SKM

Wimmera Catchment Management Authority

Waterways for Life.

Mt. Cole Creek Waterway Action Plan

- Final
- 3 September 2005

action Salinity & Water AUSTRALIA

Victoria The Place To Be

Mt. Cole Creek
Waterway Action Plan

- Final
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Glossary

Term	Definition
aggradation	The process of raising the bed level of a stream through deposition of sediment
alluvial	Sediment deposited by flowing water, in a riverbed, flood plain, or delta
bedrock	Exposed solid rock that underlies loose material, such as soil, sand, clay, or gravel
bench	A level elevation of deposited material attached to a stream bank that exists between the streambed and the floodplain
degradation	A decline or lowering of the condition/quality, of the stream or floodpain
erosion	Processes, such as weathering, dissolution, abrasion, , and transportation, by which material is worn away from a surface
geomorphology (morphology)	The branch of geology that studies the characteristics and configuration and evolution of rocks, land forms
headcut	Vertical or near vertical drop in channel elevation greater than 300mm
incision	Lowering of a waterways bed level r
reach	A stream management unit i.e. a segment of a waterway
riparian	Of, on, or relating to the banks of a natural water course.

Executive Summary

The Mt Cole Creek Waterway Action Plan is one of many such plans being prepared by the Wimmera Catchment Management Authority (Wimmera CMA) as part of a program to identify site-specific actions to ensure the health and stability of the waterway across the Wimmera catchments.

This Waterway Action Plan focuses on key waterway management issues within the Wimmera CMA's scope of responsibilities and outlines recommended initiatives to improve the health of the waterways over the next five to ten years. The initiatives and priorities have been set in line with the objectives of the Wimmera Regional River Health Strategy (2005).

The plan provides a readily accessible form of information and analysis of the key waterway issues that have been identified and prioritised. Information contained within the plan aims to provide an understanding of the management approaches the Wimmera CMA encourage.

Mt Cole Creek is a small seasonally flowing tributary of the Upper Wimmera River with a 230 km^2 catchment. Rising from the granitic and sedimentary slopes of the western end of the Pyrenees ranges and draining to the upland valley plains of the Wimmera River floodplain near Crowlands, the stream traverses a range of foothill areas. The catchment has undergone widespread clearance since European settlement, triggering a range of degradation processes, including incising tunnelling and gullying. Today there are still identifiable areas of active bed and bank erosion along with sediment transport. There are also a number of areas that still contain high values, and effort is encouraged to identify, preserve and where possible, enhance these values.

The investigation process undertaken for this study included a review of the relevant previous studies, aerial photography analysis, an information collection process with local landholders and stakeholders and a field inspection of the catchment. This investigation process showed that with exception of a few active reaches most of the streams in the Mt Cole Creek system have undergone the primary incision process, with most now only showing some lateral adjustment or reworking of sediments.

The major issues for erosion remain within the sedimentary reaches of the foothills. This is generally associated with a loss of robust and continuous riparian vegetation communities as well as evidence of saline discharges and colonisation of weeds species such as Spiny Rush. The resultant impacts on water quality and instream values of Mt Cole Creek are marked. The impacts are also felt in the receiving waters of the Wimmera River through the addition of salt and turbidity loads.

The key issues identified in the Mt Cole Creek catchment that the Wimmera CMA needs to address include:

- The protection and enhancement of areas of higher fauna and flora quality;
- The rehabilitation of areas of stream erosion and degradation due to impacts of unfettered stock access through stabilisation and revegetation programs;
- The need to negotiate improved stock watering arrangements;
- The protection and enhancement of seasonal wetlands and sediment stores along the streams and associated floodplains, to protect their intrinsic habitat values and water quality management roles;
- The support of interagency programs, including the resolution of widespread salinity discharge and production issues; and
- The support of weed management programs along all streams.

Many beneficial projects have already been undertaken by individuals in conjunction with the Wimmera CMA and other agencies. Whilst this work is commended, much more remains to be done.

A prioritised set of activities for the CMA to concentrate on have been identified in this report.

Contents

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1. Introduction

1.1 What is a Waterway Action Plan

A Waterway Action Plan (WAP) examines catchments and individual reaches of waterways and identifies site-specific actions to ensure the health and stability of the waterway.

The intention of Waterway Action Plans is to provide information in an easily accessible form for users. Waterway Action Plans set out strategic directions and outline actions to address key issues associated with specific reaches of the waterway. They set a framework from which the Wimmera CMA is able to prioritise rehabilitation works for the next 5 to10 years. However, while Waterway Action Plans are predominantly works oriented, they only define the outline of projects and do not contain detailed project prescriptions or detailed costing estimates. These are additional tasks that need to be undertaken at the project implementation stage.

1.2 Objectives of the Wimmera Waterway Action Plans

This plan focuses on key waterway issues for which the Wimmera Catchment Management Authority (Wimmera CMA) is responsible, namely:

- Progressive reduction in the amount of sediment, suspended solids and turbidity originating from the Mt Cole Creek and tributaries to the Wimmera River;
- Protection of the existing floodplains and wetlands for their water quality treatment role;
- Rehabilitation of unstable waterways and gullies through tackling bed and bank erosion and rehabilitation of old structures;
- Protect and enhance existing high value riparian areas and achieve the improvement of riparian vegetation condition along the waterways with a key focus of regional biodiversity connection;
- Protect and rehabilitate existing high value and critical instream habitat areas; and
- Support the attainment of the Regional Salinity Management Plan.

It sets out a framework by which the Wimmera CMA is able to prioritise rehabilitation works for the next five to ten years.

The Wimmera CMA will address the following aims through the development of Waterway Action Plans:

i) establish a set of objectives for the management of the stream systems with a view to improving the river health over time;

ii) produce a plan that focuses on key waterway management issues in the Wimmera CMA's scope of responsibilities and priorities as outlined in the Wimmera Regional River Health

Plan, such that an outline works program for the stream can be identified for the next five to ten years;

iii) provide an accessible form of information and analysis of key waterway issues so that other agencies organisations and community groups are aware of those issues and the plan's prioritisation of works; and

iv) encourage landowners and community groups to be aware of the plan's contents, which provides a framework for undertaking additional planning or works along the stream corridors, and addressing their responsibilities in the areas of land management. Waterway Action Plans thus present an opportunity to assist coordination between management authorities and have the potential to promote a shared vision for the waterways between Councils, DPI, DSE, Wimmera CMA the community and other stakeholders.

1.3 Project Scope

The scope of this project is to:

i) Develop a report that documents appropriate management techniques for waterways within the Mt. Cole Creek catchment over the next five to ten years; and

ii) Facilitate the implementation of waterway action works where required.

1.4 Key Tasks

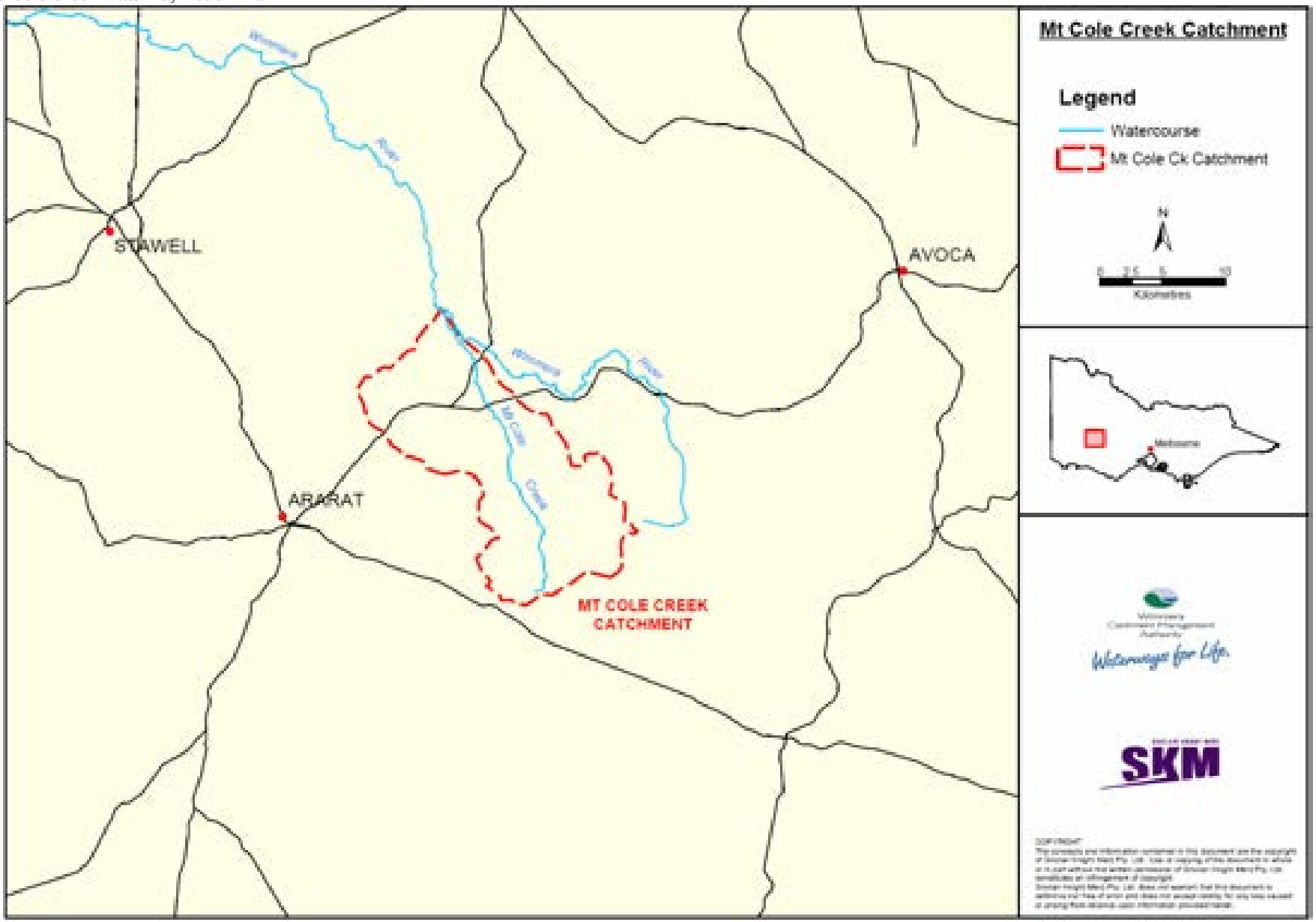
The following key tasks are outlined in the project brief and have been completed to achieve the above:

- Review of available information including relevant state and regional strategies, reports, aerial photography, longtitudinal profiles, water quality information etc;
- Consultation with stakeholders, ie department organisations.
- Consultation with the community i.e. landholders.
- Inspection of the catchment.
- Division of the catchment into smaller 'sub-catchments' or 'reaches'.
- Development of detailed sub-catchment management plans that detail the risks and opportunities within each sub-catchment.
- Prioritisation of management actions.
- Development of detailed sub-catchment maps showing the location of proposed management actions.
- Identification of bed and bank instabilities.
- Identification of pest plant and animal species that may pose a threat to waterway health at a sub reach scale.

- Assessment of the extent and condition of riparian vegetation and fencing at a sub reach scale.
- Identification of high value assets and detail any risks and opportunities associated with these assets.
- Provision of an indicative budget to undertake management actions.
- Development of the WAPs with a "Landscape" or whole of catchment approach to natural resource management (NRM), giving consideration for other natural resource management (NRM) programs and projects planned or underway within the catchment.

1.5 Catchment Location

The Mt. Cole Creek catchment is located in Western Victoria and covers an area of approximately 230 km^2, as shown in Figure 1.1 below. Major towns located near the catchment include Stawell, Avoca and Ararat. The main town located within the catchment is Warrak.



- **Figure 1.1 – Mt. Cole Creek Catchment Location.**

1.6 Major waterways in the Catchment

The major waterways in the Mt. Cole Creek catchment are all identifiable by name including:

- Mt. Cole Creek;
- Iron Pot Creek;
- Spring Creek.

