and plans focusing on clean air, clean land, clean water and national heritage.
- Queensland Pest Animal Strategy 2002-2006 (Queensland Government, 2002)
  This strategy is currently under review.
- Queensland Plan (Queensland Government, 2014)
  Includes goals regarding supporting healthy communities; improving community capacity building and knowledge transfer; increasing community resilience; supporting cultural heritage growth and protection; develop and adopt appropriate infrastructure; promote sustainable economic growth; promote industry innovation; support healthy lifestyles; support sustainable environmental and natural resource management.
- Queensland Weeds Strategy 2002-2006 (Queensland Government, 2002)
  This strategy is currently under review.
- Queensland's Agriculture Strategy 2040 (Department of Agriculture, Fisheries and Forestry, 2014)
  A 2040 vision to double agricultural production and includes goals regarding agricultural industry protection, growth and sustainability; securing and increasing availability and use of critical resources; driving productivity growth across the supply chain through development and adoption of innovation; protect biosecurity status; develop energy and water strategies; develop suitable transport infrastructure and logistics pathways.

- Queensland's Department of Agriculture, Fisheries and Forestry (DAFF) Agricultural research, development and extension plan (Department of Agriculture, Fisheries and Forestry, 2014)
  Contributing to the Agriculture Strategy 2040 vision to double Queensland's agricultural production. Includes goals regarding lowering the costs of production; increase yields; improve sustainability; encourage efficient resource allocation; preventing and responding to emergent pest and disease incursions; support development and adoption of new industry innovations; build resilience to seasonal changes and foster adaptation; promote development and uptake of best management practices; protect and improve natural resources; develop integrated pest management systems; improve food quality and reduce residual pesticides
- South East Queensland Natural Resource Management Plan 2009-2031 (SEQCatchments, 2009)
  This plan is under review.
- Southern Downs 2030 Community Plan (Southern Downs Regional Council, 2013)
  Includes goals regarding agricultural industry protection, growth and sustainability; bushfire preparedness; carbon dioxide emissions reduction; community awareness of environmentally sustainable practice; food security; renewable energy use; research on resource sector impacts on environment and agriculture; reuse and recycling by all sectors; sustainability and access to natural resources; and water supply development, reliability and sustainability.
- State Planning Policy December 2013 (Queensland Government 2013)
  Includes goals regarding agricultural sector, biodiversity, cultural heritage, emissions and hazardous activities, energy and water supply, liveable communities, mining and extractive resources, natural hazards, state transport infrastructure, strategic airports and aviation facilities.
- Strategic Research Priorities (Australian Government, 2013)
  Includes goals regarding the adaptability of changing natural and human systems; maximising Australia's competitive advantage; maximising the effectiveness of production value chains; optimising food and fibre production; lifting productivity and economic growth.
- Our Future Plan (QMDC, 2015)
  This plan is under development.
- Toowoomba Regional Community Plan (Toowoomba Regional Council, 2013)
  Includes goals regarding water quality and waterway health; air quality and atmosphere; biodiversity and ecosystems, climate resilient environment; ecosystem services; environmental offsets; land resources management; productive agricultural land protection; sustainable natural resource management; sustainable production; and sustainable water use.
- Western Downs 2050 Community Plan (Western Downs Regional Council, 2011)
  Includes goals regarding catchment management; climate change impacts; community environmental activity; groundwater sustainability; Indigenous environmental knowledge; natural environment and habitats; resource extraction management; soil condition; strategic cropping land and non-urban land use protection; sustainable transport network, infrastructure and waste services; water quality, water supply and water use efficiency; and weeds and pests.
- Wide Bay Burnett Environment and Natural Resource Management Plan 2012-2031 (BMRG, 2012)
  This plan is under review.

Risks

What risks do we face?
An assessment of risks has been undertaken in order to develop mitigation measures that will maximise the effectiveness and outcomes of the Plan. A risk is defined as the chance of something happening that will have an impact upon objectives and is often specified in terms of the likelihood of an event or circumstance and the consequences that may flow from it. It has been determined that there are two categories of risks associated with this Plan: the risks facing the catchment's natural resources and the risks associated with the implementation of the Plan. This Plan considers environmental, social and governance risks in order to provide a holistic approach.

