

East Gippsland Shire Council **Urban Waterway Management Strategy**

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**Victorian Local
Sustainability Accord**

Executive summary

This project was funded through the Victorian Government's Sustainability Fund under the Victorian Local Sustainability Accord and has been commissioned by the East Gippsland Shire Council.

This management strategy reviews the works undertaken by the East Gippsland Shire Council in a number of key reserves and provides guidance on future management opportunities. In addition, the strategy examines the opportunities and constraints in a number of waterway assets that will, after land development, become the responsibility of the Council.

This 'Management Strategy' has been prepared with companion 'Waterway Guidelines' document that provides advice on considerations to progress towards a best practice approach to the management of waterways in the urban environment.

Council manages and maintains a number of minor waterways in urban areas. These waterways are primarily ephemeral in nature, subject to high nutrient, sediment and litter loads and weed invasion. Whilst often degraded by the urban influence these waterways often provide valuable ecological and social assets.

An enhanced urban waterway creates a habitat corridor for many native fauna species and filters potentially polluted water before it enters the receiving waterbody (eg Gippsland Lakes). The minor waterways are also important in their own right as many native fish species either reside in or migrate into these smaller waterways to complete their life cycle.

Importantly, accessible urban waterways are where the community maintains a frequent interaction with the natural environment. As such, these waterways enable an opportunity to provide information to the community on the ecological and cultural significance of the rivers, wetlands, flora, fauna and estuaries of the region.

This management strategy has reviewed the current condition, threats and management of;

- Merrangbaur Heights Creek – Lakes Entrance
- Magees Gully - Bairnsdale
- Goose Gully – Eastwood
- Lake Bunga Gully – Lake Bunga
- Eagle Point Creek – Eagle Point

A brief desk-top assessment of Nicholson Gully (Nicholson), Livingstone Creek (Omeo) and Shady Gully (Mallacoota) was also undertaken.

The review found that where Council has been undertaking rehabilitation activities there has been a significant improvement in the vegetation condition of the waterway. There are opportunities to further enhance the works with the inclusion of additional structural habitat and, where possible, the removal of barriers. Identifying holistic rehabilitation and corridor linkages will assist the Council in State and Federal funding bids.

The primary risks to the waterways were found to be weed invasion, changes to the hydrological regime with urbanisation and, in particular, high sediment loads from developing areas and major roads.

Management of the waterway starts in the catchment and the reduction in the changes to the hydrology through capturing, storing and using rainwater have benefits to the waterway. Clearly documenting the objective of a rehabilitation program will assist in the planning and implementation of works. The incorporation of an effective monitoring and evaluation program will assist East Gippsland Shire Council in the on-going improvement of its waterway asset improvement works.

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1. Introduction

This project was funded through the Victorian Government's Sustainability Fund under the Victorian Local Sustainability Accord and has been commissioned by the East Gippsland Shire Council. The strategy reviews recent works that have been undertaken by Council on waterways and identifies opportunities to improve the implementation whilst providing guidance in relation to their rehabilitation.

The information derived from assessments developed by the project will be provided to potential developers, interested community groups, and immediate neighbours of any designated sites.

This strategy is to be read in conjunction with the companion 'Guidelines' document which provides guiding directions that may assist in the improvement of waterways that are subject to future development.

In the context of this strategy 'urban waterways/waterways' are the minor tributaries that are either currently, or will be in the future, surrounded by urban development in the major townships of East Gippsland. In this case it does not include the major rivers such as the Mitchell, Tambo, Snowy, Nicholson or the foreshores of the Gippsland Lakes or other estuaries.

The overriding aims of this strategy and the companion Guidelines is to assist and guide the East Gippsland Shire Council in achieving:

- Reduction in sediment and nutrients entering the Gippsland Lakes from urban areas
- Establishment of vegetation corridors through the urban areas
- Reduction of weed species in urban waterways
- Improving community perception and value of urban waterways
- Identification of recreation opportunities in line with the East Gippsland Shire Council Trails Strategy

To this end this strategy identifies direct actions that Council can undertake in improving the 'health' values of a selection of waterways currently under management responsibility of the Council.

1.1 Waterway health

Across the communities of Gippsland there are many thousands of kilometres of waterways in varying degrees of 'health'. Waterway health is a measure of the ecological condition when compared to a natural or undisturbed state. For the purpose of this document a 'healthy' waterway refers to a river or stream with unimpaired ecological function. Poor waterway health may be caused by poor water quality, exotic or no vegetation, altered flow regime and a lack of physical habitat value. A community response to what constitutes a healthy waterway may often focus upon visual observations of water quality, presence of litter or observations of fauna.

There is no single template of what constitutes a healthy waterway as each waterway has a different set of characteristics, ecological values and fauna that may rely upon it. There are also limits to the likely health outcomes and targets that will be dependent on surrounding land-use, catchment characteristics and previous modifications. Setting realistic health targets for a waterway is the first step to developing a remediation plan to improve the health.

The benefits of a healthy waterway can be felt beyond the immediate vicinity of the waterway corridor. In East Gippsland in particular the focal point of the tourism industry is the productive and recreational value of the Gippsland Lakes. The health of the Gippsland Lakes

is reliant upon the surrounding catchment and the waterways and rivers that flow to them. Even minor urban waterways have an influence on the water quality and recreational values of the Lakes. Urban waterways can either be a source of poor water quality, contributing large quantities of sediment and nutrients to the receiving waterways, or can serve to reduce the impacts of urban development by trapping pollutants. A healthy urban waterway can also contribute to fish stocks if migratory fish have free movement and are provided with the structural habitat that they require.

In the urban context waterway health contributes to a feeling of wellbeing and community connectedness to the environment. Urban waterways and rivers are often the most visited natural areas due to their close proximity to population and as such are highly valued (DSE, 2009). This can be demonstrated by the popularity of the path adjoining the Mitchell River in Bairnsdale and the Goose Gully development in the Eastwood development. Conversely a waterway with perceived poor health and limited community access is most likely treated as such and becomes an area of limited value, attracting antisocial behaviours.

1.1.1 Victorian Waterway Management Strategy

In late 2012 the Victorian Government released for comment the draft Victorian Waterway Management Strategy. The Waterway Management Strategy provides a framework across Victoria for government, in partnership with the community, to manage river, estuaries and wetlands.

The document outlines the values waterways provide and the numerous challenges that face them. This policy guidance sets the direction and focus to the Catchment Management Authorities in the preparation of the Regional Waterway Management Strategies, to be prepared in 2013.

This Council document broadly aligns with the Victorian Waterway Management Strategy by building upon the core themes of; recreational use, environmental water, riparian vegetation, water quality, channel stability/connectivity, urban waterways, invasive species and extreme events (floods & bushfires). These themes have been captured in the following sections of this document and tailored for use in the context of urban development in the East Gippsland region.

It is anticipated that the East Gippsland Waterway Management Strategy (EGWMS) will also expand upon the same themes at the regional scale. Once the EGWMS has been released it may be advantageous to review this document in light of any possible policy updates that may be warranted.

2. Community attitudes to waterways

In 2009 the Department of Sustainability and Environment undertook a State wide survey into the community attitudes to waterways (DSE, 2009), a copy of which is included in Appendix C. Some of the key findings from this survey included:

- Victorians visit waterways to engage in a wide variety of recreational and commercial activities. Results found that 92% visit waterways to enjoy scenery; 76% to walk, hike or cycle; 37% to plant native trees and clear weeds; 36% to fish and 21% for stock and irrigation purposes;
- 99% of Victorians have high aspirations for our waterways and 98% agree that it is important for our waterways to be as healthy as possible so they continue to provide for our needs
- 83% feel most personally connected to a waterway local to them and 96% agree that they have a personal responsibility to our waterways;
- 67% of Victorians have good to excellent knowledge of waterway health;

- 90% of those surveyed know that planting native plants along a waterway's bank improves the health of the waterway;
- 77% know that algal blooms are unhealthy; and
- 86% understand that the presence of carp in a waterway is not a sign of good health.

A similar survey in Queensland found that when asked "How do you rate the value of South East Queensland's waterways for each of the following" the respondents gave the greatest emphasis with a very high value to:

- 53% for Health of the environment;
- 48% for Future generations;
- 35% for the economic wealth of the region;
- 25% for your lifestyle; and
- 21% for your recreation.

There is a generally supportive attitude to the expenditure of funds on urban waterways where there can be a demonstrated benefit to both recreational access and the observations of fauna.