There are also numerous other named and unnamed tributaries throughout the system.

1.7 Relevant Reports and Background Information

The Mt. Cole Creek catchment system is part of the upper Wimmera River catchment. Regional strategies and policies that are relevant to this WAP include:

- Victorian River Health Strategy (2002)
- Wimmera Regional Catchment Strategy (2004)
- Draft Wimmera Waterway Health Strategy (2005)
- Wimmera Water Quality Strategy (2002)
- Wimmera River Geomorphic Investigation (2001)
- Geomorphic Categorisation and Stream Condition Assessment of the Wimmera River Catchment (2003).

This Waterway Action Plan has been compiled in line with the key management actions, objectives, goals and recommendations made in these documents.

1.8 Supporting Programs

Wimmera CMA, together with DSE and DPI are the principle authorities responsible for delivering the recommendations of these strategies and policies on a regional basis. Collaborative programs that play a vital role in supporting these objectives include:

- Wimmera Weed Action Plan
- Wimmera Salinity Management Plan
- Steep Hill Country Management Plan
- Whole Farm Planning
- Wimmera Rabbit Management Action Plan
- Victorian pest management framework (DSE)
- Victorian Biodiversity Strategy
- Pyrenees Shire Planning Schemes
- Crowlands Landcare Group
- Project Platypus

2. Catchment Description

2.1 Whole of Catchment Overview

This section provides an overview of the catchment generally. A more detailed analysis on a reach by reach basis is provided in Sections 4 to 8.

2.1.1 Water Quality

Water quality in the Mt. Cole Creek catchment is very much a reflection of the land use and geology. The two dominant issues for the catchment with respect to water quality and stream ecology are:

- The transport of salt loads to the Wimmera River and negatively impacting on the residual and refuge values of all tributaries and the mid and lower segments of Mt Cole Creek and all of Iron Pot Creek.
- Transport of high loads of very fine suspended solids and turbidity to the mainstem reaches and the Wimmera River thus impacting on the stream ecology of those waterways.

Most of the waterways in the catchment have seasonal flows, however there are a number of natural springs at the foothill slopes near to the granite rises of Mt Langi Ghiran and Mt Buangor. Spring Creek flows from the Mt Cole reservoir and is the only waterway in the catchment that is believed to flow continuously, largely due to environmental flow releases from the reservoir. Environmental flows released from Mt Cole Reservoir together with flows from the various springs critically maintain permanent ponds in the upper parts of the catchment. This is of particular relevance from the Warrak township to the Allenders Road ford crossing and approximately 4 km further downstream.

The influences of the saline discharges from the more sedimentary and salt loaded soils of the Telegraph Hill tributaries start to influence the salinity downstream of this point with the small flows at Big Hill Road being slightly brackish. All the tributaries and the main stem showed a strong presence of Spiny Rush (*Juncas Acutas*) in the bed of the stream indicating long term elevated salinity levels.

Recorded data at the Crowlands bridge site at the Pyrenees Highway (DSE data warehouse) confirms the seasonal nature of flow in the waterway and also indicates that elevated levels of salt shown by electro-conductivity values of around 6500 uS/cm are common at the start of winter. These values then typically dilute to approximately1200 uS/cm in the spring time.

Similar results are also reported in Iron Pot Creek. A hydrogeology study, undertaken as part of a Project Platypus project (Coffey 1997), reported a seasonal variation of salinity in the Crowlands reservoir of 500 uS/cm by the end of winter and as high as 2000 uS/cm at the end of summer.

Whilst the first flush from known saline discharge areas into the dam is estimated as being as high as 14,000 uS/cm the more common levels are reported to be around 6,000 uS/cm. Other impoundments and dams in the area of Iron Pot Creek were as high as 1000 uS/cm indicating a generally high level of salt exist in the soils. Some seeps have been recorded as high as 20,000 uS/cm (Coffey 1997). During an inspection of the catchment, many observations were made of salt fluorescence in banks of the weathered and incised streams. This is believed to contribute to elevated levels of salt in the first seasonal run off, which decline there after through to the end of spring.

Elevated salt levels were particularly noticeable on the tributaries around Mt Boswell, with levels reported to be greater than 12,000 uS/cm. Suprisingly, sheep were observed as relying solely on this flow for there water supply. This classic pattern of foothill saline discharge through weathered sedimentary soils with discharge at the lower break of slopes is replicated right across the Mt Cole Creek and tributary catchment. This area is a primary focus of the Wimmera Salinity Action Plan (WCMA, 2004).

Some areas of saline discharge were also observed in the upper stratigraphy of the tertiary terraces in the mid catchment. These were particularly noticeable in the segment upstream of the Pyrenees Highway.

Being on predominantly sedimentary soils with moderate to high slaking characteristics, sheet erosion is prevalent throughout the catchment. This impacts on the health of the waterways by contributing sediments and increasing turbidity.

Unfortunately there is no reported data on suspended solids, turbidity or nutrients in the Water Quality Data warehouse (DSE, 2005) to enable an appraisal of the loads to the Wimmera River. Given the observed mitigation of suspended solids loads in the foothill fans, wetlands and swamps, it is likely that only low loads of settleable solids will be experienced in the downstream reaches. However there is a high probability of high turbidity levels throughout the whole of the stream system across the catchment despite some mitigation by the swamp systems in the lowland plains.

The field inspection stage of this study was undertaken at the end of an extended dry period with no flow being encountered at most sites in the downstream end although permanent pools were noted nearer the Wimmera Junction.

With respect to instream fauna there has been some biological monitoring of the streams due to the Platypus Project. Doeg (2000) also undertook an assessment of the values of the area as part of the preparation of the Upper Wimmera River Water Resources Management Plan (Environmental Flow Study) 2002. This later data showed that some species of significance existed in the region.

These include the following:

- Mountain Galaxias *(Galaxias olidus)*
- River Blackfish *(Gadopsis maroratus)*
- Southern Pigmy Perch *(Nannoperca australis)*
- Flat headed Gudgeon *(Phylipnodon gradiceps)*

Platypus studies were undertaken in the catchment over a period of three years (Holwell *et al*. 1998; Serena and Williams 1998, 1999; Worley and Serena 2000), followed by a final study in 2000 (Serena and Williams 2002) as part of the Platypus Project.

These studies showed that platypus were colonised in the upper reaches of Mt Cole Creek around the Warrak Township with other captures occurring seasonally at the Crowlands bride on the Ararat-St Arnaud Road. It is obvious that the maintenance of the permanent pools from the springs and environmental flow releases are critical in maintaining this habitat. The large phragmites swamp (and spring) upstream of Warrak on Spring Creek is also likely to be performing a critical role in the water quality treatment of these flows.

Other species were captured as part of the platypus netting program. As well as confirming the presence of the above species, Water Rat (*Hydromys chrysogaster*) was also noted to occur along with the Eastern Snake Necked Turtle (*Chelodina logicollis*). This indicates that the upper segments are fairly significant habitat areas and need protection and enhancement to secure those values.

No studies have been undertaken for the permanent pools observed nearer the Wimmera River junction. It is likely that these are also important habitat and connected the Wimmera River habitats. These should be investigated to determine their importance as refuges in drier periods.

2.1.2 Vegetation

The Mt Cole Creek Catchment has been heavily modified and disturbed from a vegetation management perspective. Large scale land clearance associated with the development of the area has removed a great deal of the original vegetation cover, while a large number of introduced species have been added to the vegetation of the region during this time. The persistence of livestock within the fragile riparian environment has resulted in poor regeneration and capacity to cope with natural environmental issues faced by the area such as drought.

Except for the larger state parks of Mount Buangor, Mount Langi Ghiran and Ben Nevis, little remnant vegetation remains intact within the catchment. The areas of high relief in the southern portion of the catchment, unsuitable for agricultural production, have retained a healthy cover of vegetation, while the lower hills and valley floor have little to no remnant vegetation remaining. Mount Langi Ghiran and Ben Nevis retain the main component of remnant vegetation in the catchment, which are the main biodiversity reservoirs within the catchment. Table 2.1 below lists

the remnant vegetation remaining within the catchment and the reaches in which they occur. Remaining remnant vegetation of the lower slopes and valley floor occurs mainly as small isolated patches, exposed to degrading pressures of weed invasion and stock damage.

- **Table 2.1 - Remaining EVC's of the Mt. Cole Creek Catchment (DSE, 2005a, b & c)**

Current EVC Remaining in Catchment (DSE, 2005)	Reach	Remaining Character	Location
3 – Damp sands Herb Rich Woodland	2, 3	Upper tributaries of the South western slopes on southern flanks.	Low alluvial flats.
20 – Heathy Dry Forest	2, 3	Lower slopes of the western facing ranges.	Shallow rocky skeletal soils.
22 – Grassy Dry Forest	1, 4	Mid to upper slopes of the southern catchment.	Range of slopes and altitudes outside of the riparian zone.
23 – Herb-rich Foothill Forest	1, 2	Upper slopes of the western facing ranges.	Relatively fertile, moderately well drained soils. Easterly and southerly aspects of lower slopes and gullies.
47 – Valley Grassy Forest	2, 3	Small remnant within the western slopes, north facing tributary.	Generally nutrient poor soils of the upper slopes.
48 – Heathy Woodland	1, 4, 5	Small component of an isolated remnant within the lower slopes of the bottom of the catchment.	Generally nutrient poor soils of the upper slopes.
68 – Creekline Grassy Woodland	4	Small, discontinuous remnants along the main stem of Mt Cole Creek.	Drainage lines and adjoining flats
71 – Hills Herb-rich Woodland	1, 2, 3	Northern flanks of upper slopes.	Slopes, thin, but fertile soil over a variety of geologies.
73 – Rock Outcrop Shrubland	2	Mid to upper slopes, associated with skeletal soils.	Exposed rocky areas, skeletal soils.
76 – Low Rise Grassy Woodland	4	Small isolated remnant on lower slopes of western catchment.	Low hills.
175 – Grassy Woodland	5	Small isolated remnant on lower slopes of western catchment.	Intermediate slopes between the plains and more infertile upper slopes.
351 – Rocky outcrop Shrubland	1	Mid- upper slopes of the western facing ranges.	Low shrublands occurring on exposed sites, usually associated with the crests of hills.
896 – Grassy Woodland/Heathy Dry Forest Complex	2, 3, 4, 5	Lower slopes, adjoining tributaries in the south of the catchment.	Lower exposed and dry slopes of low to moderate fertility.

The riparian vegetation assemblages have all but been removed, with some canopy species remaining in certain areas. Such remaining vegetation tends to be very narrow and discontinuous

across the landscape. The regeneration of native vegetation is minimal within the riparian zone, largely the result of unrestricted livestock assess to the riparian environment and the encroachment of weed species such as Spiny Rush that can limit natural regeneration.

Vegetation management approaches need to focus upon the protection of existing remnant vegetation and the stabilisation of the riparian landscape to capitalise on natural revegetation/rehabilitation and provide connectivity between remnant stands by establishing wildlife corridors. The best form of riparian protection in the capacity of the Mt Cole catchment should take the form of riparian fencing to control stock access, with the inclusion of simple revegetation works to create the fabric of remnant vegetation. Within the scope of such revegetation works, the establishment of nodes within the revegetation corridors of the riparian zone, that would return a diverse species assemblage to the area, allowing species to spread into adjoining areas with time. Once the systems have been stabilised, natural regeneration should facilitate the return of the species diversity of the surrounding EVCs.

2.1.3 A model of catchment change

The gullies and broader-scale hillslope erosion that are now apparent in the Mt. Cole Creek catchment are likely to have been initiated in the middle of the Nineteenth Century when valley floor vegetation was cleared for agriculture (and later more extensive fuel wood cutting) along with the introduction of hoofed stock. These changes in landuse have resulted in increased runoff and decreased erosion resistance (Prosser and Slade, 1994). When runoff is concentrated in hillslope hollows, the ability of flows to erode waterways increases, sometimes incising gullies into the valley floor. Once initiated, gullies spread at an exponentially declining rate with much of the networks being formed within the first few decades (Graf, 1977). This model of landscape change has been widely used to explain the occurrence of gully erosion (Prosser and Slade, 1994).

