5 BOOROWA CATCHMENT ISSUES

Environmental issues such as land and water degradation are complex and often interrelated. The main environmental issues that affect the Boorowa Catchment are:

- **Dryland salinity**
- **Native vegetation and biodiversity decline**
- **Soil acidity, erosion and soil structure decline**
- **Water quality decline**

Downstream water users from the Boorowa Catchment are also affected due to declining water quality in the Lachlan River, as the result of salt and sediment load from the Catchment.

5.1 Dryland Salinity

Dryland salinity is a widespread problem, and has occurred where saline watertables rise, bringing salt to the soil surface. Indicators of dryland salinity are waterlogged areas that establish salt tolerant plants such as couch grass, sea barley grass, strawberry clover and spinney rush. Dead or dying trees in depressions or bare ground (scalding) are also significant indicators of dryland salinity outbreaks. Salt crystals on the soil surface are often evident during dry periods.

The main issues for management are: Loss of productivity from affected sites; and offsite impacts. When considering the affect of salinity management actions on our landscape and river systems, it is important to think about the impact of increased vegetation on reducing runoff, thus increasing stream salinity concentrations. Another consideration worthy of thought is the possible impact of extracted/drained groundwater on stream salinity concentrations. It is important to consider the affect of remediation works in relation to Catchment scale issues such as this, and come to a balanced strategy or approach. A clear understanding of water balance within our Catchment is also required to enable the formation of useful, targeted, salinity abatement strategies.

There are several definitions of ‘saline’ water. The Australian desirable standard for drinking water is 800 EC. Although water starts tasting salty around 1700 EC, it is safe to drink, but not for long periods of time. Aquatic biologists define water as saline at 5000 EC. If salinity is 10,000 EC or above the growth of trees is severely impeded.

What causes dryland salinity ?

The reduction of vegetation, through clearing or grazing, over the last 200 years, has reduced the amount of rainfall being utilised by vegetation on the surface. The rainfall then leaks below the root zone (recharge), and adds to the water tables. As water tables rise, salt is bought to the surface (discharge) killing vegetation and leading to soil erosion and degradation (Nicholson and Wooldridge, 2000).

To achieve widespread (catchment scale) control of dryland salinity, it is recognised that recharge control is the most significant factor in addressing the cause of this issue. In understanding why the current landscape is “leaking” we must look at the base resource - our soil. Although current Best Management Practice focuses on vegetation as the key to control recharge, the soil plays an equally major role. Through improving soil structure and organic matter, our soils will become healthier and provide a ‘sponge’ to retain and use water in the landscape and support more vegetation to restrict recharge.

The challenge in dryland salinity management is to decrease groundwater recharge rates and to identify the key salt storage areas and flow paths in the landscape. Various management options can then be employed to target exactly where management strategies such as planting deep rooted trees, healthy perennial pastures, and using engineering solutions such as drainage control, will be most effective. This will enable the most efficient use of funds by very specific targeting of the areas at greatest risk of salinisation.

The signs and symptoms of a rising watertable and surface salts are:

- *Reduced yields and productivity*
- *Decline in plant growth*
- *Decline in water quality*
- *Waterlogging*
- *Change in species, favouring salt tolerant varieties*
- *Increased erosion hazard*
- *Dead and dying native vegetation.*
- *Bare patches - scalding*

Saline areas (discharge) areas are very visible and are a concern to the community, however there are many management strategies that can be applied to regain some economical return from the land (Packer, 2002). Moderately affected areas can support highly productive salt-tolerant pastures.

Groundwater Systems

The groundwater system in the Catchment is characterised by a large number of small, local flow systems, usually correlating very closely with topographical catchments. Two distinct types of aquifers have been identified.

- Shallow soil/weathered zone system
- Deeper fractured rock system

Both aquifers can be unconfined to semi-confined in nature, and are local in distribution. That is, the aquifers recharge and discharge in close proximity (usually within 2-5 km), and this generally means that inter-valley or Catchment flow of groundwater is non-existent (Evans & Bradd, 2001).

Soil/weathered zone aquifer system

The upper weathered bedrock and overlying soil form a shallow, unconfined aquifer system. It is generally discontinuous and restricted to the mid to lower parts of the landscape, with a maximum thickness of about 10 metres. The aquifer can contain a series of perched aquifers in the upper levels of the aquifer, due to presence of basal clay aquitards, with low permeability. This aquifer system contains the major salt store in the catchment.