3. Links to other strategies and documents

Activities within the East Gippsland Shire Council administrative area impact on the health of aquatic environments. Runoff from urban areas, sediment from unsealed roads and other sources, domestic wastewater discharges and entrained and dissolved pollutants from stormwater outlets enter the catchment and eventually the marine environment. A large selection of existing documents has been identified as being relevant to the urban waterways strategy. Within this selection, the following documents have been individually assessed for their relevance to the current work:

- East Gippsland Shire Sustainability Strategy 2008 - 2013
- East Gippsland Shire Council Urban Stormwater Management Plan (WBM, 2003)
- East Gippsland Shire Council Plan 2009 - 2013
- Gippsland's Water Quality Action Plan (EGCMA, 2005)
- Victorian Stormwater Action Program Final Report (EPA, 2007)
- WSUD Engineering Procedures (Melbourne Water)
- East Gippsland Shire Council Planning Scheme (2012)
- Victorian Planning Provisions (VPP), Department of Planning and Community Development (DPCD, 2012)
- VPP Practice Note: Using the integrated water management provisions of VPP Clause 56 – Residential subdivision (DSE, 2006)
- Floodplain management in Australia: best practice principles and guidelines. SCARM Report 73 (CSIRO, 2000)
- VPP Practice Note: Applying the flood provisions in planning schemes (DPCD, 2000)
- East Gippsland Regional Catchment Strategy 2012-2018 (DRAFT)
- East Gippsland Regional River Health Strategy (2005-10)
- East Gippsland Shire Council Trails Strategy 2012

3.1.1 East Gippsland Shire Council Sustainability Strategy 2008 – 2013

The East Gippsland Shire Council administrative area encompasses a range of significant natural assets, including seven National Parks such as the well-known Errinundra and Croajingolong National Parks. The municipality contains significant areas of old growth forest, and is home to a number of rare and threatened species and vegetation communities. With regard to these assets, the key objectives of the Strategy include:

- Ensure Council makes the pursuit of environmental sustainability a priority when undertaking operations;
- Ensure Council develops new, and strengthens existing, partnerships to effectively deliver environmentally sustainable outcomes;
- Ensure Council and the people of East Gippsland are informed on ways to better protect, enhance and enjoy the environment;
- Promote collective responsibility for environmental sustainability by engaging the community and supporting change.

The East Gippsland Shire Council Sustainability Unit, in conjunction with the Environmental Sustainability Advisory Board, is responsible for implementing the Strategy and ensuring that its actions are incorporated into the business plans of relevant Shire departments.

The Strategy includes priority objectives and key actions that are focused around the themes of Biodiversity (maintaining and restoring natural assets); Water, Energy and Waste (using resources more effectively); and Land Use and Economic Development (reducing everyday environmental impacts). With specific regard to the management and protection of urban waterways, the following sections and actions within the Strategy are considered especially relevant.

Section 2.1 - Land Use and Development – Council will continue to implement the Coastal Spaces Landscape Assessment Study (CSLAS), including significant elements that retain and enhance native vegetation and landscape protection, and work in conjunction with a range of stakeholders and community groups to manage erosion to reduce the impacts of land degradation on waterways.

Section 2.2 - Biodiversity - About 90 of Victoria's 300 Ecological Vegetation Classes (EVCs) occur within East Gippsland and contain a large number of vulnerable, endangered and critically endangered species of flora and fauna. East Gippsland Shire Council will work with stakeholders, community groups and adjoining Shires to promote the effective management of weeds within the region. The East Gippsland Shire Council will ensure that Council's construction projects include appropriate measures to control erosion and sediment during works, and improve land stewardship (including weed management) across the Shire.

Action 2.2-05 Establish a native vegetation 'Landbank' for Council projects requiring vegetation offsets. Identify areas of Shire owned and/or managed land for potential listing on Conservation Management Network site register.

Section 2.3 – Water Consumption and Quality – The Strategy identifies threats to the waterways of East Gippsland that include: flow regulation, salinity, degradation of riparian land and vegetation, reduced oxygen and light availability, habitat loss, algal blooms, increased sediment loads, altered pH, increased turbidity, pollution, pest animal and plant species, and wildfire.

The East Gippsland Shire Council is committed to enhancing the environments adjoining the Gippsland Lakes to target sites that are sources of nutrients and sediments. To this end the East Gippsland Shire Council has committed to implement the East Gippsland Shire Council Stormwater Management Plan (WBM, 2003), and encourage the inclusion of Water Sensitive Urban Design (WSUD) principles into design and construction of urban developments.

Action 2.3-04 Suggests that the East Gippsland Shire Council review, update and implement the East Gippsland Stormwater Management Plan, taking into account opportunities and innovation for stormwater reuse and quality improvements.

Action 2.3-06 Encourages retrofitting of Water Sensitive Urban Design (WSUD) systems into existing urban developments, and undertakes to ensure (via planning approvals) that the design and built form of new developments gives due regard to the principles of WSUD.

3.1.2 East Gippsland Shire Council Urban Stormwater Management Plan (2003)

The Urban Stormwater Management Plan (USWMP) was completed by WBM Oceanics Australia, and was adopted by Council on 23rd April 2003. The USWMP was developed to guide Council in improving the environmental management of stormwater throughout urban areas.

The USWMP provides a review of the main waterway quality threats in the Shire. Specifically, commercial land use runoff has been identified as a high threat to receiving environments in the Bairnsdale CBD, a high to very high threat in Lakes Entrance and a moderate to high threat in Paynesville (particularly over peak tourist times). Building site runoff is also considered to represent a high stormwater threat in Paynesville, and a moderate to high threat in Metung. Residential land use runoff is perceived to be a high stormwater threat to Bairnsdale Central, Bairnsdale East, Bairnsdale West, Bairnsdale North and Lakes Entrance localities. Residential land use is distributed across the municipality and is considered to be a moderate to high threat.

Table 3-2 in the USWMP provides a useful summary of the top ten prioritised water quality risk issues. Specifically it lists industrial land use runoff in Bairnsdale (1), commercial land use runoff in Lakes Entrance, Paynesville and Bairnsdale (2), general land and infrastructure development across the East Gippsland Shire Council municipality (4), residential land use runoff in Paynesville, Lakes Entrance, Bairnsdale and Metung (5), building site runoff in Paynesville (6) and industrial land use runoff in Lakes Entrance (7) in the top ten threats.

Table 4-1 Advocates construction of an artificial wetland in McGees Gully upstream of Macleod's Morass, incorporating a GPT with an oil and grease trap at the inlet (Action 5), and also focuses on sediment control practices (Action 2). Development of literature on stormwater management / water quality guidelines for developers is also suggested (Action 8).

Table 4-2 suggests extending the WSUD literature / guideline documentation to the general community (Action 6) and specifically promotes use of GPTs in strategic locations (Action 9).

Table 4-4 suggests extending the WSUD literature / guideline documentation to active development and construction sites to educate developers (Action 1) and calls for the development / implementation of site specific Environmental Management Plans (EMPs) (Action 2). Sediment control practices are also emphasised (Action 4).

Table 4-5 contains some specific task lists for waterway rehabilitation (North Arm, Kalimna Gully, Eastern Creek (Actions 4, 5 and 10), and advocates for an artificial wetland at Eastern Creek (Action 9), together with screening devices and/or sedimentation basins at a range of locations (Actions 11-15).

Table 4-6 calls for preparation of suitable stormwater quality guidelines for building and construction sites (Actions 1 and 4).

Table 4-8 endorses the use of side entry pit basket traps (Action 1), rainwater tanks (Action 2), velocity reduction / deflection devices (Action 3), and strategically located small wetlands at gully discharge locations into creek lines (Action 4).

Table 5-1 calls for establishment of mechanisms for implementing the USWMP, including a requirement that all officer reports to Council include a section addressing the consistency of any submitted proposal / issue with the USWMP.

Table 5-3 calls for a review of the planning scheme to include the addition of local policy provisions to address stormwater management (Action 1), and to establish links with WSUD through reference to the Victorian Stormwater Action Plan (VSAP) (Action 2). Other measures include the requirement for stormwater modelling data to be introduced as standard for large scale development / subdivision applications (Action 3) to minimise the

impact of increased run-off and pollution loads from existing, new and infill development. The Plan encourages the adoption of WSUD principles and innovative solutions into the planning of new developments, including water recycling and on-site water storage and re-use. For major developments and subdivisions (e.g. greater than 1ha), the Plan requires the preparation of a site management plan (Action 5).

Table 5-5 encourages greater public awareness of all waterways in East Gippsland, to improve the physical condition and visual appearance of creeks, including implementing a signage system to identify waterways. The development of interactive and interpretive material for visitors to the waterways is recommended to facilitate greater public access to waterways.

Section 6.1 recommends that a Stormwater Management Coordinator and Stormwater Management Implementation Committee be appointed.

3.1.3 East Gippsland Shire Council Plan 2009 - 2013

Several links between the current review of urban waterways strategy and the Council Plan are evident.

Sustainability Objective

Strategy 2.1.1 identifies a priority area is to work with the community and other levels of government to protect and improve the environment for future generations.

Strategy 2.2.1 emphasises the need for the East Gippsland Shire Council to responsibly manage the natural environment to ensure its sustainability and diversity. The strategic outcome indicators for the sustainability (natural environment) section also list the condition of natural waterways and waterways as a priority indicator and has the restoration of the Eastern Creek project as a high priority.