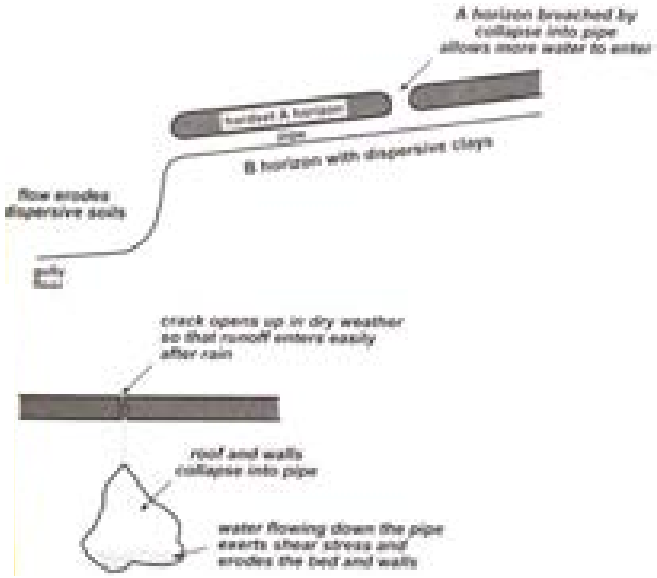
Channel initiation by overland flow has been viewed as a threshold phenomenon related to the size of the contributing area and its slope (Horton, 1945). The relationships between source area and slope have been explored in a number of environments to predict the onset and the stable extent of gully networks (e.g. Dietrich *et al.*, 1992; Prosser and Abernethy, 1996; Morgan and Mngomezulu, 2003). Once incision occurs, gully heads migrate upslope until some threshold of contributing area and/or slope is met. At this point runoff, capable of further incision, cannot be generated and the gully stabilises in its headward extent. This topographic threshold is also influenced by vegetation. The loss of groundcover and enhanced runoff results in an increase in the erosivity of flows on the valley floor. The effect of this is to reduce the critical area/slope required for gully initiation and stabilisation.

The other dimensions of gully networks are gully width and depth. Gullies often continue to incise down to bedrock or until some stable gradient is achieved from the baselevel of the downstream drainage network (see Schumm *et al.*, 1984). After the gully floor has stabilised the gully walls

tend to lay back under the influence of water and gravity until they are reduced to relatively stable slopes (Crouch, 1987). As gully floor elevation and sidewall slopes stabilise, vegetation is able to colonise the surfaces, further damping the effects of erosion processes.

Relating gully morphology to erosion process provides a useful field technique to assess gully stability. The further a gully head from its upstream drainage divide the more potential there is for continued headward extension. Secondary nickpoints in gully floors indicate that some change in baselevel has renewed the incision process and that the gullies will continue to deepen (sometimes to bedrock). Deepening gullies will promote sidewall instability and maintain the walls at steep angles. Lower angles on the sidewalls indicate general gully stability. Overtime, with the establishment of vegetation, the gully will begin to infill and begin the process of landscape recovery.

Much of the gully erosion in southeast Australia, occurred only after valley floor vegetation had been disturbed (Prosser and Slade, 1994). However, other factors, such as the strength and hydraulic properties of valley-floor soils, also influence erosion processes. Many Australian soils have hard-setting A-horizons, and more clayey sodic B-horizons (Young and Young, 2001). The B-horizon often has a lower permeability and water is forced laterally and moves as throughflow downslope. If the clays in the B-horizon are dispersive, fine soil particles can be carried in suspension in the throughflow (Figure 2.1). The transport of clay-sized particles by subsurface water leads to piping, tunnelling and seepage erosion (Young and Young, 2001). While the removal of vegetation has increased runoff rates, the characteristics of the underlying soils can have a strong influence on the potential for gullying to occur.



- **Figure 2.1 - Gullies and seepage flow (from Young and Young, 2001).**

These principles and geomorphic processes, provide an appreciation of the setting in which the processes of erosion and deposition operate within the catchment. The potential to misinterpret the natural instability which can exist in a catchment, as simply being a result of human impact, or to exaggerate the human impact, has been recognised as a consistent problem in geomorphic studies (Dollar, 2000). Recognition of the different factors that have contributed to the development of the erosion problem, and the role that subsurface and overland flow paths have in driving the erosion processes is important as a precursor to recommending appropriate rehabilitation options.

In assessing the stability of the waterways within the catchment, it is important to consider the natural characteristics of the area such as the geology, soil types, topography, and type and extent of vegetation cover.

2.1.4 Flooding

The information on flooding is derived from in field observations of the terrain and provision of flood information obtained from DSE (Department of Natural Resources. *Flood Data Transfer Project,* www.dse.vic.gov.au/Interactive maps/Victorian Water Resources).

Site observations and the presence of flood level markers provided an indication of where floodwaters from tributaries is likely to cause some dislocation to low level road crossings. Reach specific observations are discussed in detail in the relevant Reach chapters below.

2.2 Management Reaches

To describe the condition, issues and recommended actions in the Mt. Cole Creek catchment, the waterway system has been divided into five primary reaches. The delineation of the catchment into reaches has been based on geographic units that uses recognisable features such as stream junctions or roads to define reaches. The tributaries connected to the five primary reach main stems have been described as ‘sub reaches’.

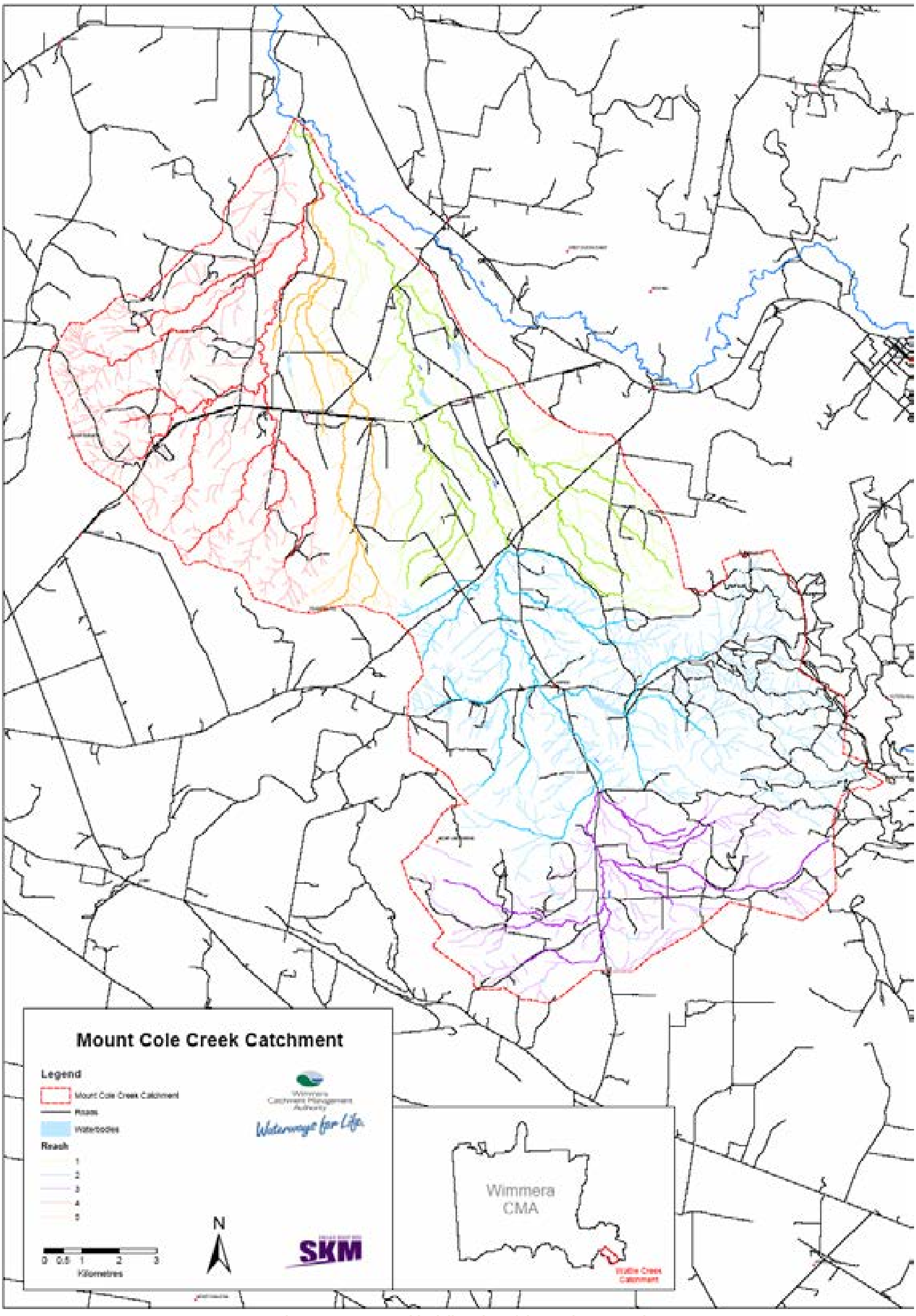
2.2.1 Reach, sub reach and tributary labelling convention

For the purposes of this report, a naming convention has been applied that identifies the reach, sub-reach and tributary. This has been used to help identify individual waterways within the catchment for the purposes of discussion in this report and identification on the respective reach maps. An example of the convention that has been applied is R1/2/4. This example refers to Reach 1, sub-reach 2, tributary 4 and are notated on the relevant waterways in the individual reach maps.

The location and extent of the five reaches are shown in Figure 2.2 with the detail of the main stems listed in Table 2.2 below.

- **Table 2.2– Reach delineation of the Mt. Cole Creek catchment**

Reach	Location description	Easting and Northing
Reach 1	Reach 1 – Mt Cole Creek - Eversley Road and Tributaries to Wimmera River	D/S - 683239 5889224 U/S - 688963 5877610
Reach 2	Reach 2 – Mt Cole Creek - Rocky Road, Warrak and Tributaries to Eversley Road	D/S - 688963 5877610 U/S - 691480 5871182
Reach 3	Reach 3 – Mt Cole Creek – Upstream Headwaters to Rocky Road, Warrack	D/S - 691480 5871182 U/S - 688304 5865964
Reach 4	Reach 4 - Headwaters from Mt Boswell and Telegraph Hill to Unnamed Mt Cole Creek Tributaries West of Dunneworthy	D/S - 684020 5887549 U/S - 680378 5877583
Reach 5	Reach 5 – Headwaters on Telegraph Hill to Unnamed Mt Cole Creek Tributaries East of Dunneworthy	D/S - 683885 5887051 U/S - 683866 5876046



■ **Figure 2.2 – Geographic delineation of the catchment reaches**

3. Method for assessing the Catchment

3.1 Information Collection

The following information sources were used to compile the information, which forms the basis of this plan:

- A desktop review of available information and documents;
- A meeting with respective stakeholders was held on 6th April 2005. Stakeholders include (but is not limited to) DSE, DPI, Wotjoballuk Community and the Pyrenees Shire Council;
- A community consultation meeting was held on 6th April 2005. Advertising means included the distribution of an information sheet via a letterbox drop, advertising in the local paper, and the placement of information sheets at various community centres/locations in the catchment;
- The study team undertook an inspection of the catchment over a 2-day period, 21-22 April 2005; and
- The study team also undertook an aerial inspection of the catchment on 21 April 2005.

3.2 Risk Assessment and Priority Setting

To help rank the recommendations made as part of this project, a risk assessment approach has been used to determine the priority of the relative importance of actions within the catchments of the Activity Plan.

