Malpas Catchment Asset Protection Plan 2017-22

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CONTENTS

Cover Illustrations:
Upper: Well managed eastern foreshores of Malpas Dam. *Photo: R Trémont, 5th June 2015.*
Lower: Guyra Dams look healthy in a good spring. *Photo: C Carruthers, 11th September 2016.*

Malpas Catchment Asset Protection Plan 2017-22

SUMMARY

This Malpas Catchment Asset Protection Plan (MCAPP) has been prepared by the Malpas Catchment Coordinator under the Malpas Catchment Project, administered by Southern New England Landcare Ltd (SNELandcare) and funded by Armidale Regional Council (ARC). This MCAPP is a proposal for collaborative involvement of stakeholders to demonstrate, and implement, best practice riparian management and water use in the catchment for Guyra and Malpas Dams. The aim of this best practice is to protect the water quality and water supply assets of the greater Malpas catchment.

Poor water quality arising from the impact of primary production and extractive land uses over many years, exacerbated by intermittent drought, is of concern for urban water supply, rural landholders and biodiversity conservation. This commonality of concern, albeit for differing reasons, provides the rationale for a collaborative approach to preventive and corrective action across the catchment. The provision of water infrastructure to support livestock grazing to coexist beside, but without accessing, urban water supplies needs to be addressed. Water supply reservoirs and their tributaries require protection from livestock, and off-stream livestock watering and sediment filtration zones are needed. Point sources of sediment and nutrients, and issues related to stream bed dynamics, also need to be addressed.

Collaborative plans were developed previously for the Malpas Catchment and much of their content is still relevant. However, and despite the success of small projects, the big issues regarding stock access to riparian areas, diffuse sediment/nutrient entry to waterways from lands with insufficient ground cover and the lack of attention to eliminate point sources of sediment/nutrients have not really been addressed.

Collaborative negotiation, co-operative partnerships and joint funding for strategic and focused changes to riparian management in the greater Malpas catchment are recommended, as is systematically targeted best practice management of the water assets of the catchment. This means developing relationships and incentives which ensure the foreshores and tributaries to the water supply reservoirs for Guyra and Armidale are free of livestock and have 80% ground cover of at least 30 cm long 100% of the time. In addition, it is recommended that remediation of other point- and diffuse sources of sediment, nutrients and/or pollutants at sites managed by government and statutory bodies take place as a high priority. Joint incentive initiatives, with private land managers, to improve the health of riparian areas, water supply assets and adjacent lands, across the greater Malpas catchment, also need to be developed. A Malpas Catchment Officer with creditable experience in riparian and water asset management, and successful engagement of land managers in new approaches to riparian management, is urgently needed. This Officer would benefit from working with a team committed to long-term and sustainable catchment-wide asset protection.

This MCAPP identifies high, medium and low priority interventions to improve water quality in the greater Malpas catchment over 5 years. A range of approaches is provided, including on-ground works, engagement and capacity building, monitoring and evaluation; and program development and funding by government organisations, private and philanthropic sectors, and individuals. Implementation of ‘Very High’ and ‘High Priority’ works (including ~35km of fencing and 5 livestock watering systems) and associated activities is costed at about $900,000 over 5 years. However, costs will vary depending on the approaches taken. Resource-sharing, efficient designs, in-kind contributions and co-operative approaches are likely to bring efficiencies of scale, reduced costs, win-win outcomes and trusting, productive, long-term relationships and regional development.

1. Aim

This Malpas Catchment Asset Protection Plan (MCAPP) is a strategic document that identifies high priority actions and supporting initiatives to improve water quality outcomes in the greater Malpas catchment and facilitate equity of access to water for production and domestic uses. This Plan is intended as a guide, supported by technical evidence and knowledge, to inform planning by stakeholders in the greater Malpas catchment to achieve strategic water quality outcomes. It is envisaged that this Plan will be utilised as a 'working document', such that it (or parts of it) can be modified, extended, extracted or enhanced to support planning, collaboration, funding, action, monitoring and evaluation. It is intended that implementation of this Plan will be supported by ongoing work to adopt a multi-stakeholder governance approach to achieving ongoing best practice catchment management and long term asset protection.

This MCAPP has been prepared by the Malpas Catchment Coordinator under the Malpas Catchment Project, administered by Southern New England Landcare Ltd (SNELandcare) and funded by Armidale Regional Council (ARC). This Plan is based on progress made by the Malpas Project over the last 15-20 years and is intended to guide investment and resource allocation across the greater Malpas Catchment over the next 5-10 years.

2. Background

The greater Malpas catchment (see Figure 1) encompasses a small area of the upper Macleay River catchment on the NSW Northern Tablelands, and provides water for Guyra and Malpas Dams and hence water supplies for the township of Guyra and city of Armidale. The Malpas Catchment Group formed in 1994, to respond to increasing algal blooms and other indicators of poor water quality. At that time the Group included landholders in the Malpas Catchment, Armidale Dumaresq Council, Guyra Shire Council, Department of Infrastructure Planning and Natural Resources, Southern New England Landcare Coordinating Committee (SNELCC) and Malpas Aquatic Association. These stakeholders had a common interest in supporting changes in land management that would improve water quality.

The Malpas Catchment Group aimed to '*Improve natural resource management resulting in sustainable and profitable land use, with an improvement in the water quality in the Malpas and Guyra Dams and Macleay Catchment'*. A Malpas Catchment Committee was formed in 1995 and a part-time Malpas Catchment Coordinator appointed in late 1996 (through SNELCC and using funding from the former Armidale Dumaresq Council and Armidale City Council).

Funding was obtained from the National Heritage Trust for the Malpas Community Catchment Planning Project, part of which was a combined stakeholder workshop held in June 1998. This workshop saw excellent stakeholder representation and recommendations were forthcoming for actions to address water quality issues from a number of perspectives (Gill 1998). The activities of the Malpas Catchment Coordinator were then guided by the outcomes and recommendations in the above report.

The 'Malpas Catchment Management Plan' of 2005 (Anonymous 2005) states that "[t]hree target areas to achieve coordinated sustainable resource management at the subcatchment level" were: stormwater and pollution from urban activity, intrinsic water management within dams, and rural land and property management. Important strategies to enable management of catchment resources were listed as: community education, awareness and participation; coordination, cooperation and information transfer between stakeholders; awareness and adoption of research, technology, engineering and new information; and monitoring and reviewing the catchment plan

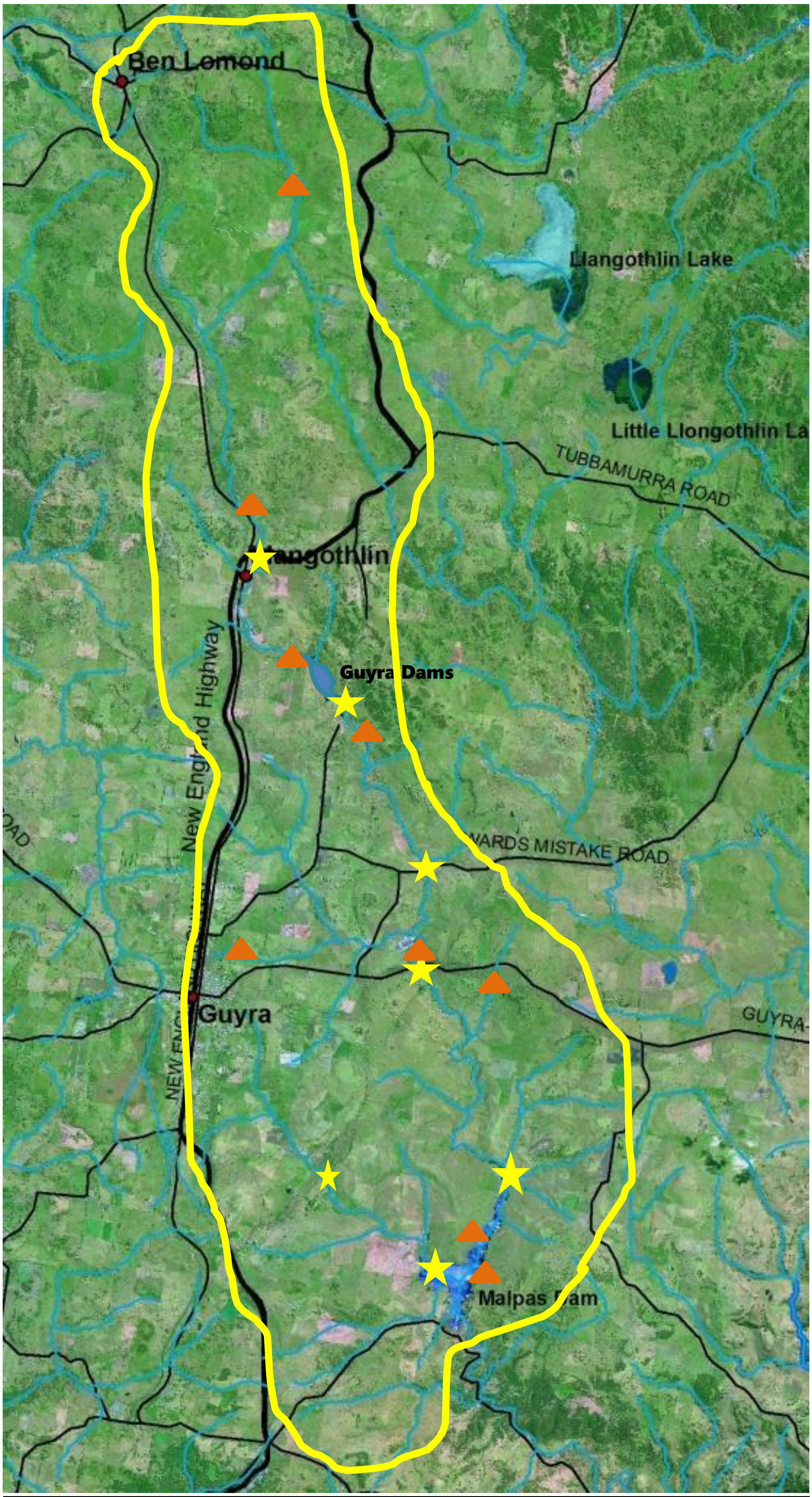

Figure 1 *– Map of the greater Malpas catchment (yellow line) for Malpas and Guyra Dams. Orange triangles indicate suggested benchmark sites (see section 5.1). Yellow stars indicate proposed water quality monitoring sites (see section 5.2).*

and activities within the catchment. In keeping with these guidelines, activities at the time of the 2005 report included: revegetation with native trees and shrubs; fox baiting; monitoring, collection and transfer of dung beetles; research into interactions between grazing management and water quality; support for local schools to be involved in water-focused environmental and agricultural education programs; yearly field days on relevant topics; catchment and property planning; and urban stormwater management. Malpas Catchment Project activities continued to focus on these sorts of matters beyond 2005.

Major community education, urban stormwater management, Urandangie Creek improvement, and biodiversity-focused activities were funded by the Federal Government's 2010-2012 High Country Urban Biodiversity Project, and facilitated and coordinated by Southern New England Landcare Ltd (SNELandare). Since 2012, the Malpas Catchment Officer has worked to help community groups support healthy fish habitat, assist local Council with dam foreshore management, and riparian, wetland and habitat management; support local landholders to undertake (and in some access funding subsidies for) courses and on-ground works to support natural resource management for improved agricultural sustainability and better water quality for the Malpas and Guyra Dams and Macleay Catchment.

Thus, the Malpas Catchment Project's awareness-raising and on-ground projects have undoubtedly increased the knowledge of some people and assisted landholders to undertake works to improve natural resource management on their land.

However, stakeholder involvement in the Malpas Catchment Project has waned over the last ten years and, overall, relatively few landholders have protected and restored riparian areas in the greater Malpas catchment and/or engaged in approaches to maintaining good groundcover. Nevertheless, despite being a minority, the landholders who have reduced the loss of sediment and nutrients from their land are knowledgeable, experienced and dedicated to actions which make a difference. They are outstandingly different from the 'average' land manager and have the potential to provide excellent peer leadership.