Fractured rock system

The fractured rock aquifer system can be found over the entire Catchment. The three main rock types of the catchment - volcanics, sediments and granites –are all fractured to the extent that they will transmit water and function as aquifers. The granites generally have higher lateral hydraulic conductivity than the volcanic units.

Generally, bore yields are low, usually less than 1 L/sec everywhere. Some exceptions exist, usually related to cavernous interbeds of limestone found in the volcanic sequences. Here yields may vary up to 10 L/sec or so. Bores range in depth from 10 to 100 m below ground level (Evans & Bradd, 2001). As with studies elsewhere in fractured rock aquifers of the central and southern parts of New South Wales most bores intersect their major water supplies in the top 50m or so.

Recharge and Discharge

Recharge to the fractured rock aquifer occurs over most of its surface extent. The soils of the Boorowa Catchment are such that they are all reasonably permeable and will allow some form of deep drainage to occur below the root zone. Generally, the more permeable soils can be found on the higher slopes and these are implicated as being sites for very high rates of recharge. Bore hydrographs in these places will show rapid filling response to winter rainfall, equally rapid draining during summer months. This water is transmitted to lower parts of the landscape, and added to by deep drainage from the soils in these lower parts.

Groundwater discharges from the aquifer generally in the lowest parts of each small catchment. This discharge will generally be by seepage to ephemeral and perennial creeks and streams. When the hydrologic balance is disturbed, groundwater discharge will be much greater than previously, so areas of land will become waterlogged and salinised, and water will be discharged via direct evapotranspiration pathways (Evans & Bradd, 2001).

Groundwater recharge occurs in all parts of the landscape and causes saline groundwater discharge to land and to streams, mainly where the hydraulic gradient reduces with slope and bedrock variation. Where these discharge zones occur in the landscape, varies due to changes topographic slope, soil and rock types. The extent of land salinisation in the Catchment varies in relation to the level of incision of the river system and the topography of the landscape surrounding the streams. Low lying flat landscapes are prone to extensive salinisation.

Groundwater levels

Several groundwater level surveys of water bores in the Catchment have been undertaken. The surveys found that although the SWL (Static Water Level) in most bores had risen since the time they were constructed, the SWL of a several bores had fallen (Evans & Bradd, 2001).
Further analysis of chemical data collected in these studies is currently being conducted by hydrogeochemists at the Australian National University.

Salinity Mapping

John Powell undertook the first salinity distribution study of the Catchment in 1992. The study was based on fieldwork and aerial photography, and covered Landcare member properties in the Rye Park and Boorowa areas. Of the 76,014 ha surveyed, about 1.5% of the area was shown to have varying levels of salinity; 865 ha were affected in a minor way, 189 ha moderately affected and 60 ha severely affected. The areas most at risk were identified as the low relief areas within a 15 km radius of the Boorowa Township (Powell, 1992). These locations are included on Map 7.

A Salinity Catchment Plan for the catchment was prepared that recommended a monitoring program, farm planning, and planting of perennial pasture and trees in ways to control the expansion of dryland salinity. These recommendations have been implemented in a series of salinity management programs (Stage I to Stage V).

In October 2002, the Dryland Salinity Outbreak Mapping group, a part of the DIPNR, provided a copy of their salinity mapping in the region (Map 7). Although the Outbreak mapping usually relies heavily on airphoto interpretation, the mapping group had access to the existing community mapping and local knowledge. Further community consultation and site investigations may enhance the accuracy and extent of saline outbreaks mapping within the Catchment. The saline discharge sites were digitised using the existing topographic base maps. Several attributes related to the severity and management of the sites were also digitally stored.

Approximately 5000 ha (or about 2.5% of the catchment area) have a surface expression of dryland salinity based on the Outbreak Mapping data. The area affected by salinisation from Outbreak Mapping is possibly an overestimate, as the width of the area displaying early stages of salinity along the creeks was drawn at about 50 metres wide. The Outbreak Mapping was designed for 1:100,000 scale map output.

Four classes of salinity (including areas at risk) were mapped by DIPNR according to the criteria shown in Table 3.