Priority has been established through an assessment of the condition (based on ISC scoring 1-5), then an assessment as to its Consequence (via a Risk Threat matrix with a score of 1-5) and then an assessment of the urgency or need to intervene quickly or over time with the action (score 1-10). These are multiplied together to get an overall numeric ranking score which determines the priority. This has then been translated into one of a five descriptor that brackets the scores from Urgent, Very High, High, Moderate through to Low according to the following bands:

- **Table 3-1 Priority ranking scores**

Priority	Ranking Score
Urgent	144-124
Very High	123-104
High	103-84
Moderate	83-64
Low	63-44

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3.3 Reach Activity Spreadsheets (Summary of Issues and Actions)

Activity spreadsheets have been compiled to document important site specific issues identified in each of the nine reaches, refer to Appendices A to E. The spreadsheets offer an overview of the extent of expenditure required to achieve the vision of this Plan in the next five to ten years. The spreadsheets detail the issues, location, recommended actions, cost estimate to and assign a priority to each respective issue. The issues for each reach have been grouped into the following activity headings:

- Stream systems and ecology (E);
- Stability (S);
- Water quality (W);
- Vegetation management (V); and
- Flood management (F).

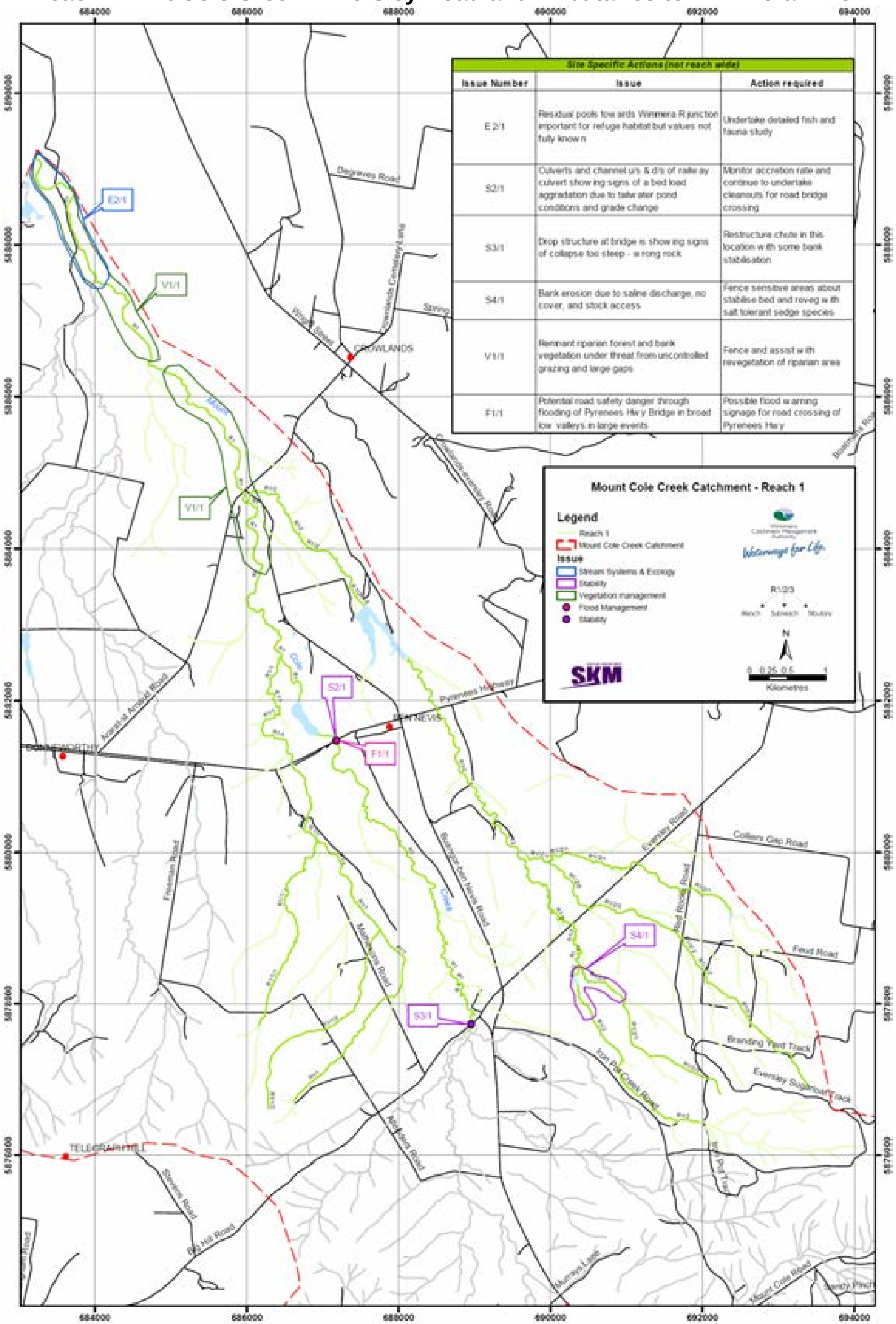
3.3.1 Issue – Naming convention

Issues have been identified using a naming convention that refers to 1) the activity heading, 2) the issue number, and 3) the respective reach. For example E1/1, refers to the first stream systems and ecology issue identified in reach one. Similarly, S6/1 refers to a sixth stability issue identified in reach one. The issue number is used to identify specific issues only and is not related to a priority. Priorities are set in another part of the spreadsheets (refer to Section 3.2 above).

3.3.2 Location of issues

Where possible a GPS location has been provided (Easting and Northing) in the MGA datum (GDA94) to identify site specific locations. Reach maps have also been compiled with an overlying grid to help identify where the respective issues are located. Further, each activity is distinguishable by colour i.e. Stream system and stability issues are represented by a different colour to Vegetation issues.

4. Reach 1 – Mt Cole Creek - Eversley Road and Tributaries to Wimmera River



- **Figure 4.1 – Extent of Waterways included in Reach 1.**

4.1 Reach Location

This reach extends from Eversley Road to the Wimmera River, refer to Figure 4.1 for more detail.

4.2 Morphological description

This portion of the catchment is the lowland plain segment of Mt Cole Creek and includes some low rolling hill country plus the tributary Iron Pot Creek. The mainstem of Mt Cole Creek is an incised 'U' shaped channel that is basically stable. The planform is slightly sinuous and is characterised by isolated pools, inter pool zones and point bars. The pools at the lower end (downstream of Crowlands Road) were dry. The bed substrate consists of coarse and fine gravels plus sands with the banks mainly of sandy loams and silts, with interbedded gravel strata. Instream vegetation is generally confined to emergent macrophytes in the pools but there are also extensive areas of Spiny Rush, Typha and Phragmites in the flatter interpool areas. In places, the instream vegetation may be redirecting flow towards the banks. Some large woody debris is also evident in low catchment areas where the interpool zone is more extensive. Stock damage to many bank areas of the mainstem was also evident.

A large Phragmites and Typha swamp exists immediately downstream of the Pyrenees Highway indicating a change in stream and floodplain gradient. Here the floodplain is well connected to the stream and tends to trap the coarse sediment load from the upper catchment areas. This sedimentation has been blamed on the potential inefficiency of the large Armco culverts under the railway, but tailwater conditions due to a natural change in grade would see the sediment fall out readily in this area.

Upstream of the Pyrenees Highway the mainstem flows through an area with a relatively compressed valley and a floodplain set within terraces on either side. Areas of saline discharge are known along this reach, giving rise to the presence of extensive areas of Spiny Rush. A large rock drop structure has been constructed immediately downstream of the Big Hill Road bridge (refer to Figure 4.2) and is in need of rehabilitation to overcome some local bank scour. A small flow of brackish water was evident at this point.

This reach also includes Iron Pot Creek, a stream that rises at the base of the Ben Nevis range or Eversley Sugarloaf region of the sedimentary Warrak formation. Whilst relatively steep in the upper catchments, the gradient flattens quickly with distance downstream. There is an abrupt increase in cross-sectional area downstream from the Pyrenees Highway. Flow in Iron Pot Creek is ephemeral with low flows likely to be prominent in the gravel and sub surface levels. Crowlands Reservoir is used for non-potable water supply to the Crowlands Township and this makes the downstream segment of Iron Pot Creek more ephemeral that it once was. Bank erosion is a common characteristic of Iron Pot Creek and other tributaries in the reach. Often the bank erosion

appears to be coincident with areas affected by salinity and consequent degradation of the riparian vegetation. Stock damage is also widespread.

4.3 Vegetation

The vegetation along the mainstem was abundant in some areas, but generally consisted of a narrow and discontinuous strip of riparian vegetation. The riparian vegetation consisted mainly of River Red Gums and pasture grasses with some weed species such as Gorse, Boxthorns and Peppercorns. As indicated previously, the bed vegetation is dominated by salt tolerant species such as Spiny Rush, Phragmites and Typha.

The tributaries all showed very poor vegetation characteristics with only a few remnant River Red Gums existing along the stream lines. The combined pressures of the long drought, open access to the stream lines of the tributaries for grazing, reducing vegetation cover in association with the sodic nature of the soils has created a situation where local stream banks are degrading at a rapid rate.

Weed species such as Spiny Rush, Gorse and some Blackberries are relatively common throughout the reach with Spiny Rush appearing in a lot of the minor tributaries The swampy areas were dominated by a mix of Spiny Rush, Phragmites and Typha.

Reach 1 retained only a small area of remnant vegetation, largely restricted to the upper portions of the reach. Table 4.1 details the remnant vegetation currently present in the reach, which is believed to have occurred prior to European Settlement. Creekline Grassy Woodland provides the most relevant EVC to the riparian environment and the re-establishment of the River Red Gum canopy would be an important step in the improvement of the waterway and initiation of a long-term environmental improvement program.

Table 4.1 - Current and Pre-European Vegetation Attributes (EVC) Reach 1.

Current EVC Remaining in Reach (DSE, 2005)	Pre 1750 EVC's in reach (DSE, 2003)	Location
22 - Grassy Dry Forest	22 - Grassy Dry Forest	Range of slopes and altitudes outside of the riparian zone.
23 - Herb-rich Foothill Forest	23 - Herb-rich Foothill Forest	Relatively fertile, moderately well drained soils. Easterly and southerly aspects of lower slopes and gullies.
48 - Heathy Woodland	48 - Heathy Woodland	Generally nutrient poor soils of the upper slopes.
	55 - Plains Grassy Woodland	Poorly drained, fertile soils on flat to gently undulating plains of low elevation.

	68 - Creekline Grassy Woodland	Drainage lines and adjoining flats
71 - Hills Herb-rich Woodland	71 - Hills Herb-rich Woodland	Slopes, thin, but fertile soil over a variety of geologies.
	152 - Alluvial Terrace Herb-rich Woodland	Alluvial plains and broad ephemeral drainage lines.
351 - Rocky outcrop Shrubland	351 - Rocky outcrop Shrubland	Low shrublands occurring on exposed sites, usually associated with the crests of hills.

Vegetation management requirements for Reach 1 centre around the need to secure the riparian zone from the impacts of livestock access and establish a suitable canopy cover. Due to the limited extent of vegetation within the riparian zone it is expected that the revegetation works in the early phase of development would focus on River Red Gum, Blackwattle and Buloke establishment. With suitable stock control, other species are more likely to establish naturally over time. The success of this approach could be gauged after a designated time period (10 years) and access the need for further weed control and species augmentation.

4.4 Habitat

The habitat complexity of the reach was generally higher for those areas with deep pools and some stock control, with a good bank and verge cover and instream attributes of large woody debris and macrophytes. Species such as Flat Headed Gudgeon, Mountain Galaxias and Blackfish frequent the reaches upstream and downstream of this site (SKM 2002). Platypus have also been recorded in the Mt Cole Creek catchment. They may also be using the deeper and more permanent pools as refuges.

The overstorey tended to be depleted or discontinuous towards the middle and upper reaches where cropping and grazing activities encroached to the top of the batter and into the stream zone. The presence of a Crown Reserve over the lower 50 % of the mainstem reach may auger well for a habitat improvement program. Unfortunately there is no Crown Reserve over the upper segment of the mainstem upstream of the Pyrenees Highway reach.