It is time for the Malpas Catchment Project to be re-energised and progress facilitated by the Project over the last two decades to be significantly boosted. SNELandcare has developed this MCAPP plan to initiate strategic targeted actions and collaboration across the greater Malpas Catchment, to tangibly build on previous awareness-raising and community-based planning activities and translate increased awareness into committed and effective action on the ground.

Investment at appropriate scales will be required, and dedicated strategic and systematic planning will be needed to obtain and make best, synergistic use of funds and other resources. Technical expertise in riparian and grazing management, and skills in working with land managers, will also be required - to ensure actions are strategically prioritised for systematic implementation and to utilise best practice management approaches for win-win outcomes among land managers.

In addition, expert facilitation will be needed to guide the implementation of this plan, collaboration among partners, prioritisation and delivery of capacity building activities, prioritisation and implementation of on-ground works, sourcing of funds and other resources, ensuring sound project and financial management, as well as monitoring, evaluation, and reporting of outcomes.

3. Current catchment condition

The general issues which currently affect water quality in Guyra and Malpas Dams are associated with:

- sediment and nutrient accumulation within water storage reservoirs;
- water quality;
- point source pollutants;
- diffuse source pollutants;
- disengaged rural community; and
- land use and vegetation condition.

These issues are further described in Appendix 1.

While the Guyra and Malpas Dams have the above issues in common, these reservoirs are also characterised by a number of differences. *Guyra Reservoirs* are:

- dammed by two dam walls separated by approximately 500m along the Gara River;
- located on granite parent material;
- relatively shallow;
- not effectively fenced around their foreshores, so domestic livestock access these reservoirs more-or-less continuously;
- contiguous with privately held land, and Travelling Stock Reserve land leased from the Northern Tablelands Local Land Services (NTLLS);
- set-stocked or regularly grazed by adjacent landholders;

and have

- some remnant woodland on their north-western and south-eastern foreshores and adjacent land;
- mixed, fairly short, grassy vegetation containing native and introduced plant species occurs to the shoreline; and
- some point sources of sediment, mostly associated with intermittent watercourses.

In contrast, *Malpas Reservoir* is:

- located on basalt parent material;
- relatively deep;
- fenced (fence varies in condition) around its foreshore, but domestic livestock access parts of the dam foreshores and Gara River in an ad hoc way;
- surrounded by privately held lands beyond the fenced foreshores;
- opportunistically grazed by some adjacent landholders;
- used for recreational activities;

and has

- negligible adjacent remnant woodland (except at the southern end);
- been planted with trees on some of its eastern foreshore
- areas of high conservation value grassy vegetation on most of the well-drained and higher foreshore areas;
- deep-rooting introduced perennial pasture grass species on lower foreshore areas where soils are frequently damp or wet; and
- point sources of sediment, mostly associated with bank slumping due to natural water course dynamics but exacerbated by livestock access.

4. Priority issues for attention

4.1 Biophysical

- Direct livestock access to Guyra and Malpas Dams and waterways which are tributaries to these water storage reservoirs.
- Diffuse sources of sediment/nutrient input (primarily land areas with herbaceous ground cover of <80% cover and <10cm height) to Guyra and Malpas Dams and their tributaries.
- Lack of deep rooted perennial vegetation (herbaceous and woody) to facilitate water infiltration (rather than runoff) in the catchment areas for the above dams and their tributaries.
- Point sources of sediment/nutrient input to the above dams and their tributaries.
- Variable rainfall events.

4.2 Socioeconomic

- Potential pathogenic contamination of domestic water supplies.
- Blue-green algal blooms and potential intoxication of human and animal populations sourcing water from Guyra and Malpas Dams, where these algal blooms are largely due to nutrient enrichment of water supply reservoirs as a result of nutrient loading from overland water runoff carrying sediment, nutrients and animal excrement into reservoirs from adjacent lands.
- Lack of water in farm dams (due to no dams or dry dams) on properties adjacent to the water reservoirs or tributary watercourses flowing through grazing lands – hence need to access reservoirs and their tributaries.
- Lack of flow over Guyra Dams resulting in no flows in Gara River below these dams and hence stock water issues (as above) for graziers located immediately below these dams, and restrictions on the quantity of water available to the township of Guyra and local enterprises.
- Responsibility for Council to provide potable water for domestic consumption to the townships of Armidale and Guyra, which is below critical levels for pathogens and Blue-green algae/toxins.
- The 'right' of freeholders of farm land to access waterways for water supplies.
- The 'right' of freeholders to manage their farm land as they see fit.
- The failure of lessees of grazing lands to maintain fences in accordance with lease conditions and best bet practice riparian management.
- The consequences of past decisions and management, the present inertia/resistance to change, the unwillingness to embrace new knowledge, the lack of interest in others' activities, reactivity rather than proactivity, short term planning approaches and lack of follow-through to enact best practice water and land management.
- Inadequate prioritisation of fundamental resource conservation measures, largely due to short term financial pressures.
- Inadequate income base of Council and landholders to fund the infrastructure required to address the above issues.

5. Best practice activities for on-ground works, capacity building, and monitoring and evaluation to protect Malpas catchment water assets

Commitment to a prioritised, integrated, sequential program of strategic targeted on-ground works, capacity building, and monitoring and evaluation activities to protect the water supply assets of the greater Malpas catchment would:

- establish benchmarks and long-term goals;
- utilise synergistic cooperation among stakeholders such as ARC, NTLLS, landholders/managers, corporate and small business/industry, Landcare networks, community groups and the wider community;
- establish strategic water quality monitoring sites (see Figure 1), from which initial/pre-works water quality baseline measurements can be made, and from which regular monitoring can then be continued;
- remediate point sources of sediment, nutrient and pollutant input to Guyra and Malpas Dams and the tributaries to these dams;
- address diffuse sources of sediment, nutrient and pollutant input to Guyra and Malpas Dams and the tributaries to these dams.

Table 1 outlines key issues, on-ground works, engagement and capacity building activities, monitoring and evaluation approaches, potential partnerships, anticipated outcomes and suggests timeframes for the protection of water assets in the greater Malpas catchment. Twelve sites are specified for targeted remedial actions to reduce sediment, nutrient and pollutants entry to water supply assets.

5.1 Benchmark sites

A number of riparian sites exist in the greater Malpas catchment which are in reasonable health or at which effective preventative and/or remedial measures already exist. These sites could be use as reference resources to provide benchmarks against which stakeholders could set goals to work towards at sites identified for intervention and remedial or altered management. Potential benchmark/reference sites (see Figure 1) include:

- Ryanda Creek at 69 Ben Lomond Rd, Llangothlin;
- Ryanda Creek entry at the north-western end of Guyra Dams;
- some sections of Gara River in Burnt Bridge and Falconer South TSRs;
- headwaters of Washpool Creek, a tributary to Gara River, on “Kenilworth”, 134 Falconer Rd;
- Native Dog Gully TSR (fenced), south side Guyra-Ebor Rd;
- some sections of Urandangie Creek;
- some sections of Malpas Dam foreshores (see Trémont 2015).

Ryanda Creek at 69 Ben Lomond Rd, Llangothlin.
Photo: R Trémont, 2015.


Well-grassed healing watercourse in Native Dog Gully TSR. *Photo: R Trémont, 2013.*


Fenced dam and riparian area, on “Kenilworth” Falconer Rd, exclude livestock from upper Washpool Creek. *Photo: R Trémont, 2015.*

5.2 Water quality monitoring

Strategic water quality monitoring, done regularly over the long term, is a tool for observing water quality and assessing any changes in water quality. Applied in the greater Malpas catchment, it would also be a tool for evaluating the effectiveness of water quality improvement measures over time and space.

Water quality monitoring should begin prior to the initiation of on-ground works and capacity building activities, and be repeated at regular intervals and at significant rain events. Benefits of riparian rehabilitation for water quality are often slow to manifest and can be highly variable in the short term (e.g. due to extremes of dry or wet weather). Therefore annual or biannual monitoring, commencing before the start of management changes, for at least 5-10 years is required to obtain data suitable for evaluating the effects of rehabilitation. Water quality monitoring should include measurements of turbidity, pH, dissolved solids, phosphorus (various) and nitrogen (various) levels.

Seven water quality monitoring sites have already been identified (see Figure 1), at:

- Ryanda Creek at the bridge on the New England Highway just north of Llangothlin village,
- Gara River crossing at ‘Burnt Bridge’ in Burnt Bridge TSR,
- Gara River crossing at bridge on Wards Mistake Road,
- Gara River crossing at bridge on Guyra-Ebor Road,
- Malpas Dam at far north end,
- Malpas Dam at Urandangie Creek entrance,
- ± Urandangie Creek at its crossing of the Urandangie TSR

Water quality could also be monitored on a biannual basis on incoming water at Armidale and Guyra water treatment plants.

Water quality testing results should be reviewed regularly over the medium to long term, to: evaluate water quality and effectiveness of measures implemented; identify ‘next steps’ and adapt strategic plans to make best-practise decisions for progressing improved asset protection.

5.3 Remedial activities – on-ground works and management changes

5.3.1 General

Provision of effective filtration of surface and sub-surface water flows into the Guyra and Malpas Dams and their tributary watercourses is urgently needed. Passive coercion of land managers to do this, over the last 18 years, has been relatively unsuccessful. Funds allocated to better management of the greater Malpas catchment need to be spent strategically and for best-bet best-practice outcomes. The establishment of a minimum of 80% groundcover vegetation to a height of at least 30 cm, for 100% of the time, adjacent to the foreshores of the Dams and water courses contributing to Guyra and Malpas Dams is of very high priority.

Dam foreshores and riparian areas under the management of ARC, NTLLS and Crown Lands are easily achievable, top priority sites for management changes and/or on-ground works to establish and maintain minimum groundcover. However, the riparian zone between Malpas Dam and the northern side of the TSR/road reserve of the Guyra-Ebor Road, as well as the foreshores of Guyra Dams and riparian zone of Ryanda Creek between Guyra Dams and the New England Highway just north of Llangothlin are also high priority sites for remediation. The establishment of a vegetation-based filter in the riparian zones of Ryanda Creek and Gara River above Malpas Dam would reduce sediment, nutrient and pollutant inputs to the tributaries to Guyra and Malpas Dams as a result of rain events, and improve on-farm water quality for domestic and livestock use.

Actions which would achieve substantial filtration of water prior to its entry to Guyra and Malpas Dams include undertaking the following activities.

- Establishing stock-proof fencing for foreshores (new or repaired, at least 8m from fence to average water line) of Guyra and Malpas Dams, as well as creek lines directly entering the dams.
- Providing off-dam and off-stream stock watering systems (pump, storage tank, in-paddock troughs, poly pipe) for landholders or lessees of lands adjoining the foreshores of Malpas and Guyra Dams, and immediately downstream of Guyra Dams.
- Ensuring exclusion of livestock from the foreshores of Malpas and Guyra Dams, and at least the 200m of creekline of watercourses directly entering the dams.
- Remediating existing point sources of sediment and nutrient input from sites on public and private land in the Malpas catchment.
- Ensuring stock-proof fencing, livestock exclusion and provision of off-stream stock watering systems along the riparian zone of Ryanda Creek, Gara River and their immediate tributaries, and the best practice remediation of riparian zones of water courses above Malpas Dam which are on public lands other than those just described (e.g. under the jurisdiction of Council or the NTLLS) .
- Ensuring stock-proof fencing, livestock exclusion and provision of off-stream stock watering systems along the riparian zone of Ryanda Creek, Gara River and their immediate tributaries,

and the best practice remediation of riparian zones of water courses above Malpas Dam which are on private lands other than those just described.

- Weed and feral animal control of the foreshore areas of Guyra and Malpas Dams.

5.3.2 Twelve sites for specific actions

Table 1, Column 4 outlines recommendations for on-ground works and management changes, for 12 sites (see Figure 2 and Appendix 2), which would make substantial improvements to riparian health, water quality and protection of water storage assets in the catchments of Guyra and Malpas Dams.