Salinity class	**Categories**	**Criteria**	**Common salt tolerant grass species**
1	At Risk	Salt tolerant species not necessarily present. Minor reduction in yield on pasture or crops. New waterlogged areas appear. Approx soil salinity EC_{1-5} range is less than 300 µS/cm.	subterranean clover and other clover species declining.
2	Early Phase	Incipient salinity. Productivity of pastures and crops noticeably affected. Crop species stunted. No bare patches or salt fluorescence. Approx soil salinity EC_{1-5} range is between 300 and 600 µS/cm.	wallaby grass; sea barley grass; couch.
3	Low-Moderate	Salt tolerant species dominate the plant community. Some plant species show signs of stress. Salt stains are visible, and small areas (less than $1m^2$) are present. Soil salinity EC_{1-5} range is between 600 and 1400 µS/cm.	sea barley grass; couch; spiny rush; tall wheat grass.
4	Severe	Only highly salt tolerant species are left or ground is bare, active erosion. Extensive areas of bare ground are present with fluorescence present. Trees are dying or dead. Approx soil salinity EC_{1-5} range is greater than 1400 µS/cm.	Trees are dying or dead

Table 12 Dryland salinity class categories, criteria and indicator species
(adapted from MDBC Dryland Salinity Mapping brochure)

The recent mapping will provide a basis for future targeting of salinity abatement site within the Catchment. An example of this salinity mapping is provided in Figure 8.

Figure 8 Dryland salinity occurrences in the vicinity of the Boorowa Township: orange - early phase of dryland salinity; pink – low- to moderate; red - severe salinity; blue circles location of groundwater monitoring piezometers (from DIPNR, 2002)

Urban salinity

Urban salinity has been identified in over 80 towns throughout Australia. Salinity in towns is the result of a combination of dryland salinity processes and over irrigation of urban areas. Irrigation of lawns and gardens on permeable soil types that overlie saline material mobilise salts, and groundwater flow redistributes these salts down slope. Towns are often located in low points in the landscape, and are adding water to those landscapes (Wooldridge, 1999). The Boorowa Township has obvious symptoms of salinity, such as:

- *dying and dead trees*
- *salt tolerant species of grass appearing in gardens and playing fields, especially couch grass*
- *bare patches in lawns and playing fields, often with white crusting on the surface*
- *cracked, broken and deteriorating concrete paths and gutters*
- *road surfaces breaking up*
- *rising damp in building – private and public*
- *deterioration (fretting) of bricks and mortar*
- *salt crusting on brickwork, concrete and pavers*
- *deterioration of house foundations*
- *corrosion of underground services, such as gas and water pipes, sewerage systems etc.*

A recent survey of the Township revealed that at least 25 houses (or about 5% of houses in the Township) were currently displaying some damage from high saline watertables (Ivey

ATP and Wilson Land Management Services, 2000). Damage to infrastructure can be costly to repair and can affect property values.

The Boorowa Council Engineering Group monitors a series of piezometers in the Township area for groundwater elevation on a monthly interval. Figure 9 depicts the response of groundwater level to rainfall events over a 10-year period; note the effect of the recent drought. This clearly demonstrates the need for recharge

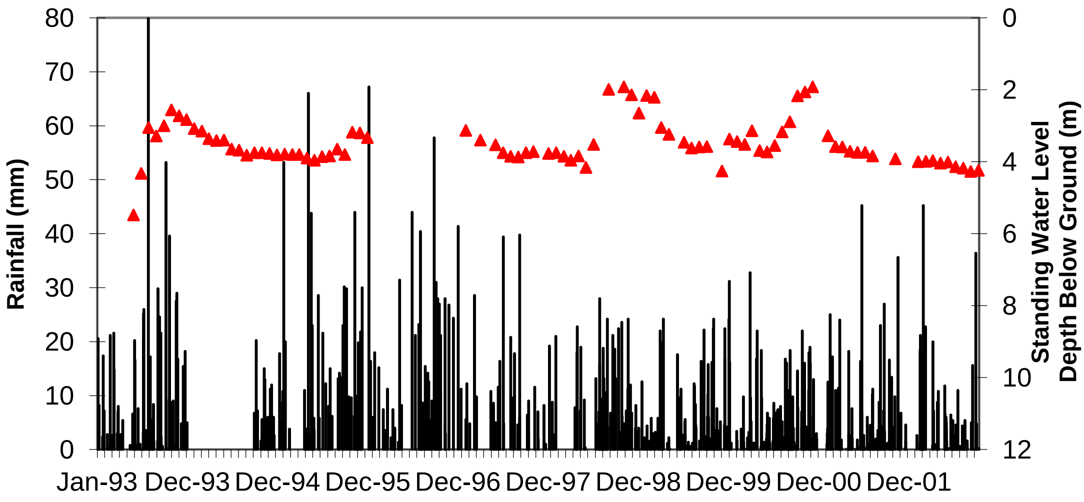

Figure 9 Boorowa Weir 2 hydrograph and bar graph of monthly rainfall (Bureau of Metrology) 1993 - 2002

5.2 Vegetation and Biodiversity

Native vegetation management is the management of native trees, shrubs and grasses to maintain biodiversity, increase the viability of rural communities, and to prevent land and water degradation.