Liveability Objective

The liveability objective (Strategy 1.2.1) of the Council Plan promotes active living and participation in community life through the development of dedicated walking and cycling trails (a strategic outcome indicator). This objective is captured in the priority action list (Section 1.2 - What do we want?) which states.

“Develop the East Gippsland Integrated Trails and Shared Pathways Strategy, including the Bicycle Strategy and implement Council’s high priority actions. This includes the development and maintenance of shared pathways that encourage interaction between communities for cyclists and pedestrians”

3.1.4 Gippsland’s Water Quality Action Plan 2005 (EGCMA)

This document maintains a broad scale approach to control of water quality entering the Gippsland Lakes system through its major tributaries. Some aspects of the plan are relevant at the smaller scale urban waterways level however.

A key component of the 2005 plan was the reduction of nutrient loads to the Gippsland Lakes of 40% by 2022. Within the content of the report however, it is important to note that the water quality modelling indicated that even with full implementation of all management actions (focused mainly on WSUD best management practices), the 40% nutrient load reduction target for the Gippsland Lakes would not be achieved. The Gippsland Lakes Environmental Study found that water quality and algal blooms in the Lakes were predominantly due to nutrients transported in catchment runoff (CSIRO, 2001).

Significantly, the plan noted that recent policy change in natural resource management has meant a move away from the “*Treat the worst*” methodology (Victorian Nutrient Management Strategy) and a move towards a “*Protect the Best*” approach (Victorian River Health Strategy).

Section 4.3 of the 2005 plan notes that riparian zones should be at least 10m wide (and preferably 30m). As well as the interception of nutrients and sediment (both through overland and sub-surface flow), riparian zones are noted to provide additional benefits in terms of wildlife habitat, waterway shading, leaf litter and large woody debris input to waterways (for food and habitat) as well as some erosion control through root stabilisation.

Section 4.4 of the 2005 plan deals with residential water quality. Specifically, non-sewered townships are identified as a major contributing factor to nutrient inputs. Domestic waste water plans (DWMPs) are advocated as the primary management tool given the current cost based impracticality of upgrading existing deficient systems. Four geographic locations for implementing management action priorities to reduce phosphorous loads to the Gippsland Lakes were identified, including urban areas in close proximity to the Gippsland Lakes (i.e. Bairnsdale, Sale, Paynesville, and Lakes Entrance).

3.1.5 Victorian Stormwater Action Program Final Report (EPA, 2007)

The Victorian Government launched the Victorian Stormwater Action Program (VSAP) in July 2000. This document identified ten common themes for stormwater management across the State, including run-off from roads and residential land, sediment and erosion control from building and construction sites, degradation of receiving waterways, and run-off from industrial and commercial sites. Measures identified and promoted include:

- Infiltration trenches (bio-retention) for treatment and re-use of stormwater;
- Rooftop stormwater harvesting and re-use;
- Town planning controls, pollution prevention procedures, regulations and community education;
- Increased reference to and use of the Melbourne Water WSUD manual and its specific WSUD strategies and best practice actions;
- Street / kerb side rain gardens;
- Roadside swales and bio-retention swales, vegetation and gravel filters, and trash racks;
- Constructed wetlands;
- Preparation and distribution of WSUD toolkits for residents and developers;
- Reduction of sediment and litter from building sites;
- Increased education and awareness in regard to potential pollutants from industrial / commercial facilities;
- Addressing domestic waste water problems through providing information about new septic system installation, maintaining existing systems, and fixing faulty systems.

3.1.6 Infrastructure Design Manual (2011)

This Infrastructure Design Manual was designed to document and standardise Council requirements for the design and development of municipal infrastructure. While the East Gippsland Shire Council has not currently adopted the IDM, several local Councils (Latrobe City, Baw Baw, South Gippsland and Wellington) utilise this document. It is understood that adoption of the IDM is being considered for early 2013 pending some modifications to tailor the document to East Gippsland conditions. The IDM provides a comprehensive assessment and design tool that has excellent potential to clarify and formalise the stormwater (quantity and quality), WSUD, and general waterway management obligations for developments in the municipality.

Clause 16 deals with urban drainage and the collection and control of stormwater. The IDM generally adopts longstanding measures outlined in the ARandR, and more recently Melbourne Water's "Water Sensitive Urban Design Engineering Procedures". Hydrological design is addressed in **Clauses 16.4 – 16.7** and sets out the rainfall and runoff design criteria suggested for urban design. **Clause 16.18** addresses identification and management of flood ways.

Clause 20 deals with stormwater treatment. Aims of stormwater treatment include the protection and enhancement of natural water systems within urban environments, and improving the quality of water draining from urban developments into receiving environments. The IDM encourages use of the following stormwater treatment methods:

- Bio-retention swales and basins;
- Bio-retention basins;
- Vegetated swales;
- Underground sand filters;
- Sedimentation basins;
- Constructed wetlands;
- Pond systems with edge vegetation;
- Water tanks;
- Gross pollutant traps; and
- Litter traps.

In keeping with Melbourne Water WSUD guidelines, the following water quality standards are adopted in the IDM:

- 80% retention of the typical urban annual load for Total Suspended Solids (TSS);
- 45% retention of the typical urban annual load for Total Phosphorus (TP);
- 45% retention of the typical urban annual load for Total Nitrogen (TN); and
- 70% retention of the typical urban annual load for gross pollutants (litter).

Post development discharges for the 1.5yr ARI event are also to be maintained at pre-development levels. Significant sections of **Clause 20** deal with design details for the range of endorsed WSUD features. Importantly, **Clause 22** addresses environmental management during construction and articulates the need to control erosion, sediment runoff and weed intrusion into receiving waterways.

Given the proposed adoption of the IDM by the East Gippsland Shire Council in early 2013, it is likely that this document will become the primary assessment criteria for subdivisions and other large development projects.

3.1.7 WSUD Engineering Procedures (Melbourne Water, 2005)

This document provides the technical basis for concept and technical design and implementation of WSUD assets throughout the Melbourne Metropolitan and outer Melbourne areas. Effectively, it is also utilised as the primary WSUD guideline documentation for much of Victoria. As noted in Section 3.1.6 of this document, the IDM has much in common with the approach and intent of the Melbourne Water WSUD Procedures (the procedures manual). It is considered that in conjunction with the IDM, the procedures manual potentially offers a comprehensive technical document for developers and Council engineers that can assist in standardising and assessing the design and construction of WSUD assets across the municipality.

Section 1.1 of the procedures manual notes that the WSUD document:

“complements existing resources that promote WSUD and provides advice on the design detail of WSUD elements. It is intended to provide a consistent approach to design that incorporates WSUD technologies into urban developments”

The procedures manual is a large and detailed document, and any review within the context of this report would be ineffectual. In brief, the procedures manual supports the appropriate use of the following WSUD elements within urban contexts:

- Sediment basins;
- Bio-retention swales;

- Bio-retention basins;
- Sand filters;
- Swale / buffer systems;
- Constructed wetlands;
- Ponds;
- Infiltration measures;
- Rainwater tanks; and
- Aquifer storage and recovery.

The procedures manual notes that the selection and locating of WSUD is not the focus of the manual, and refers the reader to the Victorian Stormwater Committee's (1999) *Stormwater: Best Practice Environmental Management Guidelines* documentation.

3.1.8 East Gippsland Shire Council Planning Scheme (2012)

As noted in the introductory section, the objectives of planning in Victoria (Planning and Environment Act 1987) include a requirement to provide for the sustainable use and development of land, the protection of natural resources, and the maintenance of ecological processes and genetic diversity. The East Gippsland Shire Council Planning Scheme (the scheme) refers directly to the objectives set out in the Victorian Planning Provisions (DPCD, 2012), including providing for the sustainable use and development of land, the protection of natural resources, and the maintenance of ecological processes and genetic diversity. The document references to waterway management and protection are scattered throughout the body of the document and an exhaustive review of all references is not appropriate to the aims of this report. In brief however, the following sections of the scheme are noted here:

- Open Space Management (**11.03-2**) requires that public access to waterways is not prevented by development activity, and that public land immediately adjoining waterways remains in public ownership;
- Coastal settlement (**11.05-5**) requires development to manage stormwater quantity and quality entering the ocean, bays and estuaries;
- Section **12.01** addresses biodiversity and covers protection of habitat (including waterways) and management of native vegetation. **12.02-5** emphasises the need to improve the quality of stormwater entering bays from construction sites and road development. **12.04-1** recognises the Gippsland Lakes and foreshores as environmentally sensitive areas;
- Section **13.02** addresses floodplain management. Specifically, the objectives include the protection of the natural flood carrying (conveyance) capacity of rivers, waterways and flood ways, as well as the flood storage function of flood plains and waterways. The document emphasises the definition of the 100 year flood event as the key determining factor, and advocates that residential and industrial developments not be located on floodplains;
- Section **13.05** deals with bushfire planning strategies and principles. With regard to this report, the question of bushfires management is linked to the maintenance and planting of vegetation in and around waterways. **13.05-1** requires that bushfire risks to residents, property and infrastructure will not increase as a result of land use and development;
- Section **14.02** focuses on water, including catchment planning and management (**14.02-1**), and water quality (**14.02-2**);
- Section **19.03-3** deals with stormwater, and includes requirements to mitigate pollution from construction site runoff, and incorporate WSUD into developments; and
- Section **56** focuses on residential subdivision including section **56.07-4** addressing urban run-off management objectives, and section **56.08-1** to protect receiving waters from sediment and pollutants from subdivision construction works.