Understanding the risks
This plan has three categories of risks that form the basis of the risk assessment for the Plan and provide a holistic view of the risks associated with the Plan. They allow consideration of appropriate mitigation actions to help the Plan to achieve what it is meant to achieve. It must be noted that the focus of this risk assessment is mitigation. When interpreting this risk analysis it is important to consider both the probability (likelihood) and consequences in order to place the real risk in perspective. The risk assessment process enables threats to be identified and prioritised and corresponding mitigating actions to be recommended.

Resolving conflict
Conflict around natural resource management can occur at many levels from within a family or business, to between two government agencies or between businesses and individuals. The options suitable for managing conflict in each situation may vary and professional advice should be sought if there is any concern that the conflict may lead to personal harm or legal concerns.

Environmental risks to natural resources

The risks facing the catchment natural resources

Habitat loss and modification		**SEVERE**	
Risk Event:	Poor planning surrounding where land uses occur due to the increasing demand for land resources.	**Almost certain**	**Major**
Mitigation:	Liaison with all levels of government, liaison with industry bodies and maintain relationships with relevant stakeholders. Included in Wildlife Quantity planning target.		

Degradation of resources		**HIGH**	
Risk Event:	Practices used by industries and landholders that do not support the long term health of natural resources.	**Likely**	**Major**
Mitigation:	Liaison with all levels of government, liaison with industry bodies, community and landholder engagement plans, regular communication with target individuals and industries. Included in all action targets.		

Inability to adjust to and mitigate the magnitude of the shift in climate		HIGH	
Risk Event:	The appropriate actions are not taken to reduce Greenhouse Gas emissions, increase capture and promote adaptation or to adapt land uses and practices to new climate conditions.	**Possible**	**Major**
Mitigation:	Liaise with all levels of government, liaise with industry bodies and open exchange of data and information. Included in all quality planning targets.		

Changes to the environment affect health within catchment communities		MEDIUM	
Risk Event:	The changes in the environment impact the health (both physical and psychological) of communities and individuals; and the values towards natural resources held by people and groups in the community differ resulting in a lack of mutual respect for resources.	**Possible**	**Moderate**
Mitigation:	Promotion of the importance of the environment for health. Promotion of connection to place and natural resource management ethos. Included in People targets.		

Environmental risks in implementation

The environmental risks associated with the implementation of the plan

Natural disasters and climate events impacting on delivery		HIGH	
Risk Event:	Disasters (ie fire, flood, etc) that occur and effect involvement, resulting in not being able to deliver targets.	**Likely**	**Major**
Mitigation:	Proactive engagement on planning and preparedness for disasters; post disaster support for recovery and planning and preparedness for later disasters. Stakeholders to build seasonal risks into planning for implementation projects. Resilience of the community and the natural resources increased through ongoing implementation of the Plan.		

Models are not representative of the natural systems		LOW	
Risk Event:	The models used in the plan do not provide an accurate overview of the condition of the catchment.	**Unlikely**	**Moderate**
Mitigation:	Review all available data and update as appropriate. Included in monitoring and update schedules for the Plan. Knowledge gaps addressed in all research targets.		

Social and governance risks

The social and governance risks affecting implementation

Approach of the plan is not appropriate		**MEDIUM**	
Risk Event:	The methodology of the plan does not accurately reflect the catchment and the community's goals.	**Unlikely**	**Major**
Mitigation:	Ensure multiple engagement opportunities for catchment community and transparency of the Plan and its processes. Maximise accessibility of Plan information. Follow the Queensland Regional Natural Resource Management Planning Guidelines for a quality plan and the Australian Government's principles for natural resource management planning to incorporate climate change.		

NRM Plan not recognised		**LOW**	
Risk Event:	The revised NRM Plan is not officially recognised by government bodies or other critical stakeholders.	**Unlikely**	**Moderate**
Mitigation:	Ensure the NRM Plan development guidelines are addressed and liaise with the Queensland and Australian Governments and other critical stakeholders during Plan development and ongoing adaptive updates. Ensure the Plan's messages go out to the relevant community members even if official recognition is not possible due to Government policy requirements.		

Disengagement or lack of engagement of critical stakeholders		**MEDIUM**	
Risk Event:	A lack of buy in and involvement of stakeholders critical to the implementation of the plan (individuals, organisations, groups) leading to an inability to deliver to targets.	**Unlikely**	**Major**
Mitigation:	Promote inclusion, cooperation and collaboration in all programs and messages around the Plan. Ensure multiple opportunities for engagement during Plan development and implementation. Include critical stakeholders in Plan development and ongoing adaptive updates to maintain relevance and ownership.		