The more permanent pools of the reach could form important refuges for fish and mammal species. Whilst insufficient detailed data is available to make a full judgement, the pools may also provide habitat for species such as Platypus and Water Rat that would readily feed off the abundant Yabbies and Freshwater Shrimp.

The Phragmites bands are important bird habitat in light of the few areas of habitat off the stream corridor. Unfortunately the habitat condition of most of the ephemeral tributaries is extremely poor with no appreciable significance.

4.5 Water Quality

The pools in the upper reach were clear at the time of inspection with no sign of algal blooms and the substrate showing little sign of gross aggradation. This supports the view formed that there is little transport of gross or settleable sediment through to the mainstems, this being attenuated in either foothill fans or the spiny rush infestations in the bed of most of the streams.

However the presence of finely divided silts in the sediments indicates that very fine silts and colloids will be transported under event conditions along with elevated nutrients from catchment sources. The higher salinity regime can be expected given the leachable country and known sources of salt in the sedimentary and sodic based soils of the upper catchment areas. Base flows upstream were noted to be about 2000 uS/m at an upstream location, but can get higher in some of the tributaries with levels of up to 14,000 uS/cm recorded.

The regional Salinity Management Plan has priority areas for management indicated and the most important area for this reach is that of saline discharge areas along the upper mainstem and discharge areas in the Iron Pot Creek catchment.

4.6 Flooding

Mainstem flooding is to be expected along the whole of the Reach 1 and over the minor tributaries. There is limited information on flooding and the views expressed arise from field observations of the terrain. The most prominent flooding potential is at the Pyrenees Highway where it is likely that the low-level bridge will become inundated in larger events. There is no flood warning signs in this area.

Minor flooding may also occur at some of the Iron Pot Creek tributary crossings along the Eversley Road.

4.7 Threats and Priorities

The following table summarises the major threats that have been identified in Reach 1. For specific details on issues, actions, locations, priorities and cost estimates, refer to Appendix A – Reach 1 Summary of Issues & Actions.

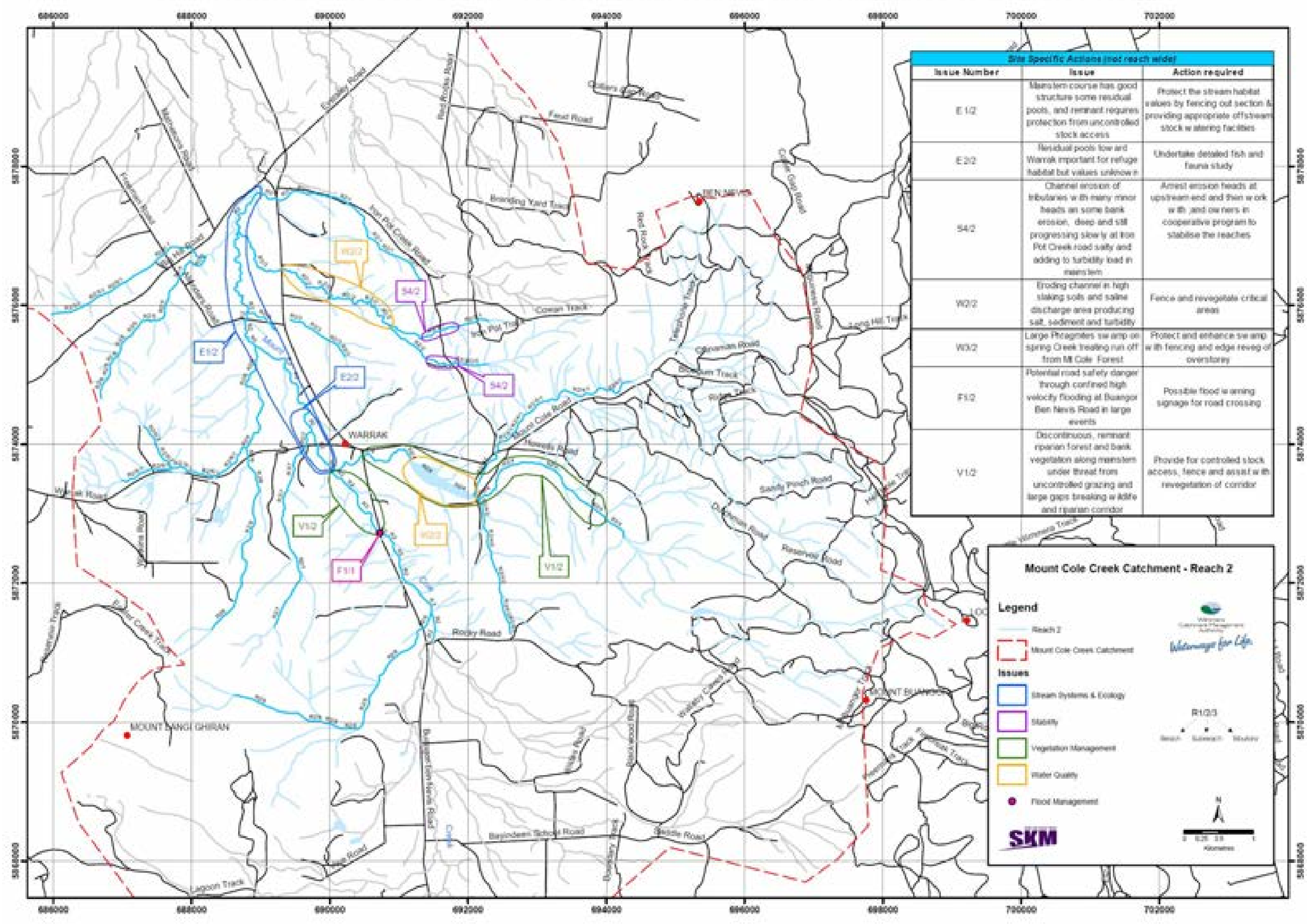
- **Table 4.2 – Threats and Risks identified in Reach 1**

Threat	Priority
Decline of high value habitat and riparian vegetation along Mt Cole Creek mainstem	Very High
Stock access to stream zones in both mainstem and eroding areas of tributaries	Very High
Salinity production in denuded catchment leading to saline discharge areas and higher salinity in the stream	Moderate
Active bank erosion in old incised tributary streams with the potential to generate and transport sediment to the mainstem	High
Potential flood danger in major events at the Pyrenees Highway	High
Loss of key ephemeral swamps to mitigate suspended solids and turbidity	High
Lack of detailed data on significant ecological values to guide management	High
Extensive Spiny Rush infestation in the stream bed	Moderate
Gorse and Blackberry infestations along stream zone	Moderate

- **Figure 4.2 – Potential Flood danger at the Pyrenees Highway at the change of grade in Mt. Cole Creek**

Figure 4.3 – Big Hill Road crossing requires appropriate stabilisation to prevent further erosion

5. Reach 2 – Mt Cole Creek - Rockv Road. Warrak and Tributaries to Everslev Road



- **Figure 5.1 - Extent of Waterways included in Reach 2.**

5.1 Reach Location

This reach extends from Rocky Road, Warrack and Tributaries to Eversley Road, refer to Figure 5.1 for more detail.

5.2 Morphological Description

Much of the catchment draining into this reach is used for sheep and cattle grazing, including fairly uncontrolled access to the waterways for stock watering. A Crown Reserve exists over most of the mainstem, but no Crown Reserves are evident along the tributaries.

This reach reflects the different nature of the catchment as it transitions out of the foothill country with a narrow flat valley floor and limited floodplain along the mainstem into flatter terrain. Deep pools are interspersed with longer run segments. The flow is generally ephemeral but the recent initiation of environmental flow releases from the Mt Cole Reservoir on top of a good set of springs in the granitic foothill break of slope areas seems to be sustaining the maintenance of the pools despite the extended dry period experienced at the time of inspection.

The tributaries rise on the steeper lateral slopes of both the Mt Cole range to the east and Telegraph or Big Hill to the west. These small streams can be seen to have undergone erosion and incision but are now displaying a relatively stable bed with eroding banks having intersected bedrock in some areas. There are some signs of bed erosion but it is mostly bank erosion that will require ongoing monitoring. Tributaries R2/5, R2/5/1 and R2/6/1and R2/6/2 require close surveillance, as some steeper portions have inherent instability due to the grade and lack of bank vegetation.

The eastern Tributary R2/2 is still showing signs of instability up to the and beyond Iron Pot Creek Road to the forest edge. Both sub tributaries are deeply incised and may need intervention. There are still areas of bank erosion along the whole reach and a decision to intervene will be only able to be made after discussions with the new land owner and planter of the Blue Gum plantation. It is likely that the plantation will slow down the bank erosion.

The eastern tributaries of Spring Creek are stable. A large swamp on the lower Spring Creek needs to be protected and if possible have overstorey and more diverse sedge species re-established to increase the habitat complexity whilst maintaining the filtration benefits of the Typha.

5.3 Vegetation

The vegetation along the main stem of Mt Cole Creek is restricted to a narrow riparian band, and is discontinuous, without any significant overstorey in many areas. Some areas of River Red Gums exist throughout the reach. Groundcover consisted of a few saline tolerant species and a suite of weeds including Spiny Rush, Broom and Gorse.

The tributaries all showed very poor vegetation characteristics with only a few remnant River Red Gums existing along the stream lines. The dominant vegetation along the tributaries was either salt tolerant pastures or Spiny Rush. The large Phragmites swamps (sedge dominated freshwater meadows) were very noticeable and need to be protected and enhanced to provide both diversity and water quality treatment functions.

A variety of factors are at play, contributing to the decline of riparian vegetation within the reach. The pressures of the drought, combined with stock access are having a significant impact on riparian vegetation and habitat within the area.

Again the condition of the ephemeral wetlands is important for water quality management and these should be the focus of a detailed mapping and protection program.

Remaining Remnant Vegetation, as detailed on the Biomap mapsheet, is generally restricted to the upper portion of the reach. The riparian associations appear to have been largely removed. Table 5.1 lists the reaming remnant vegetation remaining in the reach, which is expected to have occurred prior to European settlement.

- **Table 5.1 - Current and Pre-European Vegetation Attributes (EVC) Reach 2**

Current EVC Remaining in Reach (DSE, 2005)	Pre 1750 EVC's in reach (DSE, 2003)	Location
3 - Damp sands Herb Rich Woodland	3 - Damp sands Herb Rich Woodland	
20 - Heathy Dry Forest	20 - Heathy Dry Forest	Shallow rocky skeletal soils.
23 - Herb-rich Foothill Forest	23 - Herb-rich Foothill Forest	Relatively fertile, moderately well drained soils. Easterly and southerly aspects of lower slopes and gullies.
47 - Valley Grassy Forest	47 - Valley Grassy Forest	Generally nutrient poor soils of the upper slopes.
	48 - Heathy Woodland	Generally nutrient poor soils of the upper slopes.
	55 - Plains Grassy Woodland	Poorly drained, fertile soils on flat to gently undulating plains of low elevation.
	68 - Creekline Grassy Woodland	Drainage lines and adjoining flats.
71 - Hills Herb-rich Woodland	71 - Hills Herb-rich Woodland	Wide variety of environments from flat ground to exposed ridges.
73 - Rock Outcrop Shrubland	73 - Rock Outcrop Shrubland	
	152 - Alluvial Terrace Herb-rich Woodland	Occurs on broad alluvial plains and along ephemeral drainage lines.
896 - Grassy Woodland / Heathy Dry Forest Complex	896 - Grassy Woodland/Heathy Dry Forest Complex	

Vegetation management requirements for Reach 2 centre around the need to secure the riparian zone from the impacts of livestock access and establish a suitable canopy cover. Due to the limited extent of vegetation within the riparian zone it is expected that the revegetation works in the early phase of development would focus on River Red Gum, Black Wattle and Buloke establishment. With suitable stock control, other species are more likely to establish naturally over time. The success of this approach could be gauged after a designated time period (10 years) and access the need for further weed control and species augmentation.