3.1.9 Victorian Planning Provisions (DPCD, 2012)

Clause 56 (residential subdivision) of the Victoria Planning Provisions came into effect on 6th October 2006.

The clause 56 provisions support and promote walking, cycling, public transport, the neighbourhood street network, integrated water management and subdivision construction site management. Specifically, clause 56.07 provides for the management of water in residential subdivisions through the key objectives of conserving potable water, promoting reuse and recycling of water for non-drinking purposes and managing urban run-off volumes and water quality.

Clause 56.07–4 addresses urban stormwater (quantity and quality) management, in accordance with the objectives of the State Environment Protection Policy. The standards to be met draw on performance objectives provided in the urban stormwater best practice environmental management guidelines (BPEMG). In general, the standards can be met by incorporating water sensitive urban design (WSUD) into the subdivision drainage design.

Clause 56.08-1 requires that subdivision planning permit applications describe how the site will be managed to minimise environmental impacts such as erosion and sediment, run-off and litter. This helps to ensure that construction works are managed to prevent and minimise run-off of sediments and other pollutants to receiving waterways.

3.1.10 VPP Practice Note: Using the integrated water management provisions of Clause 56 – Residential subdivision (DSE, 2006)

Residential subdivision planning requirements are contained in Clause 56 of the Victoria Planning Provisions. As detailed in the October 2006 VPP Practice Note, Clause 56 contains for sustainable water management that aims to:

- Integrate use of all water resources including rainwater, reused water, recycled water and stormwater;
- Conserve the supply and reduce the use of potable water;
- Use alternative water supplies where potable water quality is not required; and
- Use best practice water sensitive design techniques to conserve, reuse and recycle water and manage the quality of stormwater run-off (<http://www.dpcd.vic.gov.au>).

Within the context of this review of urban waterways management, the VPP Practice Note contains advice on best practice urban run-off management, stormwater quality objectives, major / minor stormwater management and WSUD objectives and treatment options.

3.1.11 Floodplain management in Australia: best practice principles and guidelines. SCARM Report 73 (CSIRO, 2000)

This document provides the basis for floodplain assessment and management across Australia, and focuses on the identification and control of flood hazards (to people and property), as opposed to environmental management of rivers. For the purposes of this review, the SCARM report defines a range of flood hazards from 'extreme' through to 'low' and provides recommendations on methodologies for determining these hazard zones, and the appropriate land uses within them. While much of the detail and technical aspects of the SCARM report exceeds the requirements of this strategy, the document contains information on defined flood events / hydrology (**section 3.5**), land uses and hazard (**section 3.6**), and implementing development and building controls (**section 3.7**).

Appendix F of the report addresses urban stormwater flooding, including preparation of stormwater management plans. In the Victorian context, the SCARM 73 report should be read in association with Melbourne Water's (2010) *Flood Mapping Projects: Guideline and Technical Specifications*, which provides detailed technical guidelines for determining flood

behaviour and defining flood hazard. Due to its highly technical nature, a review of this separate document is not presented here.

3.1.12 VPP Practice Note: Applying the flood provisions in planning schemes (DPCD, 2000)

This Practice Note provides a concise and useful summary of the practical application for Councils of the technical process of flood mapping. **Table 1** of the Practice Note contains a concise rendering of the types of flood overlays / zones and the suggested appropriate land uses. As such, and in the context of this report, the Practice Note is a useful adjunct to the more technical process driven floodplain management documents (CSIRO / Melbourne Water).

3.1.13 East Gippsland Regional Catchment Strategy 2012-2018 (DRAFT)

This document is presently available in draft form only. The final version will replace the previous regional catchment strategies prepared by the EGCMA in 1997 and 2005. The document is primarily aimed at developing high level priorities for the wider East Gippsland Region.

With specific reference to the aims of this report, **Table 4-2** of the draft strategy provides an example summary of river threats. These include altered flow regimes (decreased flows especially), reduced water quality, livestock intrusion into waterways, barriers to fish migration, reductions in floodplain connectivity, loss of aquatic habitat, and invasive flora and fauna (aquatic and terrestrial).

Section 5 of the draft strategy defines a series of management programs based on the geographic setting of the waterways. These areas comprise:

- Gippsland lakes and hinterland program;
- Gippsland lakes upper catchment program;
- East coast program;
- Far east catchments program; and
- A region wide program.

Each of the programs develops a list of significant features and environmental assets, reviews the rare and threatened species and ecosystems present, and assesses the condition of streams and rivers within the program area. Based on this review, each program then defines the key threats and management objectives for the program areas. Management themes across the different program areas vary in their determination of priority threats and actions, but the broad scale issues are consistent and include:

- Invasive plants and animals (particularly to threatened species and ecological communities);
- Increasing salinity in estuaries and wetlands;
- Degraded water quality (nutrients and sediment);
- Impacts of grazing stock on riparian and wetland vegetation;
- Reduced freshwater inflows and resultant impacts on vegetation communities (wetlands) and significant fauna;
- Soil compaction, salinity and erosion;
- Loss of native vegetation remnants; and
- Coastal erosion.

Proposed actions in response to these threats appear to be principally aimed at rural / semi-rural land areas, and centre on the following typical themes:

- Establishing perennial vegetation in vulnerable areas;
- Remediating gully and tunnel erosion in high priority locations;
- Excluding livestock from riparian areas; and

- Establishing / protecting native vegetation in riparian, wetland and estuarine environments.

Section 6 of the draft strategy provides a framework for the monitoring, evaluation and review of the catchment management programs.

3.1.14 East Gippsland Regional River Health Strategy (2005-10)

The East Gippsland Regional River Health Strategy uses a risk based approach to the management of the rivers throughout the region. It is therefore focussed on the high value assets, those in very good health or in good health and at risk of decline.

As such the references to urban waterways are focussed primarily in terms of reducing the deleterious impacts of the urban areas on receiving waterways, particularly the Gippsland Lakes and not on their inherent values.

3.1.15 East Gippsland Shire Council Trails Strategy

The East Gippsland Shire Council 'Trails Strategy' sets out the future planning of trails throughout the Council managed area.

The trail strategy has the joint aims of providing the high level strategic direction while also providing the guidance and resources necessary to enable local trail plans to be prepared as a part of 'place based' strategic planning.

The trail strategy contains prioritisation criteria that include; likely number of visitors, whether it is likely to provide economic benefit, in areas of population growth, value adds to existing trails, has low environmental impacts, supports cycling and accessibility, connects facilities, has external funding support and multiple partners, supports other councils plans, assists with marketing the region, and supports the equitable distribution of paths throughout the East Gippsland Shire Council area.

There are recommendations to incorporate trails alongside the majority of the urban waterways. These will be prioritised in-line with the regional prioritisation approach set out in the Draft Trails Strategy.

3.1.16 Draft Victorian Waterway Management Strategy (2012)

The draft Victorian Waterway Management Strategy (VWMS) has been prepared by the Department of Sustainability & Environment to set the policy framework direction of waterway management across the State. This update of the 2002 Victorian River Health Strategy includes estuaries and wetlands as well as rivers. Following approval and endorsement by the State government the Catchment Management Authorities will commence the preparation of Regional Waterway Management Strategies that are locally focused, setting resource management targets with defined reportable actions.

The VWMS covers each of the major challenges facing waterways, proposed policies to be developed to ameliorate issues and state level actions. Chapters of management issues include:

Chapter 7	Recreational use of waterways
Chapter 8	Environmental water management
Chapter 9	Riparian management
Chapter 10	Water quality
Chapter 11	The river channel
Chapter 12	Wetlands
Chapter 13	Estuaries
Chapter 14	Waterways in urban areas
Chapter 15	Extreme events of flood and bushfire
Chapter 16	Invasive species management in waterways
Chapter 17	Adaptive management
Chapter 18	Management arrangements

The VWMS covers off on many of the aspects, at a state scale, that are identified in this Council document. Whilst the Council document has been prepared concurrently with the VWMS they are both broadly aligned in terms of objectives and outcomes and the topics that have been addressed.

3.1.17 Planning for Bushfire Victoria (2012)

Planning for Bushfire Victoria has been designed to support the implementation of the Bushfire Management Overlay (BMO). The publication specifically relates to the development application process to ensure that communities are better protected from threat of bushfire.