Loss of funding		**HIGH**	
Risk Event:	Insufficient funds allocated to or available for projects to successfully implement activities towards achieving targets.	**Likely**	**Major**
Mitigation:	Efficient and effective financial planning processes by coordinating organisations; Prioritised and risk based approach to the distribution of funds; Ongoing communication with potential investors; Encouragement of all catchment stakeholders to contribute and spread the load. Encourage catchment stakeholders to collaborate for efficient use of available funds.		

Changes in government policy and legislation		**HIGH**	
Risk Event:	Changes in policy that impacts the way natural resource management projects are delivered, which has the potential to impact achieving targets.	**Likely**	**Major**
Mitigation:	Regular communication with all levels of government. Involvement of government in Plan development and ongoing adaptive updates. Provision of feedback to government on policy proposals where appropriate.		

Monitoring and updates

How will the Plan stay relevant?
The Condamine catchment and its community are constantly changing. In order to address emerging issues and changes in the pressures and issues facing our natural resources, this Plan needs to change in response to community and catchment needs.

This section describes how each of the components of the Plan will be reviewed and updated to maintain the currency and relevance of the Plan to meet community and catchment needs.

Update Schedule

COMPONENT	REVIEW INTERVAL
Our Catchment	
Content (including maps)	Ongoing for individual content sections as new information is identified; and more broadly across all themes in line with monitoring and evaluation timeframes to incorporate target progress assessment findings
Our Priorities	
Priorities (including maps)	Annually in June - July
Activity targets	In line with monitoring and evaluation timeframes
Resource targets	In line with monitoring and evaluation timeframes
Alignment of targets	As other relevant strategic planning processes occur
Our Tools	
Regional catalogue	Ongoing as new resources are identified
Scenarios	In line with monitoring and evaluation timeframes
Catchment models	In line with monitoring and evaluation timeframes
NRM Plus	Ongoing update of survey tools against program requirements; and data reviewed in line with monitoring and evaluation timeframes
Our Progress	
Activity progress	In line with monitoring and evaluation timeframes
Resource health	In line with monitoring and evaluation timeframes
Risks and improvements	In line with monitoring and evaluation timeframes
Monitoring and evaluation methods	Ongoing as new opportunities and information sources are identified; and as key monitoring and evaluation activities occur

How is change being monitored and progress assessed?

In order to understand progress towards the community's goals and vision for the catchment, it is important that we watch for changes that tell us if we are on-track, and if there are emerging considerations that change the catchment's risks.

The key questions guiding the monitoring and evaluation of progress for each area of People, Water, Land, Wildlife and Air include:

- How well do the model scenarios represent the changing land use and climate and how do any differences affect our targets?

- How well are management actions tracking towards the targets and how do any differences affect the targets?
- How well is the catchment condition tracking towards targets and how do any differences affect our targets?

Monitoring and evaluation is a continual process that happens over a period of time. Whilst monitoring data is collected constantly, the evaluation component of the process can often take longer. The Plan's evaluation process is conducted both annually through annual reviews and over the period of 2-6 years depending on when the data source becomes available.

A monitoring and evaluation plan has been developed to support answering these questions and to guide adaptive management and improvement of the Plan and its implementation over time. This monitoring and evaluation plan is summarised for each question below.

When we manage our natural resources well, we often find that the good practices we implement also have unexpected benefits for other natural resources than our main intent. For example, when we manage our pasture well for grazing production, we are also improving habitat for ground-dwelling native species like our reptiles. If you'd like to find out more about these co-benefits from resource management activities, have a look at the co-benefits table in the Good Practice Guide.

This updated Condamine Catchment NRM Plan is funded by the Australian Government. Condamine Alliance is custodian of the Plan on behalf of our region's community, industry and government.

About Condamine Alliance
Condamine Alliance is a local and experienced not for profit organisation specializing in environmental philanthropy who partners with community, industry and government to optimize public and private investment for the benefit of our regionals natural and cultural resources. Condamine Alliance acts as the custodian of the Condamine catchment's Natural Resource Management Plan on behalf of the catchment community.

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PEOPLE WATER LAND WILDLIFE