5.4 Habitat

The habitat of the mainstem is very poor due to the loss and modification of the riparian vegetation through grazing. Some of mainstem pools have some good complexity and hence habitat potential but most were cleared and or fringed by Spiny Rush.

The presence of a Crown Reserve over the majority of the mainstem gives rise to opportunities to secure some higher values through revegetation and fencing. Again there will be a need to address stock watering access.

The permanent pools of the upper portion of the mainstem reach could form an important refuge for fish and other species if they were rehabilitated. Based on the data previously referred to (SKM 2002), it may be possible to establish a habitat capable of supporting a range of fish and mammal species. The pools near the Ararat Road at Warrak are basically stable and have some remnant River Red Gums that could provide a framework to work from.

With the exception of Spring Creek the habitat condition of most of the ephemeral tributaries is extremely poor with no appreciable significance or habitat value.

5.5 Water Quality

The water in the pools were clear at the time of inspection with no sign of algal blooms and the substrate showing little sign of gross aggradation except where the lateral and eroding tributaries enter the stream. The mainstem is showing signs of some sediment aggradation and degradation but most of the sediment seems to be locally contained.

However the presence of finely divided sands and silts in the sediments indicates that the finer solids and colloids will be transported under event conditions along with elevated nutrients from catchment sources. The higher salinity regime can be expected given the sedimentary overlay of a granitic base with obvious signs of salinity in the tributaries.

The small base flows at the upstream were noted for a slight brackishness but lower than that at the downstream end of the reach.

5.6 Flooding

Limited mainstem flooding is likely in this reach as the valley floor is confined in most places and the waterways are generally incised into the landscape.

There is no detailed study of flooding of the area and only flooding of road crossings on some of the tributary roads would appear to be at risk of flooding. This is based on field observations and the need for an expansive flood study probably not warranted at this stage.

5.7 Threats and Priorities

The following table summarises the major threats that have been identified in Reach 2. For specific details on issues, actions, locations, priorities and cost estimates, refer to Appendix B – Reach 2 Summary of Issues & Actions.

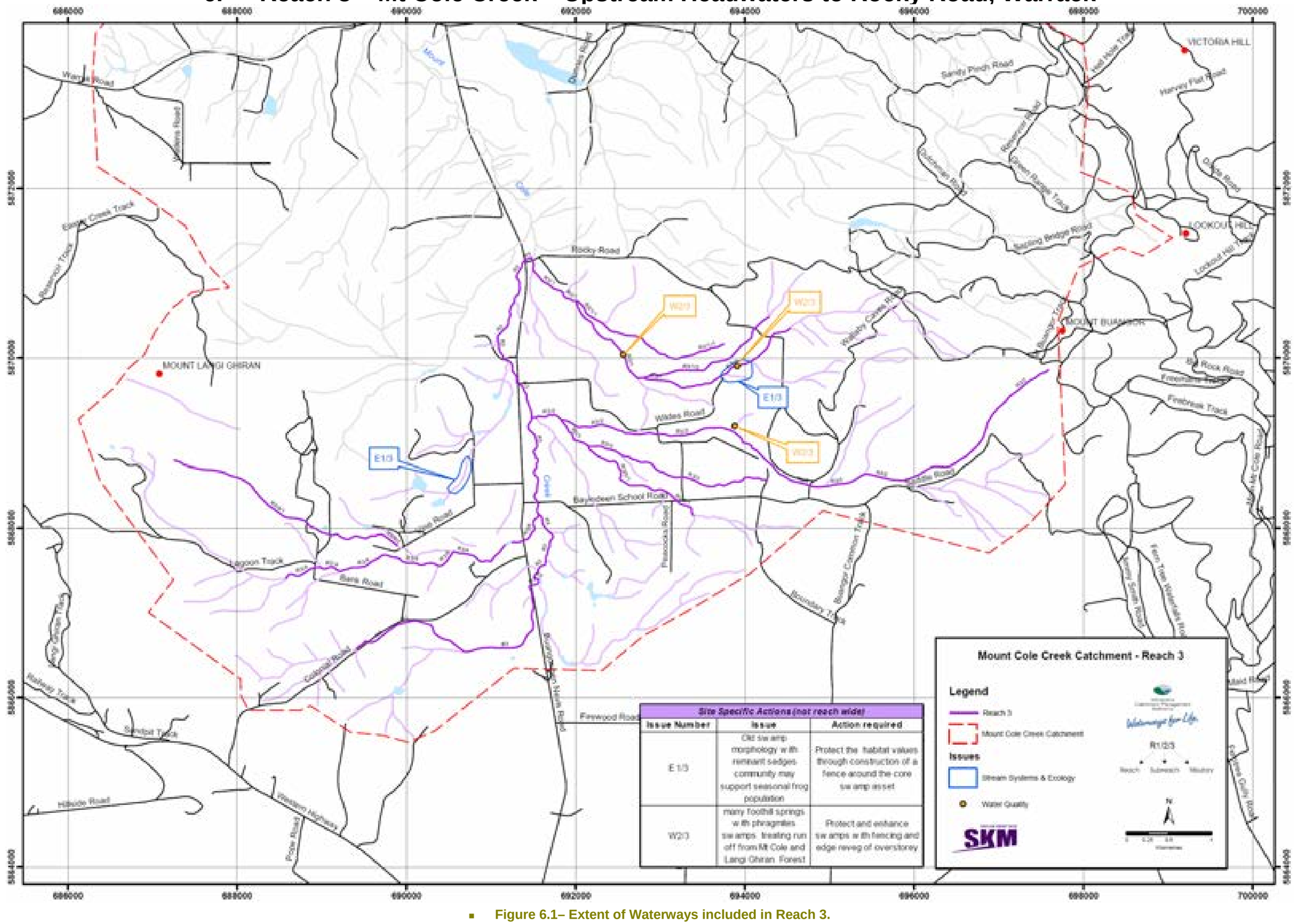
Table 5.2 – Threats and Priorities identified in Reach 2

Threat	Priority
Increased decline and or loss of habitat and riparian vegetation along the Mt Cole Creek mainstem and Spring Creek	Very High
Stock access to stream zones in both mainstem and eroding areas of tributaries	Very High
Need to protect the spring areas and or Phragmites swamp on Spring Creek	Very High
Maintenance of Environmental flow releases	Very High
Decline of pool habitats as key refuges in nil flow periods	High
Small amounts of active erosion in upper tributary streams with the potential to generate and transport sediment	High
Extensive Spiny Rush infestation in the stream bed	Moderate
Nutrient transport from the catchment due to land use and loss of mitigation systems	Moderate
Salinity production in denuded catchments and or discharge areas along lateral tributaries leading to saline discharge areas and higher salinity in the stream	Moderate

- **Figure 5.2 – An intact valley floor that is not subjected to stock pressures**

Figure 5.3 – Erosion and a lack of habitat result in poor waterway health. Stock pressures are major contributors to these factors

6. Reach 3 – Mt Cole Creek – Upstream Headwaters to Rocky Road, Warrack



- **Figure 6.1– Extent of Waterways included in Reach 3.**

6.1 Reach Location

This reach includes the majority of the headwater tributaries and the mainstem of Mt Cole Creek.

6.2 Morphological Description

The main channel occurs in a well-defined valley with some areas of remnant and near intact vegetation. The channel is characterised by a pool/run morphology with extended lengths on interpool runs. The channel is basically stable with some intersects of bed rock evident. Flows appear to be ephemeral with all streams dry at the time of our inspection. There may be, however, subsurface flows in the sandy and gravely substrate. The mainstem is fed from a series of seasonal springs that occur at the break in slope at both the Mt Cole and Mt Langi Ghiran foothills. The two main tributaries from Mt Langi Ghiran are reasonably well vegetated and need protection.

6.3 Vegetation

The vegetation along the mainstem of Mt Cole Creek and the R3/8 tributary from Mount Langi Ghiran have a reasonable width of riparian vegetation, although there are some areas of discontinuity along the reach. The overstorey was dominated by River Red Gum, with some Swamp Gum and Manna Gum also present. Some small areas of intact remnant vegetation do appear along the mainstem and have been mapped as Alluvial Terrace Herb-rich Woodland (EVC 67).

As the area receives slightly more rainfall than other areas of the Mt Cole catchment, an increase in weeds such as Blackberry, Sweet Briar and Tutsan were noted.

Remnant vegetation is also largely restricted to the upper areas of the reach, where land use pressures have been minimal due to the steeper nature of the area. Some of the tributaries draining from the southwest contain some remnant vegetation along their courses. Table 6.1 lists the remnant vegetation remaining in the reach as detailed on the DSE biomap (DSE, 2005). A list of remnant vegetation thought to have occurred in the catchment prior to European settlement is also included.

Table 6.1 - Current and Pre-European Vegetation Attributes (EVC) Reach 3

Current EVC Remaining in Reach (DSE, 2005)	Pre 1750 EVC's in reach (DSE, 2003)	Location
3 – Damp sands Herb Rich Woodland	3 – Damp sands Herb Rich Woodland	Alluvial splays, lower tributaries
20 – Heathy Dry Forest	20 – Heathy Dry Forest	Shallow rocky skeletal soils.
	23 – Herb-rich Foothill Forest	Relatively fertile, moderately well drained soils. Easterly and southerly aspects of lower slopes and gullies.
47 – Valley Grassy Forest	47 – Valley Grassy Forest	Alluvial plain and lower slopes

		outside riparian influence
	68 – Creekline Grassy Woodland	Drainage lines and adjoining flats
71 – Hills Herb-rich Woodland	71 – Hills Herb-rich Woodland	Wide variety of environments from flat ground to exposed ridges.
896 – Grassy Woodland/Heathy Dry Forest Complex	896 – Grassy Woodland/Heathy Dry Forest Complex	Upper slopes of diminishing fertility

The rehabilitation of the riparian zone of the primary tributaries and mainstem back towards the forest edge should be a long-term goal. Due to the current depleted state of the vegetation within this reach, particularly in the tributaries, revegetation works will require a great deal of work. The removal of stock from the riparian zone and the establishment of canopy species within the area are recommended. Species augmentation along the main stem should also be undertaken to improve the ecological condition of the reach.

6.4 Habitat

The instream habitat of the mainstem is impacted on by the lack of permanent flows and reduced number of pools. There is no data to suggest that there is residual pool areas that sustain any significant instream or macro fauna. It is likely due to the stronger riparian condition that the normal array of ephemeral species will avail themselves of the stream habitats once flows become evident. The areas of improved riparian condition and habitat gives rise to a more complex set of terrestrial interactions. Again whilst there is no data available these stream corridors could form important habitat for Owl species that may nest in the upper ranges such as Sooty or Powerful Owls.

As with previous reaches, the habitat condition of most of the cleared and grazed ephemeral tributaries is extremely poor with no appreciable significance.

6.5 Water Quality

The water quality of this upland section is likely to be without the significant problems of suspended solids and turbidities, given the lack of eroding streams and or other significant catchment disturbances, mainstem pools are brackish to sub saline and shows no sign of algal blooms. The substrate shows little sign of gross aggradation but there is evidence of more sands.

The lack of appreciable and noticeable sediment in the lower mainstem segments reinforces that there is little transport of gross or settleable sediment through to the mainstem, this being attenuated locally in foothill fans or a series of small ephemeral swamps across the catchment.

Salinity regimes are likely to be lower as the catchments are predominantly granitic as different to sedimentary. No data is available to support this contention.

6.6 Flooding

Except for the low culvert capacity of the main stem crossing on the Buangor - Ben Nevis Road, there are no significant flooding issues in this reach.

This area is not marked with any warning signs as a flood hazard and is hence potentially unsafe.