Remnant vegetation does not necessarily refer to ‘untouched’ vegetation, as much of the catchment has been ringbarked, cleared, grazed or burnt since settlement. Much of the vegetation that remains today represents regrowth from this era, with many of the stands showing evidence of these past activities. It is recomended that these areas are preserved, as they may represent important samples of Boorowa area vegetation communities.

Why is native vegetation important ?

Protecting and managing areas of native remnant vegetation can have multiple benefits in promoting sustainable catchment health. These include:

- *providing windbreaks, shade and shelter for stock*
- *enhancing economic value (agroforestry, firewood, property value)*
- *providing a source of seed for regeneration*
- *reducing groundwater levels and recharge*
- *filtering nutrients and pollution in the stream bank zone*
- *controlling erosion*
- *increasing and maintaining biodiversity*
- *providing wildlife habitat and corridors.*

Shade and shelter provided by native vegetation can increase production. Sheep on sheltered plots produced 35% more wool and 6kg more liveweight than those without shelter, during a five-year study at Armidale. Native vegetation also provides an important aesthetic function in attracting tourism to farming areas, and plays an important role in local and regional cultural history.

What causes native vegetation decline?

Native vegetation decline has occurred through *direct loss* of vegetation, *fragmentation* of vegetation and *degradation* of those areas.

Clearing, continuous grazing and dieback are the primary causes of native vegetation decline in the Boorowa area. Clearing in the catchment dates back to 1800s with much of the remaining vegetation consisting of small remnants or individual paddock trees. These small, segmented remnants are generally not protected from grazing pressure and as a result, are more susceptible to the pressures influencing dieback and tree decline. This can affect reproduction, species diversity and exposure of remnants to weather and the impacts from adjoining landuse (fertiliser/herbicide drift, weeds and stock) known as the 'edge effect'. Many isolated paddock trees in the catchment are also old and in their later stages of life, reducing their ability to recover from dieback.

Weeds

Annual weeds generally increase when competition from desirable perennial plants is weakened or removed and/or an imbalance of nutrients occurs in an area. The main problem weeds species found in the Catchment area are: (For a more complete list see Appendix 2)

- Serrated Tussock - *Nassella trichotoma*
- St John's Wort - *Hypericum perforatum*
- African Boxthorn – *Lycium ferocissimum*
- Scotch thistle -
- Paterson's Curse - *Echium plantagineum*
- Sharp Rush - *Juncus acutus*

Environmental Weeds (from Priday et al., 2000 NSW NPWS)

Exotic plant species are widespread throughout Boorowa Shire, particularly in the areas used for intensive agricultural activities. Although many species with reputations as serious weeds occur in the Shire, few appear to occur in large numbers. Some of the worst weeds in the southwest slopes region, such as Paterson's Curse (*Echium plantagineum*) and St Johns Wort (*Hypericum perforatum*) occur mostly in scattered infestations. Thistle species appear to be widespread but reasonably well contained. Serrated Tussock (*Nassella trichotoma*), a serious weed of the southern highlands and southern tablelands, was recorded only in the north east of the shire in the vicinity of Wyangala Dam. African Lovegrass (*Eragrostis curvula*) was observed at a small number of locations along the Lachlan Valley Way. Sharp Rush (*Juncus acutus*) was generally restricted to areas that appeared to be subjected to waterlogging and possibly high salinity.

In native vegetation remnants, the most common weeds recorded were ubiquitous species such as Flatweed (*Hypochaeris radicata*) and Quaking Grass (*Briza maxima*). Also prevalent in the majority of remnants, particularly those on more fertile soils, was Rough Dog's Tail Grass (*Cynosurus echinatus*). This species formed a dominant component of the understorey in a large number of plots. It may represent a threat to the integrity of some of the native vegetation remnants in the shire. Some exotic pasture species, particularly Cocksfoot (*Dactylis glomeratus*) and Phalaris (*Phalaris* spp.), were also common in native vegetation remnants, particularly roadside remnants in more fertile areas.

Other potentially problematic species that were not obvious because of the timing of the surveys are also likely to commonly occur in the shire. Among these is Onion Grass (*Romulea rosea*), which is an invasive species that commonly occurs in native grasslands and grassy woodlands.