The resource was developed to provide clear guidance to planning permit applicants, the Responsible Authority and Referral Authorities. *Planning for Bushfire Victoria* supports CFA's decision-making process as a referral authority under the *Planning and Environment Act 1987* and Victoria's planning system.

The publication is split into the following components:

Section 1 – Bushfire risk - how do fires behave and how does house design influence the likelihood of loss

Section 2 – Buildings – what design features can be incorporated into a house design to better protect it from loss. This is specific to single lot developments or modification to existing dwellings

Section 3 – Subdivisions – consideration in the planning process that can mitigate the risks for proposed communities

Section 4 – Further resources.

Whilst Section 2 is useful for determining the risk to properties that already adjoin established waterway corridors, for this Council document it is Section 3 that is the most significance in terms of policy for new subdivision. Section 3 states that all subdivisions must comply with the permit application requirements as specified in the BMO at Clause 44.06 of planning schemes. These include a locality and site description as well as a Bushfire Management Statement. The Section sets out in detail the requirements for a subdivision in an area subject to fire risk. There are recommendations that are complementary to some of the waterway objectives, such as the placement of roads adjoining vegetated areas.

It is important to note that a comprehensive risk assessment process in the planning stage of developments, and implementation of rehabilitation efforts, can facilitate the acceptance of the community that the risk is well understood and managed. Section 2 in particular is a useful tool in conveying the responsibility of the resident in mitigating and managing their own risk within a property.

4. Rehabilitation toolbox

The following management techniques are available for consideration when rehabilitating waterways. In most instances, a combination of the following management techniques will be required to achieve the desired outcome.

4.1 Vegetation

4.1.1 Revegetation

Revegetation involves the planting of native vegetation within the riparian zone to re-establish or enhance native vegetation indigenous to the site (Figure 4-1). The riparian zone is defined as the corridor of land that borders a waterway, where the structure, function and composition of the landscape is influenced by the waterway. The native plants established through revegetation must always reflect the species and type of vegetation community suited to the site conditions. The establishment of revegetation may also involve other complementary river health works such as weed control.

The primary objective for completing revegetation may differ at each site. Typical objectives for the establishment of revegetation include:

- To improve bank and channel stability.
- To improve water quality through the development of a buffer zone or filter strip.
- To provide habitat for terrestrial and aquatic fauna, through both direct and indirect influences
- To improve biodiversity within the catchment.
- To re-establish vegetation in areas completely devoid of vegetation, such as following woody weed control.
- To establish corridors for the passage of fauna between areas of remaining intact remnant vegetation.
- To enhance aesthetic or recreational values of the waterway.

The objectives for revegetation for a given site need to be based on realistic outcomes that are practical to achieve and maintain.

Revegetation is considered the most cost effective method in providing long term channel stability and should be a major component of any erosion control program. Without revegetation almost all erosion control works will likely fail in the longer term.

Abernethy *et al.* (1999) provides guidance for designing vegetated riparian zones aimed at managing stream bank stability. These guidelines recommend a method for determining the appropriate width of revegetation required for bank stabilisation. The width determinations consider the rate of bank erosion and time for riparian vegetation to mature to a point that it will provide sufficient protection against bank erosion.

Riparian vegetation widths recommended by the guidelines are measured from the top of bank and comprise:

- A starting width of 5 metres; plus
- a width not less than the height of the bank from bank toe to bank crest; plus
- a width equal to the amount of bank migration expected to occur in the time it takes for vegetation to establish.

Revegetation works which have the primary objective of controlling headward migration of small nickpoints (also known as erosion heads or head cuts) should be densely planted with an approximate spacing of 0.5m or 4 plants/m² at the nickpoint, surrounding the nickpoint and extend upstream and downstream of the nickpoint for at least ten metres.

Revegetation activities must involve a mixture of species to provide for both bank stability and biodiversity. Grasses, reeds, rushes, sedges and shrubs all have a significant role in

assisting bank stability, and should be the primary focus of revegetation activities aimed at assisting bank stability. The revegetation should consist of indigenous species and should be planted in the zones that will meet the requirements of these species.

The face of the stream bank is the zone most requiring revegetation for bank stability. Often this zone is overlooked, with vegetation plantings focusing beyond the top of the stream bank. While revegetating beyond the bank may be beneficial for biodiversity, it will do little to address many bank erosion issues in the short term. A comprehensive revegetation program should aim to plant:

- the toe of the bank (where practical)
- the face of the bank.
- the top of the bank.
- beyond the top of bank.

Vegetation alone will not completely arrest bank erosion and it should be accepted that some bank erosion is both inevitable and natural. The impact of vegetation will be limited by the depth that it can effectively stabilise the bank. Specific considerations associated with revegetation activities include:

- The proposed revegetation site will require preparation prior to planting, which may involve slashing, woody weed control, pest animal management and fencing.
- Site preparation, soil characteristics, time of planting and climatic conditions may have an impact on the success of revegetation at individual sites.
- Best results are likely to be achieved at sites with ongoing weed control and regular inspection and maintenance of plants.
- Revegetation works take several years to establish, which means that objectives may take 5-10 years to be achieved.

Approximate costs of revegetation are \$0.5-\$2.50 m² depending on planting densities, vegetation type, community involvement and whether mulch is required.



Figure 4-1 Revegetation works

4.2 Channel stabilisation

4.2.1 Rock Chute

A rock chute is a relatively short and steep section of the bed of a channel which has been armoured with rock (Figure 4-2 and Figure 4-3). Rock chutes are normally intended to stabilise a nickpoint (also commonly referred to as an erosion head or head cut) and prevent it from migrating upstream in the channel or reduce the overall grade of a steep section of channel by providing a weir within the channel bed (Department of Sustainability and Environment 2007). Rock chutes provide an alternate form of drop structure to sheet piling or weirs and are generally the preferred method of stream bed stabilisation due to their robustness.

The Department of Sustainability and Environment (2007) identify that the objective of individual chute rock chute design is to ensure that:

- The rock chute geometry and rock size are matched with expected flow conditions so that the rock remains stable under the design flow conditions.
- Abutment treatment prevents the chute failing by outflanking at the crest.
- The grading of sizes within the rock mixture minimises the presence of voids and minimises the area of individual rocks exposed to forces from the flow.
- Rock chutes are located where they can serve their function most efficiently and effectively.

Rock chutes can be designed to facilitate fish passage over the structure. The design arrangement of a rock chute can be determined through the use of the Chute software package accessed from the eWater Toolkit web site.

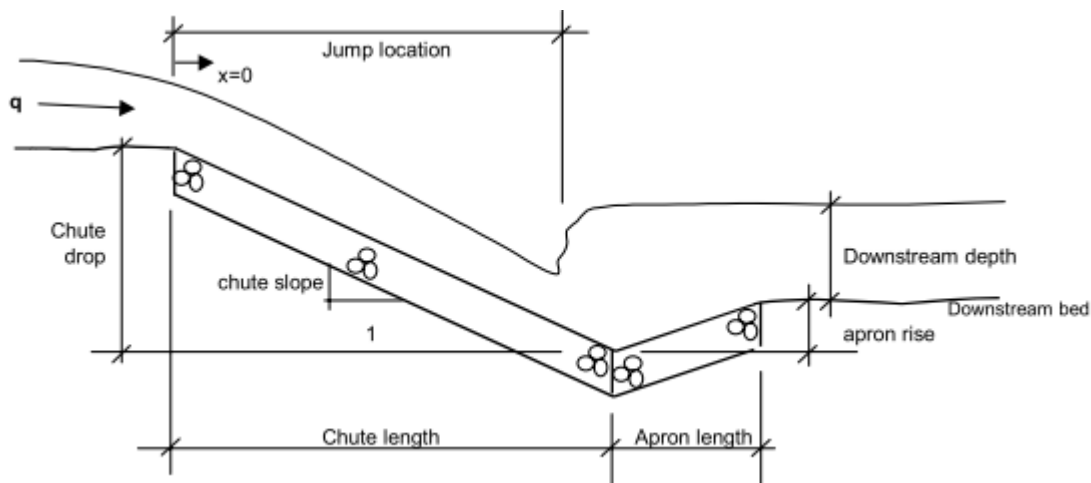


Figure 4-2 Schematic of a typical rock chute (Source: Keller (2003)).

Approximate costs of rock chutes vary depending on access, proximity to quarries and earthworks. As a rule of thumb a detailed design will be between \$5,000 and \$10,000, survey costs \$1000-\$2000 and construction \$100/m³ of rock, supplied and placed.



Figure 4-3 Looking downstream at a rock chute

4.2.2 Rock Beaching

Rock beaching (also known as riprap or rock riprap) involves the placement of angular sized and graded rock against a stream bank that removes the pressures of moving water against the material contained within the bank profile (Figure 4-4 and Figure 4-5). Rock beaching is a favoured management technique as it is suited to addressing multiple localised mechanisms of bank erosion. Erosion processes not associated with hydraulic action (e.g. geotechnical instabilities) may still occur behind rock beaching.