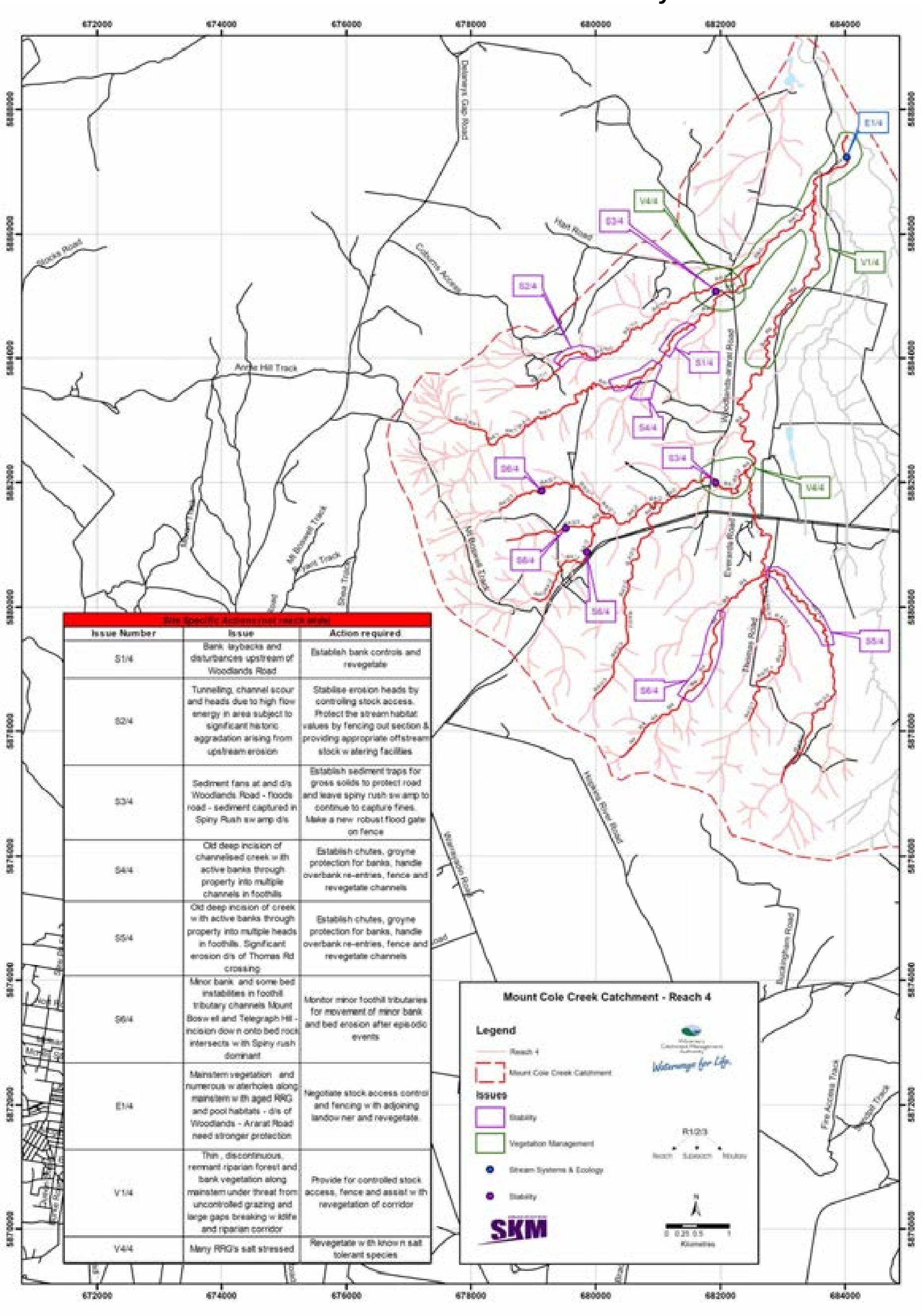
6.7 Threats and Priorities

The following table summarises the major threats that have been identified in Reach 3. For specific details on issues, actions, locations, priorities and cost estimates, refer to Appendix C – Reach 3 Summary of Issues & Actions.

Table 6.2 – Threats and Priorities identified in Reach 3

Threat	Priority
Further loss of habitat and riparian vegetation along Mt Cole Creek and the primary tributaries of Mt Buangor and Mt Langi Ghiran	High
Stock access to stream zones in both mainstem and tributaries	High
Loss of vegetation of the key spring areas at the toe of slope	Moderate
Road safety of the Buangor Ben Nevis Road crossing	Moderate
Weed infestations along the mainstem and key waterways	Moderate

7. Reach 4 - Headwaters from Mt Boswell and Telegraph Hill to Unnamed Mt Cole Creek Tributaries West of Dunneworthy



Site Specific Actions - not reach wide		
Issue Number	Issue	Action required
S1/4	Bank, layBacks and disturbances upstream of Woodlands Road	Establish bank controls and revegetate
S2/4	Tunnelling, channel scour and heads due to high flow energy in area subject to significant historic aggradation arising from upstream erosion	Stabilise erosion heads by controlling stock access. Protect the stream habitat values by fencing out section & providing appropriate offstream stock w atering facilities
S3/4	Sediment fans at and d/s Woodlands Road - floods road - sediment captured in Spiny Rush sw amp d/s	Establish sediment traps for gross solids to protect road and leave spiny rush sw amp to continue to capture fines. Make a new robust flood gate on fence
S4/4	Old deep incision of channelised creek w ith active banks through property into multiple channels in foothills	Establish chutes, groyne protection for banks, handle overbank re-entries, fence and revegetate channels
S5/4	Old deep incision of creek w ith active banks through property into multiple heads in foothills. Significant erosion d/s of Thomas Rd crossing	Establish chutes, groyne protection for banks, handle overbank re-entries, fence and revegetate channels
S6/4	Minor bank and some bed instabilities in foothill tributary channels Mount Boswell and Telegraph Hill - incision down onto bed rock intersects w ith Spiny rush dominant	Monitor minor foothill tributaries for movement of minor bank and bed erosion after episodic events
E1/4	Mainstem vegetation and numerous w aterholes along mainstem w ith aged RRG and pool habitats - d/s of Woodlands - Ararat Road need stronger protection	Negotiate stock access control and fencing w ith adjoining landow ner and revegetate.
V1/4	Thin, discontinuous, remnant riparian forest and bank vegetation along mainstem under threat from uncontrolled grazing and large gaps breaking w ildlife and riparian corridor	Provide for controlled stock access, fence and assist w ith revegetation of corridor
V4/4	Many RRG's salt stressed	Revegetate w ith know n salt tolerant species

- **Figure 7.1– Extent of Waterways included in Reach 4.**

7.1 Reach Location

This reach includes a number of tributaries that join Mt Cole Creek near the confluence of the Wimmera River. They all rise from the steeper sedimentary hills of Mt Boswell and Telegraph Hill (refer to Figure 7.1 for more detail). These hills are underlain by granite and sedimentary deposits and this gives rise to salinity problems.

7.2 Morphological Description

The hills are denuded in this reach. However, the salinity management program and the effort of a few landowners has recently seen the extensive revegetation of some areas of the very steep upper slopes where infiltration would occur. This work needs to be supported as it not only assists in addressing the salinity issues, it will also slow the rate of runoff from these steep and bony hills.

The streams are all deeply incised through the foothill regions and upper slopes, but for the majority further incision seems to have been arrested or bedrock intersected. These streams are now extensively colonised with Spiny Rush. Some areas of the very upper reaches appear to be still actively eroding driven by the rapid runoff generated on the rocky cleared hills. These areas need to be monitored for any rapid increase in gully formation and appropriate responses made.

Downstream of the break of slope a number of tributaries are still undergoing a process of tunnel erosion followed by collapse and then nickpoint formation. R4/1 and R4/1/1 are still very active and need rapid intervention. Both of these streams show the impacts of salt. A problem to be solved concurrently is that of access to the stream by sheep for watering, thus further destabilising the banks.

The rest of the streams are undergoing bank erosion. The deeper areas of Reach R4/1 would benefit from some active toe protection and revegetation works in this regard. A problem of instability exists on R4/3/2 where it crosses Thomas Road. A large erosion head exists downstream of the culverts and needs to be stabilised. Some bed load is also evident in this reach indicating a degree of bed and bank instability upstream.

Sediments are being transported from the foothill areas onto the flatter lowland plain segments, particularly east of the Woodland Ararat Road. The bed load is being retained a series of alluvial fans and Spiny Rush swamps. The impacts of finer material not captured in these floodplain areas are still likely to effect these receiving streams. The ability to enhance the removal capability of the swamp areas exists but may be constrained by the desires of the landowner.

7.3 Vegetation

The vegetation along the tributaries is scarce and essentially restricted to some Tussock Grasses and Spiny Rush. The upper tributaries are essentially without overstorey and or midstorey

vegetation. Stock access seems to be basically uncontrolled except by the steep banks along the deeper sections.

The lower floodplain areas have a narrow riparian zone consisting of a few salt stressed River Red Gums and Spiny Rush. In the upper slopes, except for the few landowner driven plantings, there is no appreciable recruitment to the overstorey or midstorey vegetation left in this area due to the stock pressure. Whilst the Spiny Rush could be regarded as a pest it has value in arresting the bed erosion in these saline impacted streams, Spiny Rush also has good habitat qualities, particularly for amphibian species.

The trial of various macrophyte species as a replacement for Spiny Rush (habitat value and erosion control value) should be undertaken as part of the removal of Spiny Rush. Spiny Rush removal and control should also be undertaken in an ecologically sensitive fashion. In that entire patches of spiny rush should not be removed (physically or chemically) in a single episode, but rather to maintain some habitat (and erosion control) facilities and treat remaining areas at a future date, once replacement habitat has established.

Little remnant vegetation remains in Reach 4. At present there are remains of small isolated patches scattered across the catchment. Table 7.1 below details the remnant vegetation remaining within the reach, which is expected to have occurred prior to European settlement of the area.

Table 7.1 - Current and Pre-European Vegetation Attributes (EVC) Reach 4

Current EVC Remaining in Reach (DSE, 2005)	Pre 1750 EVC's in reach (DSE, 2003)	Location
22 – Grassy Dry Forest	22 – Grassy Dry Forest	Range of slopes and altitudes outside of the riparian zone
48 – Heathy Woodland	48 – Heathy Woodland	Generally nutrient poor soils of the upper slopes.
	67 – Alluvial Terrace Herb-rich Woodland	Broad alluvial plains and ephemeral drainage lines.
68 – Creekline Grassy Woodland	68 – Creekline Grassy Woodland	Drainage lines and adjoining flats
76 – Low Rise Grassy Woodland	76 – Low Rise Grassy Woodland	Lower hills
	152 – Alluvial Terrace Herb-rich Woodland/Plains Grassy Woodlands Complex	Lower slopes with peak flood level influence
	175 – Grassy Woodland	Intermediate slopes between the plains and more infertile upper slopes.
896 – Grassy Woodland/Heathy Dry Forest Complex	896 – Grassy Woodland/Heathy Dry Forest Complex	Intermediate slopes between the plains and more infertile upper slopes.

The control of stock assess to the riparian zone is a major issue and one which should form the first stage of revegetation works. Following stock control, the reintroduction of suitable canopy species corresponding to the EVC's is likely to have occurred at the site should also be undertaken.

7.4 Habitat

The habitat of all of these tributaries is severely depleted by the lack of vegetation and lack of permanent flows.

7.5 Water Quality

The water quality of these tributaries is grossly impacted by the dominant salinity problem. However the presence of finely divided silts in the sediments indicates that very fine silts and colloids will be transported under event conditions along with elevated nutrients from catchment sources. A separate study into the importance of the attenuation capability of the swamps and wetlands in this catchment is required

The higher salinity regime can be expected given the leachable country and known sources of salt in the sedimentary based soils of the upper catchment areas. As well as the small base flows noted at the downstream end with an estimated salinity of 3000- 5000 uS/cm, it is likely that there are deeper gravel and sand leads that transport flows and or provide springs along these systems in the lowland valleys.

This would explain why some of the waterholes on the stream east of Woodlands Road have semi-permanent to permanent pools in extended dry periods.