The Southern Slopes Noxious Plants Authority has identified 46 noxious plants within the Southern Slopes County Council control area, which includes Yass, Boorowa, Harden and Young Shires (Appendix 2).

Weed Management

Infestations can occur from poor land management such as:

- over grazing which leads to a decline in desirable perennial species allowing annual grasses and weeds to establish
- uneven distribution of soil nutrients from set stocking in large paddocks
- salt tolerant weeds such as sea barley grass or spike rush in salinised areas

The best way to prevent weeds on grazing lands is to look after native and/or introduced perennials and manage these to avoid over-grazing and to maintain ground cover. Herbicides can be strategically used to control weed infestations.

Threatened Species Management in Boorowa Shire

There are no reserves within Catchment currently managed solely for flora or fauna conservation and/or endangered ecological communities. The future of threatened species and endangered communities is dependant on suitable management of habitats on private properties, roadsides and public lands such as travelling stock reserves and cemeteries.

The most important legislation applying to the management of threatened species and endangered ecological communities in NSW is the *Environmental Planning and Assessment Act 1979*, the *Threatened Species Conservation Act 1995* and the *National Parks and Wildlife Act 1973*. These acts provide for various mechanisms for the management of threats to threatened species and endangered ecological communities. However, most activities on agricultural lands are exempt from restrictions applied under the *TSC Act 1995*. Thus outcomes towards the management of threatened species and endangered ecological communities are largely reliant on action from Boorowa Shire Council and local landholders.

A critical issue in the conservation of fauna and flora is awareness within the community. Although the level of awareness of environmental issues in Boorowa Shire is high, understanding of specific issues such as the conservation and management of endangered ecological communities and threatened species will need to be further developed. It is hoped that the report from the NSW NPWS is of assistance to the people of Boorowa gaining greater understanding of fauna and flora issues across the Shire (Priday et al., 2000).

Riparian Vegetation

In 1998 an assessment of Riverine Corridor Health in the Lachlan Catchment (Massey 1998) looking at eight riverine environment attributes assessed in this study including an overall assessment.

Data was collected at 41 riparian sites throughout the Boorowa and Hovells Creek Catchment. Tributaries included in the survey area were; Boorowa River, Breakfast Creek, Buffalo Flat Creek, Castles Creek, Flakeney Creek, Forest Creek, Gunnary Creek, Harrys Creek, Hovells Creek, Langs Creek, McKays Creek, Narrallen Creek, Pudman Creek and Water Hole Creek.

Willows
A survey of the willow population along the Boorowa River and some of its major tributaries, such as Pudman Creek, found that the willow population was relatively stable. The survey found that there was almost no evidence of seeding willow population, with the recommendation that the willow population in the township of Boorowa required monitoring, as potential seeding willows occur in the same location. The species of willows found in the catchment are:

- *Salix babylonica* – Weeping willows
- *Salix fragilis* – Cracked willows
- *Salix alba variety vittlina* – Golden Upright
- *Salix matsudana x alba* – N.Z. Hybrid
- *Salix matsudana tortuosa* – Tortured willow

Although there is possibly no seeding willows in the catchment there are still locations where willows are causing structural problems with streambeds and banks. This is mainly where willows have established in mid-stream and are causing flow to be diverted into stream banks, where major erosion has been occurring. Another problem with willows is that many of the species present have been rapidly spreading vegetatively causing major stream blockages as flood debris becomes lodged in the intertwined limbs.

The specific objectives for willow management will vary from sub-catchment to sub-catchment, and include the following situations:-

- In most situations willows may be retained.
- Where willows are growing in the stream bed, they often deflect high flows into adjacent banks, creating bank erosion. These willows should be removed.
- Overhanging branches and broken limbs which trap water-borne debri, can create bank erosion or infrastructure damage downstream during high flows. These branches can be trimmed or trees removed to minimise this occurrence.
- When willows drop their leaves in autumn, they decompose in the water, depriving aquatic organisms of oxygen. This can have a major effect on aquatic ecology. Tree removal strategies should take this into consideration.
- In some situations, with high ecological value, it may be desirable to entirely remove all exotic species.

In NSW , it is necessary to obtain approval from DIPNR before removing any vegetation from within 20 metres of a river or watercourse. You may also need to submit a plan for replacement vegetation in order to prevent bank erosion. Before starting a willow control program, seek advice from your local Landcare group or Council. A strategic approach to willow control, starting upstream and working methodically downstream (to avoid reinfesting treated areas) is recommended. Such strategies are possible through Landcare networks or though local interest groups such as fishing clubs etc.