The Department of Sustainability and Environment (2007) identify that the objectives of rock beaching design is to ensure that:

- The rock is of sufficient size to resist movement by the action of flowing water.
- The grading of sizes within the rock riprap minimises the presence of voids within the protective layer and minimises the area of individual rocks exposed to hydraulic forces.
- Where necessary, a filter layer is provided to prevent bank material washing out through the protective rock beaching layer.
- The rock beaching extends a distance upstream and downstream which is appropriate to the level of security to be achieved and the cost of the protection.
- The rock beaching covers a proportion of the bank height which is appropriate to the level of security to be achieved and the cost of the protection.
- The rock beaching extends below estimated scour depth.
- The rock is of suitable quality.

The design arrangement of rock beaching can be determined through the use of the Riprap software package accessed from the eWater Toolkit web site.

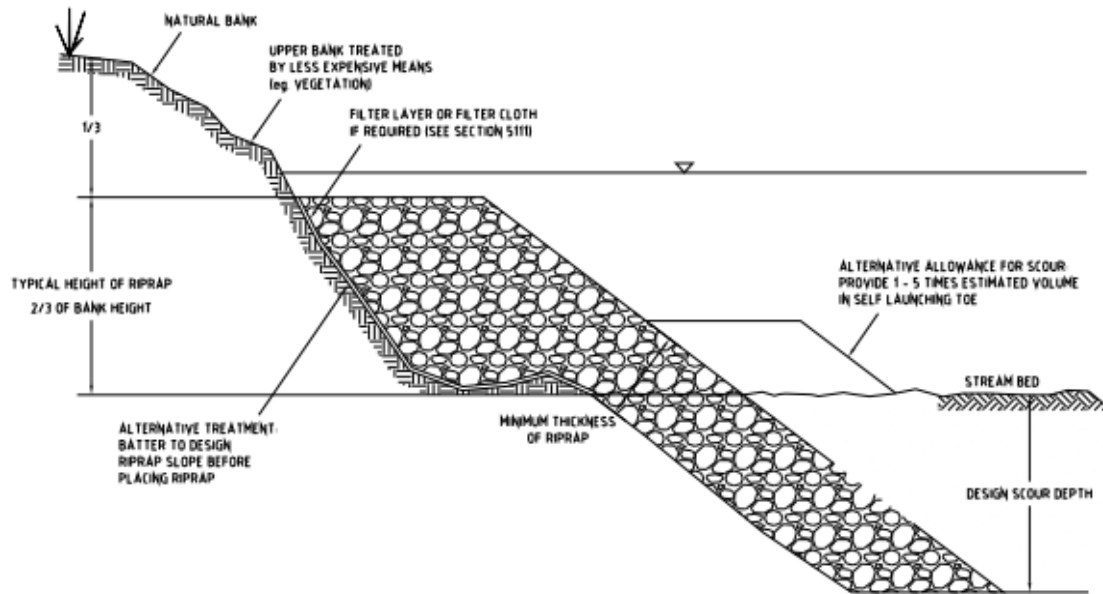


Figure 4-4 A typical rock beaching arrangement (Source: Department of Sustainability and Environment (2007)).



Figure 4-5 An example of rock beaching works

Approximate costs of Rip Rap vary depending on access, proximity to quarries and earthworks. As a rule of thumb a detailed design will be between \$1,000 and \$3, 000, survey costs \$1000-\$2000 and construction \$100/m³ of rock, supplied and placed.

4.3 Water quality

Urban run-off can be a significant influence contributing to the decline of water quality in receiving waterways. Declining water quality can be managed through regulation, education and a range of on-ground interventions. The most effective interventions will be those that address the underlying cause of the declining water quality (The Department of Sustainability and Environment 2007).

Melbourne Water (2005) summarises several Water Sensitive Urban Design (WSUD) techniques that aim to improve the quality of water draining from urban developments into the receiving environment. These techniques, summarised from Melbourne Water (2005) include:

- Litter traps, which provide a physical screen, trapping gross pollutants and coarse sediments.
- Vegetated swales. Swales typically comprise small channels that are either grass lined or more densely vegetated with grasses, reeds, rushes, sedges and shrubs that provide for stormwater conveyance and screening of gross pollutants.
- Infiltration trenches. An infiltration trench is a shallow, excavated trench filled with a porous material such as gravel or rock. Stormwater run-off is directed into the trench, where particulate and some dissolved pollutants are trapped. Infiltration trenches are typically lined with a layer of geotextile fabric that prevents soil movement into the rock or gravel fill. The top surface of the fill is also covered with a layer of fibre fabric and finished with a thin layer of topsoil.
- Wetlands. Constructed wetlands can be designed so that sediments and pollutants can be filtered and retained within the wetland. The water quality treatment is achieved through the reduction in stormwater velocities and incorporation of suitable native vegetation within the wetland.

Several of the WSUD water quality techniques, such as infiltration trenches, wetlands and vegetated swales are designed in such a way that they also retard flows, thus reducing the time of concentration of the catchment.

The selection of an appropriate WSUD water quality treatment method should consider:

- The pollutants of concern.
- The required treatment processes.
- Potential site constraints.
- The expected lifespan of the infrastructure.
- The maintenance requirements and costs.
- The effectiveness of the technique.
- The environmental and social value of the waterway.

Approximate costs for WSUD options are contained in the WSUD Manual.

4.4 Hydrological control

Urbanisation has a number of impacts on stream processes, in particular by altering the flow characteristics within a stream. These impacts include:

- The clearance of native vegetation across the catchment area and subsequent construction of largely impermeable infrastructure such as roads and houses, leading to an increase in the volume of run-off that enters the stream.
- The time of concentration of the catchment (the time it takes the catchment to reach peak run-off during a rainfall event) decreases, resulting in a more rapid rise in water levels and higher peak flows.

Examples of WSUD measures aimed at reducing the time of concentration of a catchment, summarised from Melbourne Water (2005) include:

- Vegetated swales, infiltration trenches and wetlands (described in Section 4.3).
- Porous paving. As an alternative to impervious pavements, porous paving allows water to percolate through to a sub-surface course, from where it infiltrates to the soil. Commercially available porous pavings include:
 - Pavements made from special asphalts that permit water to filter through the pavement surface.
 - Concrete grid pavements that allow stormwater to filter through voids in the concrete.
 - Plastic modular block pavements that allow stormwater to filter through voids in the plastic matrix.
- Rainwater tanks. In addition to being used as a source for domestic waters supply for garden watering and non-potable household use, rainwater tanks can assist in reducing peak flows and the time of concentration of a catchment through temporary storage and the delayed release of flows.
- Landscaping features such as rain gardens.
- Rooftop greening, involving the establishment of vegetation to filter roof runoff and the capture and storage of that roof runoff for reuse.

4.5 Habitat

Waterways and their riparian zones provide important refuges for native flora and fauna. These habitats can be threatened by a number of human induced influences and activities including urban encroachment, vegetation clearing, de-snagging, channelisation and construction activities leading to impacts and processes including erosion, sedimentation, pollution, loss of riparian vegetation and in-stream channel diversity. General principles that should apply to habitat management include:

- Providing a diverse range of sustainable aquatic and riparian habitats.
- Protecting the existing aquatic and riparian habitat and ecological values.
- Rehabilitating and where possible restoring habitat and ecological values.

The establishment and enhancement of aquatic and riparian habitat can be achieved through activities including:

- Revegetation involving suitable indigenous species both in-channel and within the riparian zone. For best results revegetation activities must involve a mixture of species including grasses, reeds, rushes, sedges, shrubs and trees.
- The placement of localised flow obstructions aimed at initiating local scour where in-stream geomorphic diversity has been lost or where it can be improved. Applicable obstructions may include large woody debris or large boulders.
- The placement of large woody debris in the riparian zone to provide habitat niches for native flora and fauna.

Pool habitat may also be created through the construction of a rock chute that provides a backwater effect.

Approximate costs of the placement of LWD in stream vary depending on access, river size/flows and proximity to timber. As a rule of thumb a detailed design will be between \$1,000 and \$3,000, and construction ~\$2000.

4.6 Establish photo monitoring points

The simplest and most efficient method of monitoring the changes in vegetation establishment is with the incorporation of photo monitoring points. It is important to place the points at locations that are able to be identically replicated and have a point of reference within the photo.

A commonly used technique involves the placement of a 90mm x 90mm post concreted into the ground, Parks Victoria have called these a “Fluker Post” (Figure 4-6). The post has a cradle on the top to ensure the exact shot is replicated.



Figure 4-6 Photo monitoring post installed by Parks Victoria

A more quantifiable approach to the assessment of the vegetation cover and abundance can be achieved through the use of the 'Braun-Blanquet Cover Abundance Method'. This quadrat based approach estimates the cover and abundance of vegetation.