On-ground remedial actions have been prioritised across the 12 sites in an order which would make the greatest improvement in the quality of water assets and would, secondarily, be easiest to execute and manage given current land tenures or management arrangements. 'Very High' priority sites should be attended to as a matter of urgency, to protecting the longevity and quality of the water supply assets of the greater Malpas catchment. Further detail and potential costs for on-ground works are provided in Table 2.

5.4 Remedial activities – engagement and capacity building

Engagement of stakeholders with vested interests in the health of water supply assets in the greater Malpas catchment is essential if changes are to be made to riparian management in this area. Awareness of the negative effects of poor riparian health needs to be increased and support provided to boost the capacity of land managers to change their management of riparian areas to provide effective water filtration.

Table 1, Column 5, lists some capacity building activities for supporting best practice management of water assets in the greater Malpas catchment. Such activities need to be managed, often presented separately in disparate ways to different stakeholder groups, so that they appeal to the various stakeholders -with their needs being appreciated and supported, and there being 'something in it for me', to motivate changes in behaviour. Adults learn best from trusted peers and when in participatory but non-threatening situations. For many land managers 'seeing is believing' and take-home messages and resources need to be action-oriented.

Field events, workshops and peer to peer mentoring could demonstrate and explain the 'what', 'why' and 'how to' of best practice management techniques for reducing sediment loss to waterways using various riparian fencing and vegetation management options. There is no substitute for personalised, respectful, face-to-face interaction and support, for developing collaborative partnerships with individuals, small groups or organisations.

Experienced and trusted facilitators and technical officers, supported by efficient effective project administration, can provide for lasting behavioural and managerial changes which impact significantly on biophysical health of riparian and other natural resource systems. Potential costs for facilitation and technical input are provided in Table 2.

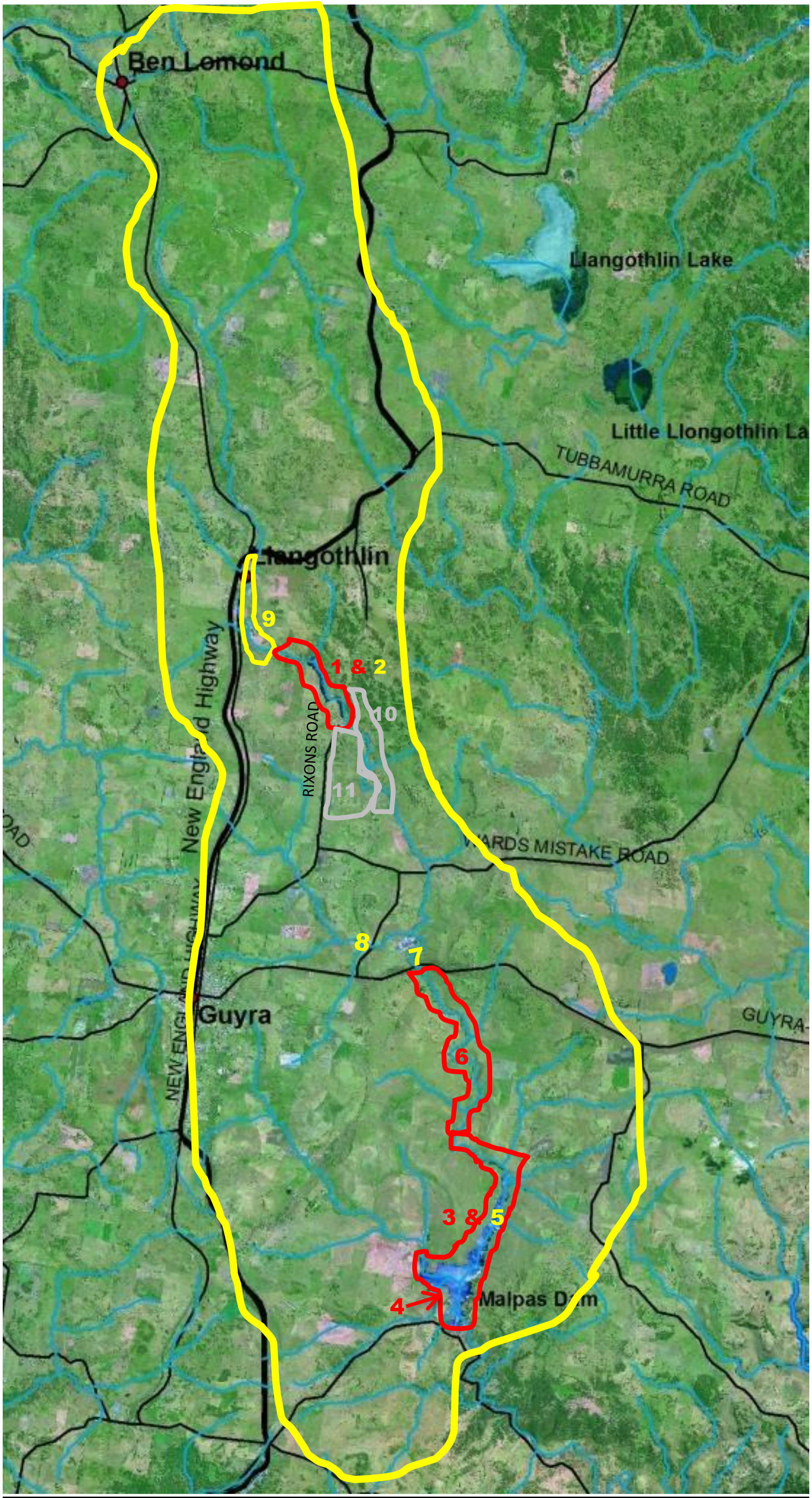

Figure 2 *– Map of the greater Malpas Catchment for Malpas and Guyra Dams. Numerals indicate sites recommended for remediation (see Table 1 & Appendix 2). Colours indicate Very High, High, Medium priority. The yellow line indicates the boundary of the greater Malpas catchment.*

***Table 1** – Summary of issues, on-ground works, engagement and capacity building activities, partnership development, monitoring and evaluation, and anticipated project outcomes for the protection of water assets at 12 sites in the greater Malpas catchment. Locations of the 12 specific sites are indicated in Figure 2 and site descriptions provided in Appendix 2. Need for remedial actions is prioritised as Very High, High, Medium priority, as in Figure 2.*

Site	Issues	Priority	Remedial Activities (see also Table 2)			Monitoring & Evaluation Activities	Anticipated Outcomes	Timeframe
			On-ground works and actions	**Stakeholder engagement and capacity building**	**Potential partners**			
1	-Livestock access [i] -Input of sediment & nutrients[ii] -Addition of wind-blown dust to reservoir. -Land manager or community disinterest, disengagement, resistance or inertia.	Very High Medium	-Construct or repair stock proof fence [iii] -Exclude livestock[iv] -Provide options for off-dam stock water[v] -Plant native trees and shrubs along access road [vi] - Plant native trees and shrubs in strategic locations[vii]	-Field events -Demonstration sites -1-on-1 neighbour and stakeholder relationships [viii] -Peer groups.	Armidale Regional Council (ARC) Adjacent land managers Southern New England Landcare (SNELandcare)	***Water Quality*** - Regular sequential (at least annual) water samplings (testing for turbidity, pH, phosphorus, nitrogen, etc) at the 7 designated sites and evaluation of results - Biannual feedback on water quality from Armidale and Guyra water treatment plants. - Optional 'before and after' samplings and testing for turbidity, pH, phosphorus,	Reduced sedimentation of dams and reservoirs. Improved water quality in Ryanda Creek, Gara River, and Guyra and Malpas Dams. Improved water quality for livestock in the greater Malpas catchment.	< 3 years
2	-Livestock access [i] -Input of sediment & nutrients[viii] -Land manager or community disinterest, disengagement, resistance or inertia.	High	-Construct or repair stock proof fence [iii] -Exclude livestock[iv]	As for Site 1.	As for Site 1.			< 5 years
3	-Livestock access [i] -Input of sediment & nutrients[ii] -Addition of wind-blown dust to dam.	Very High	-Construct or repair stock proof fence [iii] -Exclude livestock[iv]	-1-on-1 neighbour and stakeholder relationships [viii]	ARC			< 1 year

	-Land manager or community disinterest, disengagement, resistance or inertia.		-Provide options for off-dam stock water[v]	-Field events -Demonstration sites.		nitrogen, etc. and result evaluations at sites where	Increased woody and herbaceous	
4	-Livestock access [i] -Input of sediment & nutrients[ii] as for Sites 1 & 3, and due to excessive mowing, vehicle access and recreational activities.	Very High Very High Medium	-Construct or repair stock proof fence [iii] -Exclude livestock[iv] - Mow grass to a minimum of 30cm tall in a 4-8m wide border adjacent to the dam's average water line - plant native shrubs, sedges and rushes along dam edge for a width of at least 4m.	-1-on-1 neighbour and stakeholder relationships [viii] -Field events	ARC	management changes are made. ***Vegetation (woody, native herbaceous & pasture)*** *-Where on-ground works are implemented &/or management changes are made*: - 'Before' and 'after' (every 2 years) photographs from	vegetation in the riparian zones of the greater Malpas catchment. Improved health and biodiversity of aquatic and riparian systems in the greater Malpas catchment. Improved ARC-NTLLS relations.	< 1 year < 1 year < 5 years
5	-Livestock access [i] -Input of sediment & nutrients[ii] -Extra sediment & nutrient inputs[ix] -Land manager or community disinterest, disengagement, resistance or inertia. -Lack of trust and respect.	High	As for Site 2.	As for Site 1.	As for Site 1.	marked points: of the watercourse and general vegetation; and of groundcover, herbage mass and composition in permanently marked quadrats	Improved ARC – landholder relations in the greater Malpas catchment.	< 5 years
6	-Livestock access [i] -Input of sediment & nutrients[ii] -Addition of wind-blown dust to dam. -Land manager or community disinterest, disengagement, resistance or inertia.	Very High	-Construct or repair stock proof fence [iii] -Exclude livestock[iv] -Provide options for off-dam stock water[v]	-1-on-1 neighbour relationships [viii] -Field events -Demonstration sites.	ARC Adjacent land managers SNELandcare	- 'Before' and 'after' (every 2 years) ground cover and species diversity measurements and assessments within stock exclusion areas,	Improved NTLLS – lessee-landholder relations in the greater Malpas catchment.	< 3 years
7	-Input of sediment and	High	-Construct stock	Adjust permit	ARC	and in paddocks with		< 5 years

	nutrients[ii], esp. from bare ground on the NW side, a denuded point- and diffuse source of sediment, sloping toward the river -Livestock access [i]		proof fence across the road reserve and TSR, on both sides of the river and road (double gates both sides may facilitate travelling stock crossing the River) at least 8m above average water height -Install off-stream stock water infrastructure (to both sides of river) -Plant dense native herbaceous vegetation and riparian shrubbery in the fenced area.	conditions as issued by Northern Tablelands Local Land Services (NTLLS). Educate & support permit holders, e.g. via -1-on-1 relationships [viii] -field events -articles in NTLLS publications to ratepayers and lessees /permit holders	NTLLS	off-stream watering facilities. ***Animal Production*** *-Where on-ground works are implemented &/or management changes are made*: Regular (at least annual) ongoing recording of weight gains, wool production, reproduction rates, parasite burdens, etc could help evaluate the benefits of providing clean water ***Attitude change and Acquisition of new skills &/or understanding*** - obtain and evaluate feedback from community consultations,	Long-term working relationships developed between ARC, NTLLS and SNELandcare. Increased capacity of land managers to utilise water and vegetation resources in and adjacent to riparian areas. Establishment of peer support groups among land managers to facilitate long-term care and maintenance of riparian areas. Demonstration of win-win outcomes and benefits to all end users.	
8	-Input of sediment and nutrients[ii],. from bare ground of quarry and biking tracks on the N of creek (similar to Site 7) ± Livestock access [i]	High Low	- Construct or repair stock proof fence [iii] on both sides of the creek in the road reserve -Exclude livestock[iv] ± plant native riparian shrubbery in the fenced riparian zone.	-1-on-1 neighbour relationships [viii] -Field events -Demonstration sites.	ARC Adjacent land managers SNELandcare			< 5 years
9	-Livestock access [i] -Input of sediment & nutrients[viii] -Land manager or community	High	-Construct or repair stock proof fence [iii] -Exclude livestock[iv]	As for Sites 1 and 6.	As for Sites 1 and 6.			< 10 years