5.3 Soil Structure, Soil Acidity and Erosion

(*Modified from Packer, 2002*)

Soil Structure

A simple way to understand soil structure is to think of the terms soil and dirt. Dirt is the end product when you over cultivate and overgraze soil. Dirt has had all or most of the porosity, organic matter and soil biology removed from it.

Soil on the other hand is a living organism with minerals (dirt), soil organisms, organic matter, air and water. The common technical definition of how these aspects are arranged is soil structure - the arrangement of the soil particles (clay, silt, sand, gravel and organic matter) and the arrangement of pores lying between them. These pores are important for the storage and movement of water and air in the soil. It can be quantified by many parameters such as rainfall infiltration/runoff, the degree of surface crusting/sealing, slaking and dispersion, soil strength/friability and soil compaction (bulk density). Good healthy soil can be felt walking across a paddock and has a rich earthy smell.

Soil Nutrients

It is important that soils have the correct balance of the major cations and adequate supply of major and minor nutrients for maximum plant productivity. Although this balance will differ for different species of plants, many soils need addressing to get cations and nutrients into the 'ball-park'. The benefits of improved soil organic nutrients to help achieve this balance should not be underestimated.

Soil Biology

Over-cultivation and overgrazing of soils has severely depleted or altered the soil biology from the undisturbed soil condition. The mass of soil biology is often forgotten when talking about ‘biodiversity’. In a healthy soil the mass of the soil biology in the top 10 cm can be more then 5 times the above ground biomass, which would include things such as the animals, trees and grasses. A healthy and diverse soil biology is essential for the break-down of organic products into soil organic matter.

Unfortunately many of our soils are ‘biologically dead’ from many decades of abuse. This poses a real problem when adopting new farming systems, which are based on the introduction of organic ‘food’ matter such as stubble and perennial pastures. To encourage the build up of sufficient numbers necessary for rapid and complete breakdown there is a need to adjust our farming systems. This means providing an environment, which addresses the food supply, temperature and moisture environment, and providing protection from the elements and predation.

Acid Soils

pH is a measure of acidity and alkalinity. Acid soils (Table 13) are often leached of many soluble ions and are commonly deficient in major plant nutrients such as calcium, magnesium, nitrogen, phosphorus and molybdenum. Acid soils may also increase the solubility of metals such as aluminium, which are toxic to plants in high concentrations.

<3.7 (extreme)	3.7 - 4.2 (v.strong)	4.3 - 4.7 (strong)	4.8 - 5.2 (medium)	5.3 - 5.7 (slight)

Table 13 Acidity ranges measured in 1:5 pH (0.01mol $CaCl_2$) solution.

Excessive soil alkalinity reduces the availability of some essential plant nutrients such as iron, manganese, copper, cobalt and zinc. Acidity and alkalinity may both result in a reduction of plant growth due to trace element deficiencies and toxicities.

Surface soil acidification hazard is the amount of acid that needs to be added to bring soil pH to critical level. It is now recognised that a soil pH level less than 5.5 in a Calcium Chloride solution ($CaCl_2$) is the critical point where nutrients become limiting and/or toxic to plant growth. To appreciate the changes in availability of nutrients with changes in pH refer to Figure 10. Animal productivity is also limited by extremes in soil acidity/alkalinity because the essential nutrients are not as plentiful in the herbage they eat.