5. Case study sites and Council works Priorities

The case studies presented below were identified as priority sites based on recommendations from Council staff and the diversity of urban waterways they represent. The case studies examine some of the site history, the current condition and a summary of the current and potential values. The identification of the values of a particular creek informs the development of a realistic prioritised action plan. Following the development of the case study priority actions for each of the study areas have been prepared and presented to assist East Gippsland Shire Council in future management.

A brief desk-top assessment of Nicholson Gully (Nicholson), Livingstone Creek (Omeo) and Shady Gully (Mallacoota) has been undertaken (refer to Appendix A – Site Maps)

5.1 Merrangbaur Heights – Lakes Entrance

5.1.1 Site History

Merrangbaur Heights is a new residential housing development to the north of Lakes Entrance. The development falls almost entirely of the catchment of two tributaries of the unnamed creek (Figure 5-1) that flows from east to west in Lakes Entrance before discharging into the North Arm.

The previous land-use within the catchment and adjoining the creek is grazing. The creek had been cleared of 100% of the native vegetation. The areas of the creek that have not been developed (the western tributary) are still subject to grazing pressures.

There have been a number of structural modifications to the creek channel form. The most significant of these is the construction of a large on-line retarding basin adjoining the Princes Highway. The channel through Lakes Entrance itself is artificially constructed and would have most likely been an ephemeral wetland prior to the development of the township.

The site is about 60% developed and the council has been instrumental in undertaking improvement works along the riparian corridor. There is a standard piped drainage network throughout the development the discharges to the creek.



Figure 5-1 Map of Merrangbaur Heights

5.1.2 Channel morphology

The ephemeral creek channel is poorly defined throughout most of the waterway length. The channel is bounded by steep valley margins with the new residential development adjoining to the valley top. Based on the current form of the waterway, the soils, and the small catchment area it is surmised that the waterway would have been an 'in-tact valley fill' form. This denotes a waterway without a defined channel and prone to change if vegetation or hydrological conditions vary significantly.

Channel change in this type of waterway is typically in the form of the initiation of a 'head-cut', a deepening of the bed of the creek causing a concentration of flows in a narrow channel and the headward erosion of an incised waterway form. This erosion mechanism is associated with the liberation of large quantities of sediment.

5.1.3 Previous works

Council has undertaken a comprehensive works program over more than 10 years re-vegetating the creek-line. The valley margins and slopes have had the exotic grasses removed through herbicide treatment and then stabilised with the use of a geo-textile. Native shrubs and trees were then planted on the banks. The waterway and valley floor have been densely planted with native sedges, reeds, rushes and grasses.

During the same period the development has progressed. Stormwater pipes have been directed towards the waterway and a walking path has been incorporated into the council reserve which encompasses the creek and passive open space areas.

The revegetation program has been very successful (Figure 5-2 and Figure 5-3) and is a credit to the council. The diversity of the species and the stable nature of the creek is testament to the works that have been undertaken.



Figure 5-2 **Undeveloped or re-vegetated reach of waterway**



Figure 5-3 **Following revegetation and establishment**

The direct discharge of stormwater to the creek has caused a few minor erosion issues at the points of discharge to the creek (Figure 5-4). Whilst this is not of a major concern at this stage there is a benefit to monitoring the situation and possibly retro-fitting the outlets with sediment basins where access is available.



Figure 5-4 Direct discharge to the creek of stormwater without adequate headwall protection

5.1.4 Future development/planned works

The development is continuing for the remainder of the land that has been zoned for urban growth. Council has plans in place to continue the revegetation program in the remaining waterways

5.1.5 Values/condition summary

The waterway needs to be split into three distinct reaches to adequately describe the condition (Figure 5-1). The values and condition have been referenced to the policy principles in the 'Policy' document.

Waterway barriers	The large on-line retarding basin across reach 1 diminishes the opportunities for the movement of fauna. The ephemeral nature of the creek however, and lack of permanent habitat refuges for fish, reduce the critical aspects of requiring free passage. There may be advantages to improving the condition on and around the basin to enable the passage of terrestrial fauna.
Channel stabilisation	The channel was stable at all the reaches that were inspected. This is largely due to the dense planting within the channel. No locations were identified that required physical intervention. (Monitoring is advisable given the increase in the density of housing in the catchment.)

Vegetation	The vegetation in the rehabilitated reaches (reach 1 and 3) is in very good condition. The canopy is establishing and the diverse understorey has provided a range of habitats. The non-worked on reaches are in very poor condition. In these areas there are no native plants and continued grazing is causing on-going degradation. Problem weed growth is largely under control. Kikuyu grass is a manageable problem and there are a few willows that could be poisoned now as the other native vegetation has become established. Blackberry will be an on-going management issue but is only present in minor infestations. The primary concern in the revegetation is the lack of natural regeneration brought about by the non-biodegradable nature of the weed/stabilisation mat. For the long-term sustainability of the site removal of this mat would be advantageous. Area between the path and the houses is mown by council and/or residents. There may be an opportunity here to plant native canopy species to supplement the corridor along the waterway and provide shade for recreational users. Consultation with residents will be required as there are potential view conflicts. Pathways make good edges for the delineation of vegetated areas and lawn. The area between the revegetation and the path would benefit from the spraying of grass and mulching. This may also allay some residents' concerns regarding snakes.
Flood protection	The steep nature of the valley sides and location of the houses mitigates any chance of flood threat in this waterway.
Fire protection	There are buffers between the houses and the creek vegetation. The Council's Municipal Fire Prevention Officer should be consulted for comment on risk.
Habitat	Whilst the waterway corridor contains very good vegetation along much of the length there has been little provision of structural habitat. There were no logs located in the waterway or in the adjoining vegetation. Placement of these habitat structures will enhance the diversity and number of fauna (assuming there is a way for them to reach the site). The lack of mature hollow bearing trees also limits fauna values. This can be compensated with the placement of nest boxes.
Infrastructure provision	No infrastructure was noted during the site inspection.
Social amenity	The pathway adjoining the creek provides access along the eastern side of Reach 1. There are no access points to the creek for viewing the water or observing the wildlife. The lack of shade canopy trees adjoining the path also would make the path unappealing in summer. These modifications would enhance the recreational value.
Hydrology	The residential catchment is serviced by traditional pit and pipe drainage. The hydrology would be severely modified compared to natural.
Stormwater quality	There are few controls to prevent the egress of sediment from the areas being developed. Large depositional areas of sediment were not observed due to the dense cover of vegetation in the creek corridor.

Education	Some signage had been presented at the location of the revegetation that explains the works on the creek. This could be supplemented with additional signage on managing pets for wildlife, structural habitat, stormwater management, flora and fauna.
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Figure 5-5 Managing the area between the riparian corridor and the houses

5.1.6 Objectives

Based on the values presented above priority objectives are presented below. These objectives guide the prioritisation of the actions after the key threats are considered.

- Create a connected vegetated corridor for a diversity of fauna
- Minimise the future changes to hydrology and water quality
- Create a social asset that educates the community on the natural values
- Engage with the community with the implementation of the works

5.1.7 Threats

The main threats are:

- The additional volume of stormwater runoff may initiate erosion in the channel
- The steep nature of the catchment and the exposed soils during future create a significant risk of sediment loads to the creek
- The geo-textile is preventing the recruitment of native plants which will inhibit the succession of the Acacias which are already in the process of dieback
- Problematic weeds, in particular Blackberry, will become an issue if control is not on-going
- Lack of structural habitat limits the habitat qualities

5.1.8 Improvement Actions

The following are priority actions that will develop the current values of the creek. It has been assumed that the new developments will be conditioned with the policy principles.

Table 5-1 Merrangbaur Heights Actions

	Action	Type	Detail	Responsible authority	Priority
MH.1	Continue vegetation and weed program	On-ground	The revegetation program has been very successful. The continuation of this on the remaining tributaries will be beneficial to stabilisation, water quality and corridor connectivity. If there is still the potential to extend a continuous vegetated corridor to Thorpes Lane at the top of the catchment there would be benefit to arboreal mammals and birds in linking to the riparian corridors to the north.	Council	High
MH.2	Supplement the habitat in the corridor	On-ground	Strategic placement of logs and rock both in the creek and within the corridor. The construction of a range of nest boxes for birds and mammals.	Council (may also engage TAFE and schools with nest box construction)	Medium
MH.3	Discontinue the use of geo-textile fabrics in favour of bio-degradable jute	On-ground	The geo-textile is now preventing the successful recruitment of flora. As a minimum it should not be used again. Ideally it should be removed.	Council	High
All.1	Encourage the use of rainwater tanks on existing houses	Education	Rainwater tanks reduce the effect of the increase of impervious surfaces within the catchment, especially the smaller rainfall events.	Council	Low
MH.4	Sediment	On-ground/	Some degree of	Council	Medium

	Action	Type	Detail	Responsible authority	Priority
	basins and/or raingardens at the piped outlets to the creek	policy	pollutant control to the waterway will facilitate an improvement in water quality		
MH.5	Monitor the stability of the channel in the gully and vegetation	Monitor	Establish photo monitoring points at key locations to document changes.	Council	High
MH.6	Provide formal steps and access to the creek with interpretive signage	Social infrastructure	Access will enable visitors to appreciate the creek, the vegetation and wildlife. Educational interpretive signage adds value to the corridor for visitors	Council	Medium
MH.7	Enforce sediment and erosion controls during development	Enforcement	Reducing the sediment inputs to the creek will protect the ecological values	Council	High

5.2 Magees Gully – Bairnsdale

5.2.1 Site History

Magees Gully lies to the south west of the Bairnsdale Township and the catchment encompasses the residential and commercial areas.