	disinterest, disengagement, resistance or inertia.		-Provide options for off-stream stock water[v]			meetings, field events, conversations with individuals - questionnaires, feedback sessions, implicit responses, etc ***Feedback between partners, evaluation of overall project outcomes*** - Regular discussions, meetings, monitoring, assessment, evaluation, reporting and adaptive planning. Q2	Justification of partnerships for natural resource management, regardless of varied interests, core business and goals. Establishment of long-term partnerships among project partners and other organisations to facilitate ongoing protection of water supply assets in the greater Malpas catchment.	
10	-Livestock access [i] -Input of sediment & nutrients[ii] -Land manager or community disinterest, disengagement, resistance or inertia.	Medium	-Construct or repair stock proof fence [iii] -Exclude livestock[iv] -Provide options for off-stream stock water[v] -Use as a demonstration site for catchment-wide field events and to build individ. landholder relationships.	-Field events -Demonstration sites -1-on-1 relationships with lessees/neighbours [viii] - Adjustment of NTLLS lease/permit conditions.	ARC NTLLS Leaseholders Landholders involved in Site 11.			< 5 years
11	-Livestock access [i] -Input of sediment & nutrients[ii] -Land manager or community disinterest, disengagement, resistance or inertia. -Overuse of groundwater springs to provide off-stream/dam watering points.	Medium	-Construct or repair stock proof fencing [iii] -Exclude livestock[iv] -Provide options for off-stream stock water from Gara River or Guyra Dams[v]	-Field events -1-on-1 neighbour relationships [viii] -Collaborate with adj Site 10 -Establish local peer support group.	ARC NTLLS Adjacent land managers SNELandcare			
12	-Livestock access [i] -Input of sediment & nutrients[ii] -Land manager or community disinterest, disengagement, resistance or inertia.	Variable, between sites	As for Sites 6 and 9	As for Site 6.	As for Site 6.			< 10 years

[i] Livestock access - contaminating water with excrement and denuding & trampling foreshore/riparian margins.

[ii] Input of sediment & nutrients - due to denuded point-sources of soil, and diffuse overland water movement resulting from insufficient perennial ground cover and woody vegetation.

[iii] Construct or repair stock proof fence at least 8m above average water height of the dams or Gara River, or 5m either side of smaller watercourses.

[iv] Exclude livestock from fenced reservoir foreshores.

[v] Provide options for provision of off-dam stock water infrastructure on adjacent lands (to minimum necessary under current paddock arrangements).
[vi] Plant native trees and shrubs along dam side of access road (on south-west side of the lower reservoir).
[vii] Plant native trees and shrubs in strategic locations across paddocks west of the upper reservoir clumps at least 50m in diameter.
[viii] 1-on-1 relationships, with stakeholders such as water users and neighbouring or key landholders/ managers in priority areas or reaches, are best developed slowly so that trust is built and collaborative partnerships can be built between local authorities and land managers, and among groups of landholders. Aim for developing 'something in it for me', as well as understanding of benefits for long-term production and ecological processes, to motivate changes in riparian management by land managers.
[ix] Extra input of sediment & nutrients - due to soil erosion from point sources such as access roads/tracks and boat launching and deposition areas, and diffuse overland water movement resulting from insufficient perennial ground cover - especially in mown areas.

***Table 2** – Summary of specific activities, potential costs and sources of funding and/or support for on-ground works, engagement and capacity building, partnership development, and monitoring and evaluation for the protection of water assets at 12 sites in the greater Malpas catchment (as in Table 1). Cost estimates are highlighted in keeping with the Very High, High, Medium priorities for remedial action in Table 1.*

Site	On-ground Works at Specific Sites			Potential Costs* ($,000)	Other Remedial Activities			Potential Costs*	Potential Sources of Funding &/or Support
	Riparian Fencing[A]	**Off-stream Stock Water Installation[B]**	**Native Plantings[C]**		**Engagement & Capacity Building**	**Monitoring & Evaluation (see Table 1)**	**Technical Expertise Facilitation & Coordination**		
1	Construct ~8 km perimeter fencing 100m fencing + grid	~ 3 systems	2ha riparian planting	\$64+\$*75* ≅ \$140 \$1.8+\$10 ≅ \$11	Demonstration and education re benefits of exclusion of livestock from watercourses and reservoirs, and the provision of clean	Water sampling Photographic	MCAPP riparian technical officer + laboratory MCAPP riparian	≥ 0.5 FTE @ ~\$200/ sample	ARC core funds NTLLS core and project funding

	Perimeter fencing for 5 clump plantings ~ 1km x 5 ~5km		5 x 2ha paddock plantings	$40 +$50 ≅ $90	water for livestock. Engagement of, and partnership with, landholders, land managers and lessees in on-ground works and altered livestock and riparian management.	monitoring Botanical monitoring Animal production monitoring Monitoring of attitude change, acquisition of new skills & understanding Monitoring of ongoing weed and feral animal control. Evaluation of implementation of change, project progress and success.	technical Officer&/or consultants / partners MCAPP Facilitation/ coordination staff - liaison, facilitation, bridge walker/HR, applying/leveraging funding, sponsorship Administrative support for project.	@ ~$500/ site/2 yrs ≥ 0.5 FTE 15% x total project costs	Subsidies from National and State Landcare, Environmental, Infrastructure, Water/Fisheries funding opportunities Funding from philanthropic organisations Private investment by landholders & managers Sponsorship and collaboration Resource-sharing through partnership.
2	Construct ~5 km (depending on fencing design for **1** above).	-	-	$40	As for Site 1.				
3	Repair ~10 km	-	-	$30	As for Site 1.				
4	Repair/construct ~1 km	-	2ha riparian planting	$8+$10≅ $18 $10	Engage field workers to adjust mowing height. Adjust user behaviour re vehicle access and use of recreation area.				
5	Construct ~2 km	-	-	$16	-				
6	Construct ~14 km	1 or 2 systems	-	$112+$30-$60 ≅ $150-$180	As for Site 1.				
7	Construct ~0.2 km	1 system	2ha riparian planting	$2+$30+$10 ≅ $42	As for Site 1, including for Permit Holders.				
8	Construct ~0.2 km		0.5ha riparian planting	$2+$2 ≅ $4	As for Site 1, for site owners and users.				
9	Unquantified but could be planned, funded and implemented in strategically opportunistic ways			Based on Site 6 ≅ $150-$180	As for Site 1.				

10	Construct ~7 km	1 or 2 systems	-	$60+$30-$60 ≅ $90-$150	As for Site 1.				
11	Construct ~1 km	1 communal system from Guyra Dams	-	$10+$40 ≅ $50	As for Site 1.				
12	Unquantified but could be planned, funded and implemented in strategically opportunistic ways				As for Site 1.				
ESTIMATED COSTS (from above)				**Singular Costs** ≅ $370k ≅ $285k ≅ $305k				**Recurring Annual Costs** $95k 1 FTE wages + on-costs $5.6k Monitoring 15% Administration	

[A] Riparian Fencing needs to be stock proof but include access gates to provide for access to control weeds and feral animals, and otherwise manage the riparian area as ecologically appropriate. Moderate average costs for fencing materials and labour: $8k/km. N.B. distances are rough estimates/indicative only.

[B] Off-stream watering systems include a water tank on a high point to gravity feed to stock water troughs, a pump (creek/river to tank), water trough(s), poly pipe. Moderate average costs for materials and labour: @ $20-30k/system.

[C] Native plantings of locally indigenous riparian shrubs and herbaceous species for areas within 5m of reservoirs or watercourses; or locally indigenous eucalypts, wattles and understorey shrubs for paddock plantings. : @ $5k/ha.

* Reductions possible with provision of in-kind labour by land managers as part of 'positive partnerships'. Funding needed could be supplemented up to 50% from subsidies obtained through successful grant applications. Administrative costs could be provided as part of core business by local, state government or statutory bodies.

5.5 Remedial activities – monitoring and evaluation

Monitoring and evaluation will be critical in guiding the implementation of this MCAPP, and facilitating the adaptive management of continuing activities under this Plan. Monitoring and evaluation should be carried out in relation to:

- biophysical parameters such as water quality, and herbaceous and woody vegetation cover in riparian and adjacent areas;
- animal production, where stock watering systems have been hanged and access to riparian areas prevented;
- social and behavioural changes with respect to increases in knowledge and capacity to implement change to improve riparian health and water quality;
- capacity and satisfaction of staff and stakeholders to manage the process and changes in this Plan;
- operational management, progress and consequences of this Plan and projects under it;
- financial status and management of this Plan and projects under it.

Table 1, Column 7 lists some activities which could be undertaken to monitor and evaluate the effects of changed riparian management, and assess any changes in water quality and asset/infrastructure protection in the greater Malpas catchment. Potential cost estimates for these sorts of monitoring and evaluation activities are provided in Table 2

6. Funding and support

Well-coordinated, consistent and co-operative efforts will be required from a range of stakeholders to enable this MCAPP framework. Realistic and efficient development of goals and plans will require facilitation; core funding (e.g. from ARC and NTLLS) will need to be allocated to synergistically support on-ground works, engagement and capacity building, and project management and administration; and applications for grants and sponsorship will need development and submission. Core/seed funding and in-kind support from stakeholders should be used to leverage funding from other (external) sources. External funding could then be used to maximise outcomes, and public perceptions, of core funding and work simultaneously and synergistically to build on the 'core business' of local government, statutory bodies, corporate organisations, local businesses/industries and communities, private landholders and water users, and interest groups.

Initiation of this MCAPP should see stakeholders previously involved in the Malpas Catchment Group or its activities being openly and respectfully (see also section **5.4**) invited to discuss current issues in the greater Malpas catchment and to be included in considerations of this MCAPP. Where previous stakeholders no longer exist or have been superseded, they could be replaced by their successors or current equivalents.

Key stakeholders who could collaborate synergistically to support this MCAPP, while setting best practice examples for conducting aspects of their core business, include:

- ARC, e.g. as a continuation of its longstanding commitment to improving the health of water assets in the Malpas catchment;

- NTLLS, e.g. as part of its business of TSR lease and permit management, and annual Healthy Rivers funding programme – to 'walk their talk' and provide on-ground demonstration of best natural resource management practice;
- freeholders, leaseholders, permit holders and user groups of lands adjacent to Guyra and Malpas Dams and the tributaries to these dams;
- industrial and domestic water users;
- educational and research organisations;
- SNELandcare, particularly as the co-ordinator and facilitator of stakeholders and actions to implement on-ground works, engagement and capacity building, and monitoring and evaluation activities.
- NSW Premier's Department and Parliamentary Member for Northern Tablelands; and
- the Federal Parliamentary Member for New England.

Potential partners for particular on-ground works and capacity building activities are also listed in Table 1, Column 6.

Table 2 lists potential costs for remedial actions to protect the water assets of the greater Malpas catchment. Potential costs of on-ground works are estimated from approximate costs of fencing per kilometre, installation of typical off-stream stock watering systems and native plantings on a per hectare basis. Implementation of 'Very High Priority' and 'High Priority' works, including about 35km of fencing and 5 off-stream livestock watering systems, and associated engagement and capacity building, and monitoring and evaluation activities could cost around $900,000 over 5 years. However, costs of materials and labour vary widely, depending on the design of works and type of labour. Similarly costs for technical support, facilitation and co-ordination, and project management and administration may vary depending on the approaches taken. Economies are possible where resource-sharing occurs, in-kind contributions are made and efficient designs utilised.