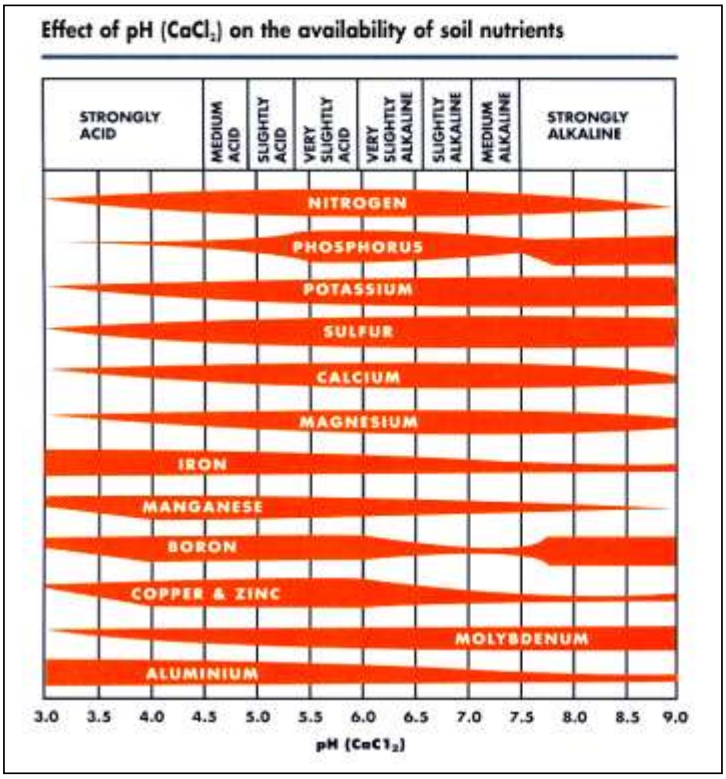

Figure 10 The Availability of Nutrients for Plant Growth as pH ($CaCl_2$) changes

The main problem with agricultural soils in the Catchment is a majority of them have surface soils (0-10 cm) less than pH 5.5 (Figure 11). Recent survey studies have also revealed in old cropping and pasture paddocks, the acidity problem has moved to 20 and 30 cm in the soil profile. Soils have become acidic from the production of excess nitrogen by legume-dominant annual pastures. When this excess is leached in the form of nitrates, the soil is acidified.

Figure 11 also shows the relationship between the pH measured in water and calcium chloride solution. i.e. $pH_{(water)} \times 0.9 = pH_{(CaCl_2)}$. This is a useful relationship when the field pH indicator kits are being used to measure paddock pH

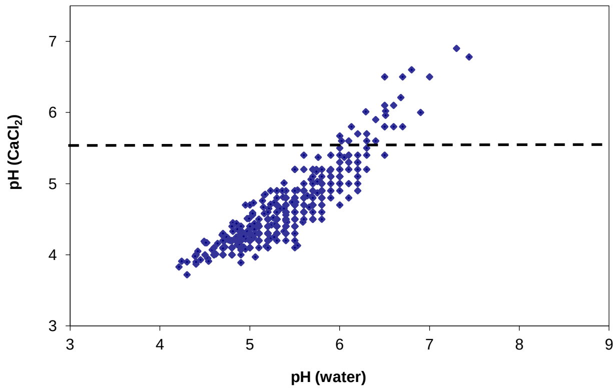

Figure 11. Top soil pH variation in the Catchment

Whilst a majority of these soils are naturally acid. However, past and current land management practices have made acid soils more acid in these areas and many areas of NSW.

Short-term treatment is the correct application of lime and use of perennial, acid-tolerant pasture species. In the long term, production systems, such as balanced perennial grass/legume pastures, need to be developed, I order to use excess nitrogen.

Sodic soils

A sodic soil contains sufficient exchangeable sodium to adversely affect plant growth and soil stability. Many sodic soils are sodic because they have been saline. As the salt leached away some sodium remained attached to cation exchange sites on negatively charged soil particle surfaces. Today the sodium remains and these previously saline soils are still sodic.

Sodic soils are prone to dispersion, are often highly erodable and have low wet bearing strength. Sodic soils are also relatively impermeable to water, reducing productivity and increasing run-off and erosion problems.

When dry, sodic soils are often dense and set hard. As sodic soils collapse when wet, surface seals and crusts often inhibit seedling emergence. Sodic soils are prone to soil structure decline and require careful management

Soil Erosion

Sheet and rill erosion is caused by rainfall runoff and severe wind events (wind erosion). This erosion typically occurs in cropping areas and is often observed in recently cultivated paddocks. It is an indication that soils have land management practices that need to be modified. Conservation farming and grazing practices, such as no tillage and cell grazing play an important role in maintaining groundcover and reducing soil structural damage. Orchards and vineyards can also adopt techniques such as sod culture for erosion protection. Properly designed windbreaks can reduce wind velocities and provide protection to livestock crops and pastures.

Gully and stream bank erosion occurs where runoff and seepage water is concentrated into flowlines. This problem occurs throughout the region and is a result of the same causes for sheet and rill erosion. Another factor exacerbating the problem is the destruction of the natural riparian vegetation in these flowlines and allowing stock access. About 30% of the drainage network in the Catchment shows signs of streambank or gully erosion. The total length of drainage lines is 4,637 km Gully erosion has been recorded on 1,537 **km**.

Where Does the Sediment Come From?