Along with the abundance of suspended solids and turbidity from eroding tributaries another source of these contaminants is likely be from rural roads under rainfall conditions. Roads can contribute substantially to the over all suspended solids export from a catchment along with the erosion of roadside drains. In particular Woodlands Road would contribute greatly to the solids loads.

7.6 Flooding

The main issue for flooding is that of the crossings of Woodlands Road. Minor flooding at the Pyrenees Highway Crossing of R/4 is only likely under extreme rainfall events.

This activity is likely to be regular, as the culverts under the road are very small in capacity. This will continue to damage the road surface and inhibit traffic during the short periods of inundation.

Whilst no mapping exists of flooding for these western tributaries, it is expected to be extensive over the flatter terrain east of Woodlands Road.

7.7 Threats and Priorities

The following table summarises the major threats that have been identified in Reach 4. For specific details on issues, actions, locations, priorities and cost estimates, refer to Appendix D – Reach 4 Summary of Issues and Actions.

Table 7.2 – Threats and Priorities identified in Reach 4

Threat	Priority
Further loss of habitat and riparian vegetation along the lower portions of the streams east of Woodlands Road due to salinity and grazing problems	Urgent
Stock access to stream zones along all reaches but particularly the areas of the upper tributaries	Urgent
Significant amounts of active bed and bank erosion in the foothill segments of the tributary streams with the potential to generate and transport large loads of sediment	Urgent
Loss or decline in performance of key ephemeral swamps and floodplains to mitigate suspended solids and turbidity arising from the tributaries	Very High
Lack of riparian vegetation along most tributaries impacting on long term stability and production of erosion products	High
Salinity production in denuded catchment leading to saline discharge areas and higher salinity	Moderate
Spiny Rush Infestations along all tributaries	Moderate
Rabbit infestations in upper catchments reducing catchment cover on the drier hills	Moderate

- **Figure 7.2 – Developing off stream watering options is essential to help stabilise waterways**

Figure 7.3 – Tunnelling and subsurface flows are contributing to erosion

Figure 7.4 – Revegetation of denuded hillslopes by landholders is to be applauded and encouraged

8. Reach 5 – Headwaters on Telegraph Hill to Unnamed Mt Cole Creek Tributaries East of Dunneworthy

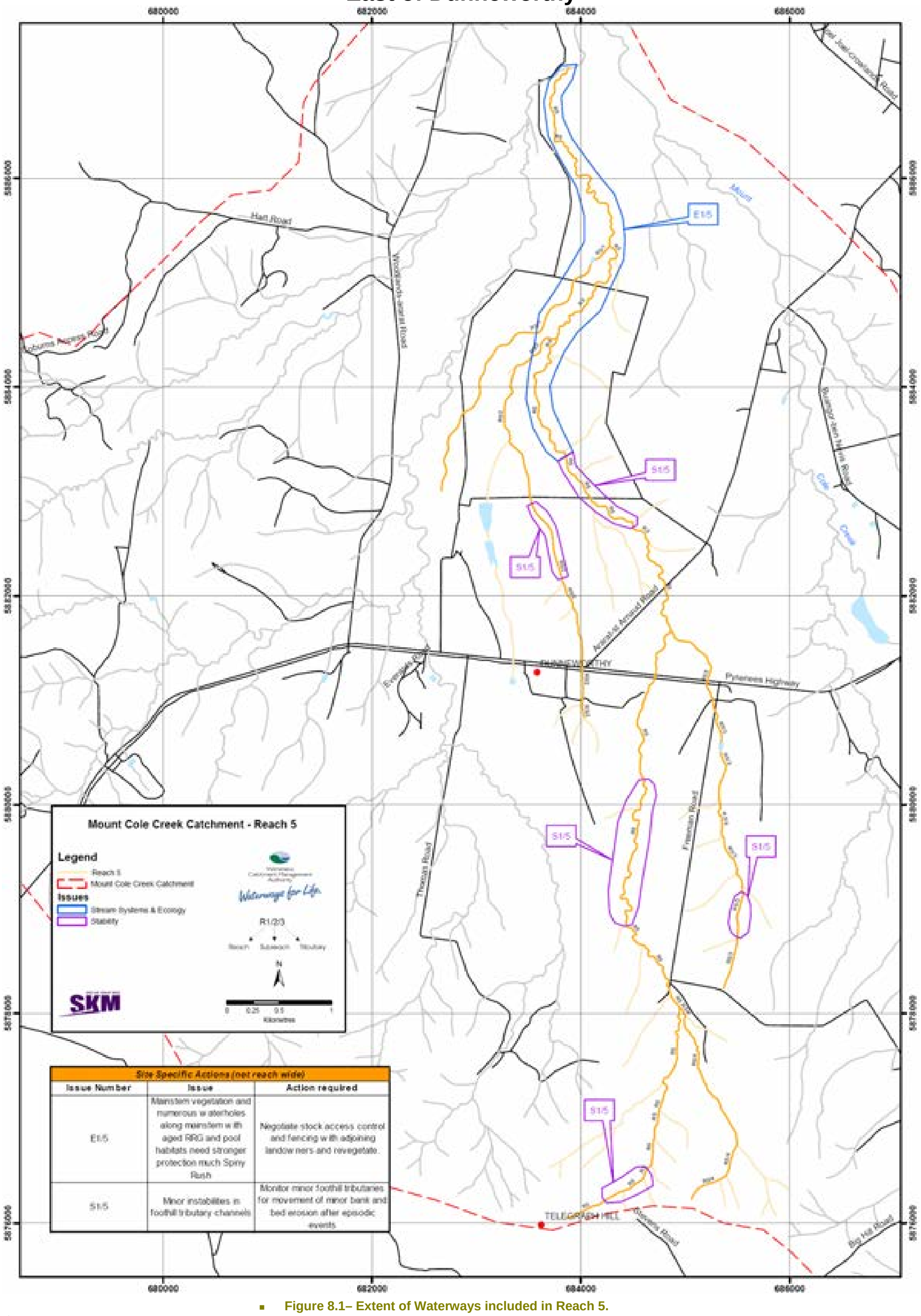


Figure 8.1– Extent of Waterways included in Reach 5.

8.1 Reach Location

This reach includes the tributaries that arise east of Dunneworthy and in particular one stream that arises out of a revegetated part of Telegraph Hill (refer to Figure 8.1 for more detail).

8.2 Morphological Description

The stream channel throughout this reach has undergone incision recently but is now essentially a stable channel that sits in a narrower floodplain. Again the main landuse is that of cereal cropping and sheep grazing. The stream in this reach is ephemeral and the tendency to form permanent pools starting to lessen. Some residual pools were still seen as far upstream as Marland Road.

Other than the insidious bank erosion of the incised and Spiny Rush infested foothill stream segments there are few serious erosion problems. Bank erosion is evident in R5 west of Freemans Road. Further up this tributary and upstream of Freemans Road, a granite gorge exists at the break of slope. This area is in the care of a well-informed landowner who is managing this area for its significance.

8.3 Vegetation

The small area of remaining vegetation along the main stem of R5 consists of a narrow and generally discontinuous riparian zone. A few scattered River Red Gums remain in a fabric of Spiny Rush.

The area of the granite gorge is being maintained as a destocked area and could provide an important seed reserve for the wider landscape, as well as providing a biodiversity refuge that should be the hub of corridors in the local vicinity. The maintenance and retention of these values is seen as important and protective measures should be instituted.

Except for the extensive revegetation of the very upper slopes of Telegraph Hill, by one land owner, most of the very upper tributaries are essentially without overstorey and or midstorey vegetation. Bank erosion is evident in areas where there is uncontrolled stock access.

Very little remnant vegetation remains within the reach. Only two small patches of remnant vegetation are apparent within the reach, based on the DSE biomap (DSE, 2005). Table 8.1 below details the remnant vegetation remaining within the reach, which is expected to have occurred prior to the European settlement of the area.

- **Table 8.1 - Current and Pre-European Vegetation Attributes (EVC) Reach 5**

Current EVC Remaining in Reach (DSE, 2005)	Pre 1750 EVC's in reach (DSE, 2003)	Location
	6 – Sand Heathland	Lower Floodplain
	20 – Heathy Dry Forest	Upper slopes, skeletal soils
	22 – Grassy Dry Forest	Lower slopes and alluvial plain outside riparian influence
61 – Box Ironbark Forest	61 – Box Ironbark Forest	Upper Slopes
	67 – Alluvial Terrace Herb-rich Woodland	Alluvial terraces
	70 – Hill Crest Herb-rich Woodland	Upper Slopes and Crests
	76 – Low Rises Grassy Woodland	Upper areas of tributaries
	83 – Swampy Riparian Woodland	Banks of Heifer Station Creek.
	86 – Creekline Grassy Woodland	Banks of Heifer Station Creek.
175 – Grassy Woodland	175 – Grassy Woodland	Slopes

The control of stock to the riparian environment needs to be undertaken through the promotion of fencing and offstream watering points. Weed control should be undertaken in areas upstream of the gorge, to attempt to protect the conservation values that are reputedly present within the area. The riparian corridor will make an excellent biodiversity corridor once it can be secured and revegetation works can be undertaken, linking up the conservation values of the gorge with the wider landscape.

8.4 Habitat

The habitat values of the Gorge area are yet to be ascertained. Other than this there appears to be few areas of significant habitat value either instream or in the riparian area.

8.5 Water Quality

The water quality of this segment is dominated by the occurrence of saline flows emanating from the sedimentary layers of the upper slopes and lowland hills towards the junction with Reach 4. As the revegetation of the upper infiltration zones mature this may decrease allowing the tackling of the Spiny Rush infestations. However it is unlikely to resolve the discharge of the rolling hill country north of the Highway.

Significant areas of salinity discharge have been identified both north and south of the Pyrenees Highway. The remnant mainstem pools are brackish to sub saline and show no sign of algal blooms.

The seriously eroding tributaries, R5 and R5/3, will see the elevation of both suspended solids and turbidity in this reach. Without the mitigating influences of on-stream wetland and sedimentation zones, the streams receive untreated flows, resulting in sedimentation of the lower reaches. It is unlikely however that this will advance downstream and become a concern for the Wimmera River.

8.6 Flooding

Flooding is not a major issue for this reach with the only potential problem being the Pyrenees Highway crossing, where the culvert is likely to be exceeded in a major flood event.

The floods will dissipate across the broader valley floors north of the Highway.

8.7 Threats and Priorities

The following table summarises the major threats that have been identified in Reach 5. For specific details on issues, actions, locations, priorities and cost estimates, refer to Appendix E – Reach 5 Summary of Issues and Actions.

Table 8.2 – Threats and Priorities identified in Reach 5

Threat	Priority
Further loss of habitat and riparian vegetation along the tributary streams	Very High
Stock access to stream zones in eroding and saline affected areas of tributaries downstream	High
Spiny Rush Infestations along all tributaries	Moderate
Lack of riparian vegetation along most tributaries impacting on long term stability and production of erosion products	High
Excessive infiltration in denuded catchment leading to saline discharge areas and higher salinity	Moderate
Rabbit infestations in upper catchments reducing catchment cover on drier hills	Moderate

- **Figure 8.2 – Spiny Rush is prevalent throughout the reach**

Figure 8.3 – Spiny rush dominates the valley lines, particularly in swamp areas

9. Summary

Specific issues and actions for the **five** individual reaches are shown in the following reach activity spreadsheets (Appendices A through to E). These sheets detail the recommended actions and have been grouped according to activity headings, namely:

- Stream systems and ecology (E);
- Stability (S);
- Water quality (W);
- Vegetation management (V); and
- Flood management (F).

A catchment wide summary of each of the above activity headings has also been compiled. These sheets (Appendices F through to J) combine the data previously presented by reach, in a single table and have been ranked by priority.

A list of Wimmera CMA incentive rates is shown in Appendix K. for more information on incentives, refer to Wimmera CMA '*Healthy Waterways Incentive Scheme*'.

A whole of catchment map that includes aerial photography, site specific issues and actions is shown in Appendix A. Note: It is recommended that this map is be printed at A0 scale for best results.

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