Projected operational expenditure needed for long term maintenance of healthy riparian areas, under the jurisdiction of ARC, the NTLLS or Crown Lands, could average up to $10,000 per annum. However, co-operative approaches are, again, likely to bring reduced costs, efficiencies of scale, win-win outcomes and trusting, productive, long-term relationships.

Potential sources of funding and other support, from outside the region, for the different activities proposed under this MCAPP are also listed in Table 2. Support and funding for on-ground works, capacity building, and monitoring and evaluation activities could be sought from:

- State and Federal Government departments/agencies/programs concerned with Fisheries, Water, Environmental Protection, Primary Industries, Roads and Maritime Services, Environment and Heritage, National Landcare Program or similar, NSW Environmental Trust, Health, Rural and Remote Community issues, youth support, Premier's Department, etc;
- corporate organisations - local, national, international (e.g. Blush tomatoes, MLA, banks/financial institutions, agribusiness) – as sponsors, partners or grant providers;
- philanthropic programs, e.g. Foundation for Rural and Regional Renewal, Conservation Volunteers Australia, memorial trusts;
- community-based groups e.g. farmer/producer groups, RFS, Armidale Tree Group Inc, 'Care' groups, recreational/interest groups, CWA, Mens' Sheds; and
- educational or research organisations.

In addition, the opportunities which sponsorship partnerships could bring to this MCAPP and long-term regional development are potentially huge. Thus sponsorship is an area worthy of attention and some seed funding.

7. Forward planning – a 5-year action plan framework

Looking forward from the experience of the Malpas Catchment Project to date, SNELandcare sees the need for committed collaborative and systematically targeted best practice management of the water assets of the greater Malpas catchment. This means developing relationships and incentives which ensure the foreshores and tributaries to the water supply reservoirs for Guyra and Armidale are free of livestock and have at least 80% ground cover of at least 30 cm long 100% of the time. In addition, it is recommended that remediation of other point- and diffuse sources of sediment, nutrients and/or pollutants at sites managed by government and statutory bodies take place as a high priority. Joint incentive initiatives, with private land managers, to improve the health of riparian areas, water supply assets and adjacent lands, across the greater Malpas catchment, also need to be developed. The Memorandum of Understanding between ARC and SNELandcare could continue to be the mechanism through which a Malpas Catchment Officer is employed. This Officer requires creditable experience in riparian and water asset management, successful experience engaging land managers in new approaches to riparian management and would benefit from working with a team committed to long-term and sustainable catchment-wide asset protection.

A possible 5-year action plan framework for implementing this MCAPP is presented In Table 3. Implicit in this 5-year plan is the provision of continuing funding, under the Memorandum of Understanding between ARC and SNELandcare, for the Malpas Catchment Officer/Coordinator (MCO). Even with no increase in present funding levels for 2017-18 the MCO could commence implementation of Year 1, of the proposed 5-year plan, in 2017-18 under the current MOU between ARC and SNELandcare and in conjunction with Armidale and Guyra ARC staff responsible for water asset management.

This MCAPP will require professional management and coordination, and the recruitment of knowledgeable, experienced technical staff with good skills in best practice riparian management, human relations and participatory education.

SNELandcare has co-ordinated the Malpas Catchment Project for over 15 years and provided a facilitator for the project (using funding from ARC). Given its track record in this role, SNELandcare is well placed to undertake:

- facilitation of project partnerships, and walking the bridges between stakeholders;
- discussions with lead organisations and land managers;
- recruiting and managing suitable technical officers to conduct aspects of the MCAPP;
- management of funds and grants obtained; and
- coordination of on-ground works, engagement and capacity building, monitoring and evaluation activities, and reporting.

Once again, however, co-operative and synergistic resource sharing could yield productive efficiencies.

Table 3 *– A 5-year action plan framework for protecting water supply assets of the greater Malpas catchment*

Year	What	Who	How
1 2017 - 2018	**A**. Present & consider the 'MCAPP 2017' & establish understanding re ARC's wishes for future directions of the Malpas Catchment Project	ARC SNELandcare	Focus meeting(s)/discussion as part of joint MOU
	B. Re-engage previous stakeholders (or their successors)	SNELandcare ARC Stakeholders previously part of the Malpas Catchment Group/Committe e	Facilitated meeting to: - revisit stakeholder interests/needs - review the Malpas Catchment Management Plans of 1995 & 2005 - introduce outcomes of **A.** above & outline future action plans.
	C. Community Catchment Meeting, to: - present outcomes of **A.** & **B.** above - present options for future activities/on-ground works - seek involvement of additional stakeholders - receive community input & feedback on presentations - create framework for next steps & further community input	ARC SNELandcare	Reps from among previous stakeholders Facilitated meeting open to: - previous stakeholders - invited stakeholders not previously part of the Malpas Catchment Group/Committee - the wider community of the greater Malpas catchment.
	D. Incorporate outcomes of **A.–C**. above into this 5-year action plan framework.	SNELandcare ARC	Adjust/add to 5-year action plan, discuss, liaise.
	E.Repair and stock-proof fencing around Malpas Dam	ARC	-Engage adjoining landholders: friendly, helpful, ± developing 'something in it for me' -utilise allocated ARC funds.
	F. Increase mowing height at Malpas Dam Recreation area	ARC	Liaison and demonstration with ARC field workers.
	G. Enforce stock exclusion from Malpas Dam foreshores	ARC	Utilise currently employed ARC field officers Engage adjoining landholders: friendly, helpful, ± developing 'something in it for me'.
	H. Conduct a field event to encourage and support land managers to be more understanding of the 'what', 'why' and 'how to' of techniques for best practice water supply asset management.	SNELandcare NTLLS Private land managers	On-farm demonstrations and discussions, using leading landholders to provide peer-to-peer learning experiences and discussion
	I. Liaise with landholders betw Malpas Dam & Guyra-Ebor Rd to exclude livestock	ARC SNELandcare Private	Personal interaction – friendly, helpful, ± developing 'something in it for me' to motivate changes in riparian management

	from Malpas Dam and Gara river riparian areas. Assess need for off-stream watering system(s) Seek funding for above if needed	landholders Northern Tableland Local Land Services (NTLLS)	± Technical plans for on-ground works ± Funding applications
	J. Conduct initial water samplings and analyses at the 7 designated sites.	ARC SNELandcare NTLLS	In conjunction with private lab or UNE. Utilise recurrent funding/reallocate some of the existing funding. Seek funding/sponsorship for ongoing monitoring.
	K.Take 'Before' photographs at the sites above where management is changing. **L.** Conduct 'Before' botanical surveys and ground cover analyses at the sites above where management is changing.	ARC SNELandcare NTLLS In conjunction with UNE &/or consultants.	Utilise recurrent funding/reallocate some of the existing funding. Seek funding/sponsorship for ongoing monitoring and evaluation program.
	M. Assess existing attitudes to best practice riparian management	SNELandcare ARC	In the course of: -**C.** above - during landholder liaison while facilitating on-ground works in section **5.2.3** & activities in this table - field events (e.g. **H.** above).
2 2018 - 2019	**A.** Continue **Year 1**, **F.**, **G.** & **I.**	As under Year 1	As under Year 1, incorporating feedback from events and stakeholder liaison.
	B. Commence liaison with landholders/managers of foreshores of Guyra Dams (including NTLLS), to discuss & plan for on-ground works to exclude livestock from dam foreshores and watercourse riparian areas ± provide off-stream watering for livestock	ARC SNELandcare NTLLS	Personal interaction – friendly, helpful, ± developing 'something in it for me' to motivate changes in riparian management. NTLLS managed areas could be used as demonstration sites & involve the TSR lessees. Prepare technical plans for on-ground works. ± Funding applications.
	C. Collaborate and plan re livestock exclusion & revegetation of Guyra Dams foreshores between access road and dam waterline, from lower dam wall to upper dam wall.	SNELandcare ARC Private landholders	Personal interaction – friendly, helpful, ± developing 'something in it for me' to motivate support for revegetation. Prepare technical plans for on-ground works. ± Funding applications.
	D. Conduct a field event to encourage and support land managers to be more understanding of the 'what', 'why' and 'how to' of techniques for best practice water supply asset	SNELandcare NTLLS Private land managers	On-ground demonstrations and discussions, using leading landholders/managers to provide peer-to-peer learning experiences and discussion.

	management.		
	E. Begin collaboration and planning re stock management and options for revegetation/grazing management/fencing of Gara River TSR at Guyra-Ebor Rd and provision of off-stream watering**.**	ARC NTLLS ±SNELandcare	Discussions. Revision of grazing management/permit conditions. Technical plans for on-ground works. ± Funding applications.
	F. Conduct repeat water samplings and analyses at the 7 designated sites	ARC SNELandcare NTLLS	In conjunction with private lab or UNE. Utilise recurrent funding or funding received for the purpose. Seek ongoing funding/sponsorship for water monitoring.
	G. Take 'Before' photographs at any newly established (since Year 1) sites where management is changing. **H.** Conduct 'Before' botanical surveys and ground cover analyses at any newly established (since Year 1) sites where management is changing.	ARC SNELandcare NTLLS In conjunction with UNE &/or consultants.	Utilise recurrent funding/reallocate some of the existing funding. Seek funding/sponsorship for ongoing monitoring and evaluation program.
3 2019 - 2020	**A.** Continue **Year 1**, **F.** & **G.**	ARC	As for Year 2 + any new stakeholders, sponsors, partners.
	B. Complete exclusion of livestock from riparian zone, on private land, betw Malpas Dam & Guyra-Ebor Rd as per **Year 1, I.**).	SNELandcare Private landholders NTLLS	Complete on-ground works to fence riparian areas and install off-stream water infrastructure. Exclude stock from fenced areas.
	C. Continue liaison with landholders/managers of foreshores of Guyra Dams (including NTLLS), to discuss, plan and commence on-ground works to exclude livestock from dam foreshores and adjacent tributaries/riparian areas	As for **Year 2, B.**	As for **Year 2, B.**
	D. Conduct on-ground works in relation to **Year 2, C.** to exclude livestock from Guyra Dams foreshores between access road and dam waterline, from lower dam wall to upper dam wall, and establish native shrubs, rushes and reeds typical of healthy riparian areas of the locality.	SNELandcare ARC Private landholders	Cooperative liaison and support. Conduct fencing, ground preparation for planting, planting and plan maintenance of plantings. Exclude livestock.