Sediments originate from erosion of hillslopes and from gully and stream bank erosion (channel erosion). The management of these two erosion types differs. It is important to determine which is the dominant source of sedimentation at the paddock/local scale. This allows a targeted approach for management of this issue (see Map 8). Channel erosion is best managed by preventing stock access to streams, protecting vegetation cover in areas prone to channel erosion, revegetating bare banks, and reducing sub-surface seepage in areas with erodible sub-soils. Hillslope erosion is best managed by promoting groundcover, maintaining soil health and structure, and promoting deposition of eroded sediment before it reaches the stream. Engineering solutions, which divert flows from eroding gullies, slow down flow velocities, or protect prone/steep banks, thus reducing erosion may be required in severe situations. Always seek professional advice for the design and construction of such works. (see Who can help)

5.4 Water Quality Decline

Turbidity and nutrients: critical water quality issues

Turbidity and nutrient load, like salinity, are critical water quality issues in Catchment. They are also features of the natural biophysical environment, to which the native flora and fauna are partly adapted. They have become problems because of the uses to which the Catchment has been put since European settlement and because their levels have been significantly increased.

Turbidity

Turbidity is a measure of water clarity and an indicator of the presence of suspended material such as silt and clay, and to a lesser extent, phytoplankton and zooplankton. The very fine clay particles that characterise the soils of much of the Catchment are the main component. Turbidity is a natural phenomenon and has long been a feature of the district, but past and some current land management practices, have exacerbated it. As with salinity, turbidity is strongly influenced by river flows and runoff from the land. Turbidity is measured in NTU (Nephelometric Turbidity Units).

DLWC has a gauging station on the Boorowa River at Prosser's Crossing. The results from the 96/97 data collected for salinity, phosphorous and turbidity is shown in Table 14. It should be noted that the data is only from one gauging station, and it would be preferable to have a number of sites monitored.

Site	EC (µS/cm)	Turbidity (NTU)	Total Phosphorus (mg/L)
Minimum	335	1.7	0.020
10 percentile	335	1,7	0.020
Median	976	4.2	0.035
90 percentile	1455	28	0.073
Maximum	1455	28	0.090
No of samples	9	9	10

Table 14 Water quality Boorowa River at Prosser's Crossing 1996-1997

Turbidity - The water in the Boorowa River at Prosser's Crossing is relatively turbid, with a Median NTU of 4.2 NTU. This is the average for 96/97 and although it is less than the guideline maximum of 10 NTU (ANZECC & ARMCANZ, 2000), it is still quite high. During the recording period a maximum of up to 28 NTU were taken, which is well above the maximum guideline. Erosion due to landuse practices has greatly impacted on turbidity as soil erosion has increased. This increased turbidity is likely to be associated with erosion within the catchment.

Phosphorous – Measurements taken by DLWC taken from the gauging station at Prosser Crossing on the Boorowa River show that the river waters phosphorous levels are relatively low. The average phosphorous content for 96/97 was 0.035 mg/L, which is well below the maximum guideline value of 0.1 mg/L.

Recent baseline water analyses at sites on the Boorowa River and Ryans Creek were undertaken as part of an Urban Stormwater program conducted for the NSW Environmental Protection Agency. General water quality parameters such as temperature, pH, salinity and ammonia, were generally within acceptable ranges for aquatic systems (Boorowa Shire Council 2001). However, nutrient and most microbiological levels exceeded the recommended levels. The water quality data is based on a limited number of samples; further analyses are required to determine more reliable observations.

A major source of sediment, nutrients and faecal (microbiological) contamination in our waterways is derived from stock camps and watering points along creeks and rivers**.** In order to limit erosion and the movement of sediment to the rivers, it is important to maintain a vegetative cover on land and to keep livestock away from riverbanks. Fencing stock out, to reduce traffic on creek and river banks, and providing alternative watering points (troughs, or safe bank access) is a viable solution in most cases. A catchment wide understanding of this issue has lead to an abundance of funding to assist in designing and implementing these types of onground works. Your local Landcare network or the Lachlan CMA should be able to assist in gaining funds for these types of projects.

Water bores Monitoring

A series of water bores have been selected from the registered water bores in the Catchment for annual groundwater elevation monitoring. Both the SWL (Static Water Level) and salinity level are been collected as part of a DIPNR regional monitoring program. Groundwater level monitoring is generally conducted in Feb - March each year. Contact your local LCMA Natural Resource Officer for more information regarding this data. Boorowa Council has been monitoring a number of bores throughout the Boorowa Township every month for several years. Contact Council for more information.