	E. Conduct a field event to encourage and support land managers to be more understanding of the 'what', 'why' and 'how to' of techniques for best practice water supply asset management.	SNELandcare NTLLS Private land managers	On-ground demonstrations and discussions, using leading landholders/managers to provide peer-to-peer learning experiences and discussion. Target landholders along Ryanda Creek between Llangothlin and Guyra Dams.
	F. Assess attitudes to best practice riparian management & compare with similar assessment in **Year 1, M.**.	SNELandcare ARC	During **E.** above & while liaising with landholders/managers when facilitating other activities in this table.
	G. Continue collaboration and planning re stock management and options for revegetation/grazing management/fencing of Gara River TSR at Guyra-Ebor Rd and provision of off-stream watering**.**	ARC NTLLS ±SNELandcare ±TSR users	Discussions. Revision of grazing management/permit conditions. Technical plans for on-ground works. Funding applications.
	H. Collaborate and plan re fencing &/or revegetation of Washpool Creek adj to the quarry at Handebo's Rd-Ward's Mistake Rd corner SNELandcare	ARC Private l'holders	Discussions. Technical plans for on-ground works. Funding applications.
	I. Conduct repeat water samplings and analyses at the 7 designated sites	ARC SNELandcare NTLLS	In conjunction with private lab or UNE. Utilise recurrent funding or funding received for the purpose. Seek ongoing funding/sponsorship for water monitoring.
	J. Conduct follow-up round of photographs and botanical monitoring, repeating samplings and measurements, for sites first surveyed in **Year 1, K**. & **L.** **K.** Take 'Before' photographs at any newly established sites (since **Years 1** or **2**) where management is changing **L.** Conduct 'Before' botanical surveys and ground cover analyses at any newly established (since **Years 1** or **2**) sites where management is changing.	ARC SNELandcare NTLLS In conjunction with UNE &/or consultants.	Utilise funding/sponsorship gained in previous 2 years. Seek funding/sponsorship for ongoing monitoring program.
4	**A.** Continue **Year 1**, **F.** & **G.**	ARC	As for Year 2 + any new stakeholders, sponsors, partners.
	B. Continue liaison with landholders/managers of	As for **Year 2, B.**	As for **Year 2, B.**

2020 - 2021	foreshores of Guyra Dams (including NTLLS), to plan and conduct on-ground works to exclude livestock from dam foreshores and adjacent tributaries/riparian areas		
	C. Complete on-ground works in relation to **Year 2, C.** to exclude livestock from Guyra Dams foreshores between access road and dam waterline, from lower dam wall to upper dam wall, and establish native shrubs, rushes and reeds typical of healthy riparian areas of the locality.	SNELandcare ARC Private landholders	Cooperative liaison and support. Complete fencing & planting, plan/conduct maintenance of plantings. Exclude livestock.
	D. Commence on-ground works to restore native ground cover and riparian veg community of Gara River TSR at Guyra-Ebor Rd, and reduce livestock access to the river ± provision of off-stream watering**.**	ARC NTLLS ±SNELandcare	Works for plantings, installation of fencing and watering infrastructure. Adjust grazing permits.
	E. Complete fencing &/or revegetation of Washpool Creek adj to the quarry at Handebo's Rd-Ward's Mistake Rd corner	SNELandcare ARC Private landholders	Conduct on-ground works.
	F. Conduct a field event to encourage and support land managers to be more understanding of the 'what', 'why' and 'how to' of techniques for best practice water supply asset management.	SNELandcare NTLLS Private land managers	On-ground demonstrations and discussions, using leading landholders/managers to provide peer-to-peer learning experiences and discussion. Target landholders east of Rixon's Road, and lesees of Falconer South and Burnt Bridge TSRs.
	G. Commence plans to fence & exclude livestock from sections of Gara River in Falconer South & Burnt Bridge TSRs ± provide off-stream watering for livestock	NTLLS TSR lessees SNELandcare	Personal interaction – friendly, helpful, ± developing 'something in it for me' to motivate changes in riparian management. NTLLS managed areas could also be demonstration sites & involve the TSR lessees. Prepare technical plans for on-ground works. ± Funding applications.
	H. Conduct repeat water samplings and analyses at the 7 designated sites	ARC SNELandcare NTLLS	In conjunction with private lab or UNE. Utilise recurrent funding or funding received for the purpose. Seek ongoing funding/sponsorship for water monitoring.
	I. Conduct follow-up round of photographs and botanical monitoring, repeating	ARC SNELandcare NTLLS In	Utilise funding/sponsorship gained in previous years.

	samplings and measurements, for sites first surveyed in **Year 2, G**. & **H.**.	conjunction with UNE &/or consultants.	Seek funding/sponsorship for ongoing monitoring program.
	J. Take 'Before' photographs at any newly established sites (since **Years 1**, **2** & **3**) where management is changing **K.** Conduct 'Before' botanical surveys and ground cover analyses at any newly established (since **Years 1**, **2** & **3**) sites where management is changing.	ARC SNELandcare NTLLS In conjunction with UNE &/or consultants.	Utilise funding/sponsorship gained in previous years. Seek funding/sponsorship for ongoing monitoring program.
5 2021 - 2022	**A.** Continue **Year 1**, **F.** & **G.**	ARC	As for Year 2 + any new stakeholders, sponsors, partners.
	B. Complete/plan for completion of on-ground works to exclude livestock from foreshores and adjacent tributaries/riparian areas of Guyra Dams	ARC SNELandcare NTLLS	Personal interaction – friendly, helpful, ± developing 'something in it for me' to motivate changes in riparian management.
	C. Commence enforcement of livestock exclusion from foreshores of Guyra Dams and adjacent tributaries/riparian areas.	ARC NTLLS Local landholders & managers	Utilise currently employed ARC field officers Engage adjoining landholders: friendly, helpful, ± developing 'something in it for me'.
	D. Complete on-ground works to restore native ground cover and riparian veg community of Gara River TSR at Guyra-Ebor Rd, and reduce livestock access to the river ± provision of off-stream watering**.**	ARC NTLLS ±SNELandcare	Works for plantings, installation of fencing and watering infrastructure. Adjustment to grazing permits.
	E. Continue planning & commence on-ground works to exclude livestock from sections of Gara River in Falconer South & Burnt Bridge TSRs ± provide off-stream watering for livestock	NTLLS TSR lessees SNELandcare	Personal interaction – friendly, helpful, ± developing 'something in it for me' to motivate changes in riparian management. Jointly undertake on-ground works. Utilise sites for demonstration to adjacent landholders. ± Funding applications.
	F. Conduct a field event to showcase examples of completed works which demonstrate the 'what', 'why' and 'how to' of best practice water supply asset management. *and* seek community input for planning targets for the next 5 years	SNELandcare NTLLS Private land managers General community	On-ground demonstrations and discussions, using leading landholders/managers to provide peer-to-peer learning experiences and discussion. Target greater Malpas catchment and beyond.

	G. Assess attitudes to best practice riparian management & compare with similar assessments in **Year 1, M.** & **Year 3, F.**.	SNELandcare ARC	During **F.** above & while liaising with landholders/managers when facilitating other activities in this table.
	H. Conduct repeat water samplings and analyses at the 7 designated sites *and* evaluate water sampling results, & any changes in water quality, over the last 4 years	ARC SNELandcare NTLLS	In conjunction with private lab or UNE. Utilise recurrent funding or funding received for the purpose. Seek ongoing funding/sponsorship for future water monitoring.
	I. Conduct follow-up round of photographs and botanical monitoring, repeating samplings and measurements, for sites surveyed in **Year 1**, **K**. & **L.** and **Year 3**, **J**. & **K.**	ARC SNELandcare NTLLS In conjunction with UNE &/or consultants.	Utilise funding/sponsorship gained in previous years. Seek funding/sponsorship for ongoing monitoring program.
	J. Take 'Before' photographs at any newly established sites (since **Years 1**, **2**, **3** & **4**) where management is changing **K.** Conduct 'Before' botanical surveys and ground cover analyses at any newly established (since **Years 1**, **2**, **3** & **4**) sites where management is changing.	ARC SNELandcare NTLLS In conjunction with UNE &/or consultants.	Utilise funding/sponsorship gained in previous years. Seek funding/sponsorship for ongoing monitoring program.

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APPENDIX 1

Current issues affecting water quality in Malpas and Guyra Dams

Sediment accumulation within water storages

All rivers contain sediments: a river, in effect, can be considered a body of flowing sediments as much as one of flowing water. When a river is stilled behind a dam, the sediments it contains sink to the bottom of the reservoir, so causing the dam to gradually lose its ability to store water. While the trap efficiency of Guyra and Malpas Dams is unreported, the precautionary principle of Ecologically Sustainable Development (ESD), coupled with climate change and future increased water demand and water security, suggest that activities which slow the rate of sediment accumulation would be beneficial to the long term viability of current water storage infrastructure.

> *The long term outcomes of the Malpas Catchment Asset Protection Plan 2017-22 will postpone the requirement for costly civil water storage upgrades, compulsory land acquisition, and provision of fish passage (as triggered by s218 of the Fisheries Management Act 1994).*

The Gara River between the two storages exhibits signs of sediment starvation, a likely result of sediment entrapment within the upstream Guyra Dams. Sediment deficiency downstream of the Guyra Dams may be the cause of channel incision by the Gara River and also leads to the hypothesis that the origin of the bulk of suspended sediment into Malpas Dam originates from overland flow from adjoining land between the reservoirs and smaller tributaries from this area. This geomorphic process is exacerbated by significant areas of unrestricted stock access to waterways, lack of riparian vegetation, land use beyond its capability (NSW OEH, 2012) and at times poor ground cover. For example, land to the east of Malpas Dam has been mapped as land and soil capability class 6[1], yet parts are cultivated and much is overgrazed.

Water quality

Malpas Dam and Guyra Dams are the primary sources of raw water for Armidale and Guyra respectively. For many years there have been problems with algae, with a number of significant blooms. If not dealt with these blooms cause taste and odour problems in the treated water and in the extreme may have an impact on human health (Keogh and Brooks, 2009). The process for algal bloom formation is well documented (Boulton and Brock, 1999; Rhaman *et al*. 2005) and it is accepted that the same processes which lead to sediment accumulation are also major pathways for nutrient input. Therefore the process of ameliorating sediment input will also reduce nutrient input. While water treatment is suitably established to deal with these issues, the proposed land management works and capacity building activities to ameliorate sediment and nutrient accumulation within the dams will also be beneficial to water treatment costs in the long-term.

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[1] LSC class 6— Very severe limitations. Land incapable of sustaining many land use practices (e.g. cultivation, moderate to high intensity grazing and horticulture). Highly specialised practices can overcome some limitations for some high value products. Land often used for low intensity land uses (e.g. low intensity grazing).

Point source pollutants

Point sources of pollution include disused quarries, severe gully erosion, severe bank slumping, stock access points and unsealed roads.

Disused or unregulated quarries and unsealed roads are a direct source of sediment input to waterways during rainfall events.

Bank slumping and erosion are indicative of lack of deep rooted perennial vegetation and unrestricted stock access.

Diffuse source pollutants

Diffuse sources of pollution include dam foreshores and upstream agricultural land with frontage to tributary waterways of Malpas and Guyra Dams.

Unrestricted livestock access contributes to degradation of riparian areas leading to erosion and sediment and nutrient input throughout much of the catchment.

Much of the catchment is devoid of native perennial vegetation leading to greater rates of wind erosion, soil degradation and nutrient and sediment input to waterways.

Disengaged rural community

Despite the efforts of the Malpas Catchment Officer and SNEL, only a small minority of landholders in the catchment are implementing effective best management practice techniques for waterway management on a long term basis. This is due to a variety of reasons, including a lack of resources, inability to run stock numbers sufficient to provide adequate income and lack of landholder willingness to participate in activities and events. It has been noted that landholders in the catchment have an unfavourable perception of the former Armidale Dumaresq Council. Landcare provides a platform as an apolitical non-government organisation (NGO) to reduce those barriers and foster a more unified effort of relevant land managers, management authorities and private landholders.

Land use and vegetation

There are a variety of land uses within the catchments for Malpas and Guyra Dams. The most prevalent being beef cattle and cross-bred sheep production on improved pastures. Most pastures have been 'improved' through the addition of phosphate and nitrate based fertilisers, and exotic pasture species, for several decades. There are also areas of cereal cropping and potato production in the northern, steeper part of the catchment (Woods, 2004). This example of intensive land use also provides a key focus area for undertaking a long term strategy to promote improved land management practices for the benefit of asset protection.

Woodland, grasses and riparian vegetation have been significantly cleared throughout the catchment for primary production. Healthy riparian corridors possess an unusually diverse array of species and environmental processes. Their value to aquatic and terrestrial ecosystems is well documented, including provision of: habitat, in an otherwise significantly cleared rural landscape; stream stabilisation; water quality regulation; large woody debris replenishment; and provision of geomorphic and hydraulic complexity. Increasing the extent of rehabilitated riparian areas provides environmental benefits to landholders and the wider community.

Intact riparian vegetation (perennial tussock grasses and woody plants) is an effective above and below-ground filter that traps diffuse sediment and nutrients from surrounding land before reaching waterways. Riparian vegetation also binds stream banks, minimising erosion and making them more resilient to the erosive power of high flow events. Additionally, Bird (1992) states that in semi-arid and dry temperate areas planting of 5% of the land to shelter can reduce wind speed by 30-50% and soil loss by up to 80%. Also, the maintenance of at least 80% ground cover with a minimum plant height of 4 cm significantly reduces overland water flow and loss of sediment and nutrients to waterways. Where the soil is left unprotected, up to 100 t/ha of valuable topsoil can be lost in a year (1 mm depth of soil over one hectare weighs around 10 t) (Murphy and Lodge, 2002).

> *Catchment scale management of waterways and riparian areas therefore also provides significant benefits to water storage managers by minimising sediment and nutrient input, and increasing dam lifespans, long term benefits to water quality, treatment costs and consumer satisfaction i.e. delivering long term social and economic benefits to the community.*

APPENDIX 2

Background information for the twelve sites prioritised for specific remedial intervention

Site 1 – Guyra Reservoir Foreshores

Location – Two in-stream reservoirs contained by dam walls, one about 450 m downstream of the other, provide the water supply reservoir (Guyra Dams) for the township of Guyra. The reservoirs are located between 30.144264°S, 151.702734°E at their northern end and the lower, most southern, dam wall at 30.157280°S, 151.710855°E.

Issues – The main issues at this site are:

- livestock access, contaminating water with excrement and denuding and trampling foreshore margins;
- input of sediment and nutrients due to denuded point-sources of soil; and
- diffuse overland water movement resulting from insufficient perennial ground cover and woody vegetation (see Table 1).

Upper Guyra Reservoir. *Photo: C Carruthers, 2016.*

Lower Guyra Reservoir. *Photo: C Carruthers, 2016.*

Risk Rating – High.

Risk Assessment – The likelihood of the above issues occurring is 100%, and they have occurred for most of the time since the construction of the Guyra Dams, with increases in input of excreta, sediment and nutrients at times of heavy rain. The consequences are that sedimentation of the reservoirs, and inputs of soil nutrients and animal excreta, have been fairly continuous since construction of the dams. Nutrient inputs would be raised above 'average' when rain events occur following fertiliser applications. Sediment and nutrient inputs would be raised with rain events, particularly heavy precipitation, following dry times and increased effective levels of grazing impact.

Recommended Management Options - See Tables 1 and 2.

Site 2 – Entrant Watercourses to Guyra Reservoir

Location –Approximately nine semi-permanent or intermittent watercourses feed water into Guyra Dams from the adjacent catchment. Some of these watercourses run down a fairly flat gradient and their entry to the Dam is slow and surrounded by reasonable vegetation cover. These entrants are less likely to contribute large amounts of sediment to the reservoirs but may carry dissolved nutrients. Other entrants to Guyra Dam run off steeper land and/or land that has minimal ground cover vegetation. Water from these entrants is likely to contribute sediments, nutrients and animal excreta to the Dams. The main watercourses entering the Guyra reservoirs do so at:

30.156777°S, 151.71001°E;
30.154017°S, 151.706760°E;
30.145287°S, 151.700366°E;
30.143594°S, 151.704126°E;
30.146841°S, 151.705666°E;
30.152292°S, 151.709056°E;
30.152579°S, 151.709695°E;
30.153335°S, 151.710446°E; and
30.154838°S, 151.711025°E.

Issues – The main issues at this site are:

- livestock access contaminating water with excrement, and denuding and trampling watercourse and dam margins;
- input of sediment and nutrients due to soil erosion from point source bed lowering (or similar) and diffuse overland water/sediment movement (see Table 1).

Bed-lowering of a tributary watercourse to Guyra Dams, due to stock access and lack of ground cover is a source of sediments and nutrients. *Photo: C Carruthers, 2016.*

Risk Rating – Medium to Very High, depending on the gradient of the watercourse and level of adjacent grazing pressure.

Risk Assessment – The likelihood of the above issues occurring is 100%, and they have occurred for most of the time since the construction of the Guyra Dams, with increases in input of excreta, sediment and nutrients at times of heavy rain. The consequences are that sedimentation of the reservoirs, and inputs of soil nutrients and animal excreta, have been fairly continuous since construction of the dams. Nutrient inputs would be raised above 'average' as a result of rain events following fertiliser applications. Sediment and nutrient inputs would be raised with rain events, particularly heavy precipitation, following dry times and increased effective levels of grazing impact.

Recommended Management Options – See Tables 1 and 2.

Site 3 – Malpas Dam Foreshores

Location – Malpas Dam is located between 30.254159°S, 151.748211°E, at its northern end, 30.27221°S, 151.729851°E at its western entrant from Urandangie Creek and 30.28985°S, 151.737258°E at the dam wall at its southern end. The foreshores of Malpas Dam are fenced, for a width varying from about 10 m to 150 m, from adjoining freehold land for the entire circumference of the Dam.

Issues – In principle, the fenced foreshore area around Malpas Dam is intended to be kept free of livestock and other activities which reduce the vegetation cover, expose soil and/or deposit nutrients adjacent to or into the Dam. Despite these intentions livestock are allowed to access some of the Malpas Dam foreshores. This causes direct contamination of dam waters with animal excreta, reduces ground cover to less than that necessary to filter sediment and nutrients from overland water flows, prevents vegetation roots from extending deep enough to facilitate water infiltration of the soil and causes erosion of the edges of the entrant watercourses and Dam edges. As a result, the main issues at Site 3 are:

- livestock access contaminating water with excrement, and denuding and trampling foreshore margins; and
- input of sediment and nutrients due to denuded point-sources of soil, and diffuse overland water movement resulting from insufficient perennial ground cover and woody vegetation (see Table 1).

Over grazed Malpas foreshores – a source of sediment, nutrients and animal excreta. *Photo: R Trémont, 2015*.

Upper Malpas Dam foreshores, fenced and over-grazed along the water's edge. *Photo: R Trémont, 2015.*

In addition, Trémont (Malpas Foreshores Assessment, May-June 2015) reported that there are areas of high conservation value grassy vegetation in some parts of the Malpas Dam foreshores, and these could be managed for the conservation of the grassy communities and rare species they contain.

Austral Toadflax (*Thesium australe*), an endangered plant, in high conservation value grassy vegetation on Malpas Dam foreshores. *Photo: R Trémont, 2015.*

Ben Lomond/Glencoe Paper Daisy (*Xerochrysum* sp.), a rare plant, in high conservation value grassy vegetation on Malpas Dam foreshores. *Photo: R Trémont, 2015.*

Risk Rating – Very High.

Risk Assessment – The likelihood of the above issues occurring varies with the section of foreshore, the integrity of the fence and/or the livestock management action or inaction of the adjacent land manager. However, certain adjacent landholders are more inclined to put stock into the dam foreshore areas to access water or additional pasture than others, and this has varied since the construction of the Dam. Increases in input of excreta, sediment and nutrients will occur at times of heavy rain. The consequences are that sedimentation of Malpas Dam, and inputs of soil nutrients and animal excreta, will have been fairly continuous from some adjacent lands and have had pulses of extra input over time. Nutrient inputs would be raised above 'average' as a result of rain events following fertiliser applications. Sediment and nutrient inputs would be raised with rain events, particularly heavy precipitation, following dry times and increased effective levels of grazing impact.

Recommended Management Options – See Tables 1 and 2. If livestock could be excluded from the dam foreshores, the perennial grassy vegetation (in most locations around the dam foreshores) provides an excellent filter to minimise entry of nutrients, sediment and livestock excreta, from grazing lands on the other side of the foreshore fence. Established tree plantings and remnant woodland on the south-eastern and southern foreshores (respectively) also contribute to filtering water inputs, and providing biodiverse habitat areas and aesthetic appeal.

Site 4 – Malpas Dam Foreshores, at recreation area

Location – A section of the fenced Malpas Dam Foreshores area, between the Dam and grazed freehold land, is used as a recreation area. This recreation area is located on the south-western foreshores of Malpas Dam, between 30.28119°S, 151.73526°E and 30.283716°S, 151.735667°E. It is accessed, through private property and a locked gate, from the New England Highway at Black Mountain via Malpas Dam Road.

Issues – Impacts from human use of the Recreation Area are of primary concern at this site but grazing livestock also access this area and add to the human impacts. The main issues at this site are:

- mowing and trampling of ground cover so that it is absent or insufficient in height and density to minimise the entry of sediment, nutrients and animal excreta into Malpas Dam;
- livestock access contaminating water with excrement and denuding and trampling foreshore margins; and
- input of sediment and nutrients due to denuded point-sources of soil, and diffuse overland water movement resulting from insufficient perennial ground cover and woody vegetation (see Table 1).

Exposed erosion-prone point-source of sediment, Malpas Dam Recreation Area. *Photo: R Trémont, 2015.*

Exposed erosion-prone point-source of sediment and pollutants, adjacent to boat sheds at Malpas Dam Recreation Area. *Photo: R Trémont, 2015.*

Risk Rating – High.

Risk Assessment – The likelihood of the above issues occurring is 100%, and they have occurred for a considerable period of time, since the development of the Recreation Area of Malpas Dam, with increases in input of sediment and nutrients in times of heavy rain. The consequences are that inputs of sediments, soil nutrients and animal excreta, from this site contribute fairly continuously to these issues for the Dam as a whole. Inputs would be raised with rain events, particularly heavy precipitation and following dry times. The likelihood of the issues occurring as a result of livestock being in the Recreation Area varies with the livestock management actions of the adjacent land manager, in combination with the prevailing water levels in the Dam and the occurrence of rain events.

Recommended Management Options – See Tables 1 and 2.

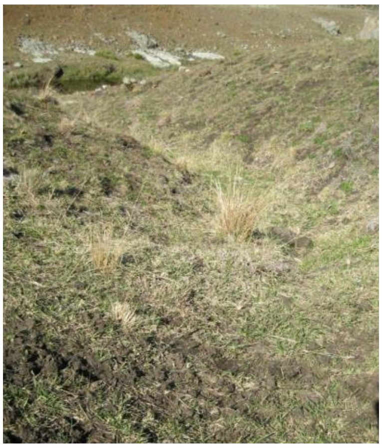
Site 5 – Entrant watercourses to Malpas Dam

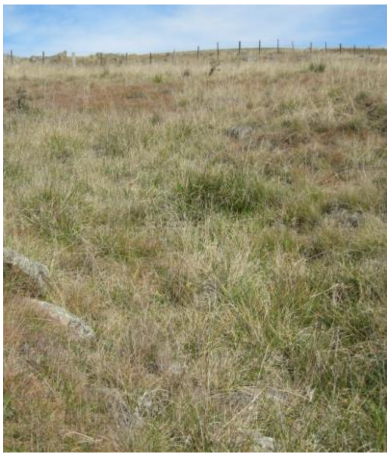
Location – About 30 small semi-permanent to intermittent watercourses feed water into Malpas Dam from the adjacent catchment, with about 60% of these tributaries occurring on the eastern/north-eastern side of the Dam. Some of the tributary watercourses run down a fairly flat gradient and their entry to the Dam is slow and surrounded by reasonable vegetation cover. Other entrants to Malpas Dam run off steeper land and/or land that has minimal ground cover vegetation.

Issues – The main issues at Site 5 are:

- livestock access contaminating water with excrement and denuding and trampling watercourse and foreshore margins;
- input of sediment and nutrients due to soil erosion from point source bed lowering (or similar) and diffuse overland water movement.

Overgrazed perennial ground cover of tributaries (background) and foreground on northern Malpas Dam foreshores. *Photo: R Trémont, 2015.*





Overgrazed groundcover (left) Vs adequate groundcover (right) in tributaries entering Malpas Dam. *Photos: R. Trémont, 2015.*

Risk Rating –High.

Risk Assessment - The likelihood of the above issues occurring is 100%, when livestock are allowed to access the Malpas Dam foreshore areas. The consequences are that sedimentation of the dam, and inputs of soil nutrients and animal excreta occur in pulses or semi-continuously. Sediment and nutrient inputs would be raised with rain events, particularly heavy precipitation or in those instances following fertiliser application of adjacent lands, and following dry times and increased effective levels of grazing impact.

Recommended Management Options – See Tables 1 and 2. If livestock could be excluded from the dam foreshores, the perennial grassy vegetation (in most locations around the dam foreshores) provides an excellent filter to minimise entry of nutrients, sediment and livestock excreta, from grazing lands on the other side of the foreshore fence. Established tree plantings and remnant woodland on the south-eastern and southern foreshores (respectively) also contribute to filtering water inputs, and providing biodiverse habitat areas and aesthetic appeal.

Site 6 – Landholdings adjacent to Gara River, between Malpas Dam and Guyra-Ebor Road

Location – The Gara River and its adjacent riparian areas and tributary watercourses, from the northern end of Malpas Dam at 30.254159°S, 151.748211°E to the Guyra-Ebor Road at 30.211462°S, 151.727646°E, are utilised directly by private landholders.

Issues – The main issues at this site are:

- livestock access contaminating water with excrement and denuding and trampling foreshore and watercourse margins;
- input of sediment and nutrients due to stock accessing river, denuded point-sources of soil, and diffuse overland water movement; and
- insufficient groundcover on land adjacent to and adjoining the riparian area.

Overgrazed private land south of the Guyra-Ebor Road and adjacent to the Gara River above Malas Dam provides a diffuse source of sediment, nutrients and animal excreta to Gara River, its tributaries and Malpas Dam. *Photo: R Trémont, 2015.*

Risk Rating – Very High.

Risk Assessment – The likelihood of the above issues occurring is 100%, and they have occurred, along this section of river, to a high degree for many years. In addition to 'baseline' inputs of sediment, nutrients and animal excreta, these inputs would increase very significantly from the overgrazed lands during times of heavy rain. Nutrient inputs along this section would be even larger when rain events follow fertiliser applications.

Recommended Management Options – See Tables 1 and 2.

Site 7 – Unfenced TSR on Guyra-Ebor Road, at Gara River

Location – The unfenced TSR on both sides of the Gara River, on both sides of the Guyra-Ebor Road, is a contributor of sediment, nutrients and animal excreta to the water supply of Malpas Dam. The priority area of the unfenced TSR at the Gara River crossing of the Guyra-Ebor Rd is the relatively bare western side of the Gara River located at 30.211416°S, 151.726633°E.

Issues – The main issue at Site 7 is that:

- little groundcover on areas (especially on the north-western side) sloping toward the river provides a point-sources of sediment and nutrients for the river via overland water runoff.

In addition, this whole site is used to water livestock accessing this part of the Guyra-Ebor TSR, further exacerbating the lack of vegetation cover and contributing to pollution of the river.

Gara River, on TSR at Guyra- Ebor Road bridge, looking downstream from water metering shed, across the inadequate perennial vegetation & groundcover of this riparian area. *Photo: R Trémont, 2014.*

Risk Rating – High, although would have a lower risk rating if the riparian areas of Site 6 were well vegetated and protected from livestock.

Risk Assessment – The likelihood of the above issues occurring is 100%, and they have occurred, along this section of river, for many years. In addition to 'baseline' inputs of sediment, nutrients and animal excreta, these inputs would increase very significantly from the bare or poorly covered areas of land at this site during times of heavy rain.

Recommended Management Options – See Tables 1 and 2.

Site 8 – Quarry adjacent to Washpool Creek, just south of the corner Handebo's Road and Ward's Mistake Road

Location – The quarry, just south of the corner of Handebo's Road and Ward's Mistake Road, is located at 30.205895°S, 151.71697°E. At its southern end the quarry adjoins about 80 m of Washpool Creek, which is one of the larger tributaries (crossed by the Wards Mistake Road) to the Gara River.

Issues – The main issue at Site 8 is:

- the bare ground of the quarry (a denuded point-source of sediment maintained by dirt biking and low fertility soil) which slopes toward the creek and has inadequate vegetation cover to filter overland water runoff of sediment input to the creek.

Quarry adjacent to Washpool Creek just south of the cnr of Handebo's & Wards Mistake Rds, looking south. *Photo: R Trémont, 2014.*

Washpool Creek receives water & sediment from the quarry south of the cnr of Handebo's & Wards Mistake Roads, looking south. *Photo: C Carruthers, 2016.*

Risk Rating – Medium to High.

Risk Assessment – The likelihood of the above issues occurring is 100%, and all the more so following gravel removal from the quarry or dirt biking activities on the site. In addition to 'baseline' levels of sediment and nutrient input, these inputs would increase very significantly from the bare or poorly covered areas of land of this site during times of heavy rain. Livestock may occasionally graze this site, with a resultant additional input of animal excreta to the creek.

Recommended Management Options – See Tables 1 and 2.

Site 9 – Ryanda Creek, downstream from the New England Highway bridge at Llangothlin

Location – This section of Ryanda creek is located between the bridge on the New England Highway at 30.121618°S, 151.690332°E and the downstream timbered area from 30.144029°S, 151.696393°E to Guyra Dams. Of particular concern is the 400-500 m immediately downstream of the bridge to about 30.127232°S, 151.687169°E.

Issues – The main issues at this site are:

- livestock access contaminating water with excrement and denuding and trampling watercourse margins;
- input of sediment and nutrients due to scalded/denuded soils providing point sources of nutrients adjacent to the creek; and
- diffuse overland water movement carrying sediments to the river due to lack of ground cover.

Livestock access to Ryanda Creek and nearby areas has exposed creek bank slumping and reduced adjacent groundcover. Looking downstream from the bridge on the New England Highway, Llangothlin. *Photo: R Trémont, 2014.*

Risk Rating – Medium.

Risk Assessment – The likelihood of the above issues occurring is 100%, and they have occurred, along this section of river, to a high degree for many years. In addition to 'baseline' inuts of sediment, nutrients and animal excreta, these inputs would increase very significantly from the overgrazed lands during times of heavy rain. Nutrient inputs along this section would be even larger when rain events follow fertiliser applications.

Recommended Management Options – See Tables 1 and 2.

Site 10 – Burnt Bridge and Falconer South TSRs adjacent to Gara River

Location – This section of Gara River is located between 30.173442°S, 151.721102°E, its southern location in Burnt Bridge TSR, and a northern location at the southern end of Guyra Dams at 30.157280°S, 151.710855°E. Access to these TSRs is via Albert Street (off Falconer Road) and/or Everetts Road (off New England Highway).

Issues – The issues at Site 10 are:

- livestock access to Gara River and tributary watercourses, contaminating water with excrement and denuding and trampling watercourse margins;
- input of sediment and nutrients due to diffuse overland water movement; and
- channel incision by the river, possibly due to sediment deficiency downstream of Guyra Dams (see Appendix 1).

However, some sections of Site 10 have the components of healthy riparian lands and may respond well to decreased stocking rates. If fenced, in conjunction with riparian land managed by landholders adjacent to the Guyra Reservoirs and/or along Rixon's Road (see under Sites 1 & 2 above and Site 11 below), these riparian areas within the TSRs could be used as demonstration sites of best practice management.

Unmaintained fences between Falconer South TSR and Guyra Dams allow stock access to Guyra Reservoir foreshores. *Photo: R Trémont, 2014.*

Gara River looking upstream from the crossing in Burnt Bridge TSR. Overgrazing with livestock has denuded and trampled river margins. *Photo: R Trémont, 2014.*

Gara River looking downstream from some distance below Guyra Dams stream. Overgrazing by livestock has denuded and trampled river margins, but if fenced from regular grazing it has all the components to make a healthy riparian area. *Photo: R Trémont, 2014.*

Risk Rating – Low to Medium.

Risk Assessment – The likelihood of the above issues occurring is high, and they have occurred for much of this length of river since the TSRs have been stocked more-or-less continuously. The levels of input of excreta, sediment and nutrients would increase in times of heavy rain, particularly for nutrient inputs when rain events follow fertiliser applications.

The risk rating for this site is comparatively lower than for other sites because stocking rates are relatively low, the ground has not been worked for cropping or improved pasture establishment, native perennial herbaceous and woody vegetation is still dominant and rocky areas reduce water runoff rates.

Recommended Management Options – See Tables 1 and 2.

Site 11 – Landholdings on the western side of Gara River along Rixon's Road

Location – The Gara River and its adjacent riparian areas and tributary watercourses, between the corner of Falconer Road and Rixon's Road at 30.185631°S, 151.704570°E and the access gate to Guyra Reservoirs on Rixon's Road at 30.157587°S, 151.710209°E, are managed by private landholders.

Issues – The main issues at Site 11 are:

- livestock access contaminating water with excrement and denuding and trampling watercourse margins
- lack of water in Gara River, for livestock, when there is no flow over the lower wall of Guyra Dams;
- channel incision by the river, possibly due to sediment deficiency downstream of Guyra Dams (see Appendix 1); and
- input of sediment and nutrients due to diffuse overland water movement.

Some landholders at Site 11 have already constructed fences excluding their livestock from the adjacent Gara River/TSR on their eastern boundaries. If also fenced on the TSR side, these riparian areas could be used as demonstration sites of best practice management (see also Site 10 above).

Landholdings along Rixon's Rd (left and mid/rear of photo) have fenced along the Gara River on their east. If the river, here in Falconer South-Burnt Bridge TSR were fenced on its eastern side the health of this riparian area could be restored. *Photo: R Trémont, 2014.*

Risk Rating – Medium.

Risk Assessment – The likelihood of the above issues occurring is high where the Gara River remains unfenced, and they have occurred for much of this length of river since the construction of the Guyra Dams, with increases in input of excreta, sediment and nutrients in times of heavy rain, particularly for nutrient inputs when rain events follow fertiliser applications.

However, demands on the Gara River by land managers at this site are limited by the flows over the lower wall of Guyra Dams. Landholders have built dams on their properties in lieu of access to the River, so reducing the need for direct stock access to the River - but depleting water supplies from underground springs.

Recommended Management Options – See Tables 1 and 2.

Site 12 – Other sections of private land along Gara River and Ryanda Creek

Location – Multiple and/or semi-continuous locations and lengths of Gara River and Ryanda Creek (other than those dealt with above) between the northern end of Malpas Dam at 30.254159°S, 151.748211°E and the northern end of the greater Malpas catchment at about 29.998°S, 151.694°E, north of Inn Road between the New England Highway and the Old Ben Lomond Rd.

Issues – The main issues of concern at the above sites are:

- livestock access contaminating water with excrement and denuding and trampling watercourse margins; and
- input of sediment and nutrients due to diffuse overland water movement.

Bank slumping and erosion of banks of upper Ryanda Creek. *Photo: R Trémont, 2014.*

Livestock exacerbate bank slumping and erosion of creek banks of Native Dog Gully, downstream of Native Dog Gully TSR (*cf* photo on p.10). *Photo: R Trémont, 2013.*

In the upper reaches of the greater Malpas catchment (upstream of the bridge over Ryanda Creek, at 30.121618°S, 151.690332°E, on the New England Highway just north of Llangothlin) some watercourses arise and seep downstream through almost flat boggy areas, which form useful filters. These filtration areas would be enhanced in this role if livestock were excluded from them.

An A flat boggy riparian area high in the greater Malpa
catchment near Ben Lomond. *Photo: B Ballard, 2013.*

A flat boggy riparian area high in the greater Malpas catchment, Ben Lomond locality. *Photo: R Trémont, 2015.*

A flat boggy riparian area opened to ‘pond’ water for livestock, with consequent bank slumping and erosion resulting. *Photo: Anonymous, 2014.*

Risk Rating – Low to High.

Risk Assessment – The likelihood of the above issues of concern occurring at a variety of sites is moderate, and they are likely to have occurred to varying degrees since pastoralism began in the area. Furthermore, the levels of input of excreta, sediment and nutrients would increase in times of heavy rain, particularly for nutrient inputs when rain events follow fertiliser applications.

However, the risk rating (and level of prioritisation for remediation) for these sites is comparatively low, as they are located high in the catchment and if sites closer to the water supply reservoirs were remediated first the latter would act as effective filters for water coming from higher in the catchment. Nevertheless, removal of livestock from riparian areas high in the catchment would see improved water quality for local use.

Recommended Management Options – See Tables 1 and 2.