The top of the catchment is to the north of the Bairnsdale West Primary School (Figure 5-6) and takes in the industrial precinct bounded by Bairnsdale Forge Creek Road and Bosworth Road.



Figure 5-6 Map of Magees Gully

The piped stormwater network discharges into the top of the creek at the Princes Highway, is again piped under Macleod Street and then remains in an open channel through to the Macleod Morass. The southern tributary is an ill-defined channel from Bosworth Road to the creek opposite Dalmahoy Street. A gross pollutant trap has been installed by council at the Princes Highway.

Magees Gully is largely hidden from the wider public and has historically been a of low recreational or ecological value whilst infested with weeds and refuse. Recent works by Council have significantly improved the visual amenity of the creek and the ecological values.

5.2.2 Channel morphology

The channel from the Princes Highway to the Macleod Street is a formed grass channel. Below Macleod Street the open channel is better defined and encompasses occasional pools and a wide inset floodplain. The gradient of the channel is minor and, combined with

the revegetation works and the willow removal, have resulted in a stabilised channel. Substrates are of a silty-clay nature and there is no rock evident.

Downstream of the railway crossing the channel steepens slightly and the creek becomes confined within a well-defined gully. The channel within the gully is enlarged below the two tributary confluences. Where there is room the channel meanders within the gully floor and is also characterised by some pools and riffles. Again there is no natural rock present. There are two structures across the main channel in this part of the creek. The first is what appears to be a temporary crossing, the second a pipe outlet structure from the east.

The lower reach of the creek downstream of the cattle yards is a straight backwater controlled channel to 2 metres deep.

5.2.3 Previous works

Council has been instrumental in undertaking significant works to improve the habitat values of the creek. There has been an on-going program of weed removal and revegetation in Reach 3a. The weed removal has been successful in the removal of the Willows in the reach and the majority of the woody weeds.

The revegetation has focussed upon the establishment of canopy species on the margins of the channel and very dense grasses, sedges and rushes within the channel. The channel planting has paid dividends in the stabilisation of the channel and the capture of sediment from the urban catchment.

Recently Council has also undertaken weed control works in the Reach 2. Reach 2 was heavily infested with Willows, Blackberry and other weeds and has been cleared mechanically. This on-going works project will also include the re-vegetation of the reach and some minor stabilisation works.

Reach 3b has a large on-line retarding basin constructed at the point of discharge to the main channel, there have been no Council initiated works in this Reach.

Reach 1 has not been worked upon yet and is still heavily infested with weeds, this is the subject of future proposed works.

5.2.4 Future development/planned works

The upper residential catchment of Magees Gully has been fully developed and is unlikely to have significant additional urbanisation. The western catchment of Reach 3b however has the potential for further industrial/commercial development. This development will alter the hydrological characteristics of the creek, something that should be considered in the development approval process.

Council has plans in place to continue the works on the creek corridor and enhance the ecological value of the creek. There is a considerable revegetation program planned in the now cleared area that will take a number of years to successfully establish with ongoing weed control.

The lowest reach (Reach 1) of the Gully will also require a similar level weed removal and revegetation at some time in the future when funds become available.

There has been some discussion regarding the development of a walking trail from the Princes Highway to Macleod Morass. This requires a feasibility and risk assessment as the path would require crossing the rail line and the priority set in-line with the Trails Strategy.

5.2.5 Values/condition summary

Table 5-2 below provides a summary of the key values and condition Magees Gully.

Table 5-2 Values/condition summary

Waterway barriers	The crossing at Saleyards Road does not present a barrier however there are a number of other barriers that detract from the aquatic values of the creek. Figure 5-7 and Figure 5-8 below are two barrier examples that prevent the free movement of fish in the creek. The first is a stormwater inlet from the north that has a pit structure in the middle of the creek, it is unclear as to the reason for this but it may be a surcharge point from the Bairnsdale sewer main. The second is an informal crossing with two pipes through the structure. It would appear both can be modified (either removed or re-configured) to enable the passage of fish. The rail crossing culverts are suitably positioned that they are unlikely to be presenting a barrier. During the assessment native fish were located in the upper reach, upstream of the railway, in what seemed to be a permanent pool. They could either be an isolated population or have made their way upstream during high flows when barriers may be out-flanked or drowned out.
Channel stabilisation	The channel was stable at all the reaches that were inspected. This is largely due to the dense planting within the channel in the upper reaches. No locations were identified that required physical intervention in the reaches that have recently been mechanically cleared.
Vegetation	The planted vegetation in the upper reaches of the creek is well established and of high quality. The dense sedge and grass planting has stabilised the channel very well and is most likely trapping much of the sediment that would run off the urban areas. There are a few persistent weeds on the site that will require on-going maintenance, Blackberry the foremost of these. Downstream of the railway the channel has been mechanically cleared of vegetation. Immediately downstream of the railway some revegetation has taken place and is establishing. This cleared reach of creek (Figure 5-9) is part of the on-going works program undertaken by council to enhance the creek. It is understood that further revegetation will commence over the coming years. The western tributary of the creek is un-vegetated and would benefit from revegetation works as part of conditions should the industrial development continue in the catchment. The lowest reach to Saleyards Road is still heavily infested with Willows and other herbaceous weeds. In-channel vegetation in the creek here is dominated by Typha. Removing the remaining weeds and connecting up the terrestrial habitat in the upper reach of the creek and Macleod Morass will provide benefits to the channel form, water quality and in-waterway values. It will also enhance the visual amenity of the corridor.
Flood protection	The steep nature of the valley sides and location of the infrastructure mitigates any chance of flood threat in the lower reaches. The houses in the upper reaches of the creek are, whilst closer in proximity and elevation, still some distance above the waterway. Flood modelling would be required to gain an appreciation of the threat to these houses but it is considered low based on visual assessment.
Fire protection	There are buffers between the houses and the creek vegetation. The Council's Municipal Fire Prevention Officer should be consulted for

	comment on risk.
Habitat	The waterway corridor contains very good vegetation along the upper reach there has been little provision of structural habitat. There were no logs located in the waterway or in the adjoining vegetation. The removal of the dead native trees (Figure 5-10) in the recently cleared reach is unfortunate and would not be advised in future works. The creek has a number of good natural pools and diversity of bed form and materials that would enable sizable populations of small native fish. The diversity and extent of the fringing vegetation habitats are also good in the upper reaches with canopy cover stabilising water temperatures and reducing evaporation. Incorporation of habitat structures will enhance the diversity and number of fauna which can migrate in from the Macleod Morass. The lack of mature hollow trees also limits fauna values. This can be compensated with the placement of nest boxes.
Infrastructure provision	There is an existing sewer line in the corridor, access to which should be considered in the planting program. The identified barrier (Figure 5-7) may be a sewer surcharge pit; this would require checking with East Gippsland Water if modifications are undertaken (as recommended in barrier removal above).
Social amenity	There is currently very little access to the creek. The location of the creek and the potential to connect the main road in town to the Macleod Morass provides an opportunity to create a trail. There are land ownership and access over the rail line to overcome before this can commence.
Hydrology	The residential catchment is serviced by traditional pit and pipe drainage. The hydrology would be severely modified compared to natural. There are opportunities to minimise further significant change if further industrial development occurs in the catchment.
Stormwater quality	A gross pollutant trap at the top of the creek prevents some sediment and litter entering the corridor. There were no other formal treatment measures identified. Given the urban nature of the catchment there was, as expected, some litter. This could be a focus of Clean-up Australia Day activities. Oils, metals and nutrients will be present in the creek due to the presence of the main road through the upper catchment.
Education	There are currently no educational materials.



Figure 5-7 Stormwater pipe inlet/barrier



Figure 5-8 Temporary crossing barrier



Figure 5-9 Recently cleared area awaiting revegetation



Figure 5-10 Native LWD has been cleared with the willows

5.2.6 Objectives

Based on the values presented above priority objectives are presented below. These objectives guide the prioritisation of the actions after the key threats are considered.

- Create a social and educational asset for the township of Bairnsdale linking the Morass and the Highway
- Maximise the opportunities for native fauna within the catchment
- Prevent further alteration to the creek from increased urbanisation of the industrial precinct.

5.2.1 Threats

- Poor condition of the vegetation downstream of the railway compromises the value of the creek
- Barriers across the channel preventing free movement of fish
- Lack of structural habitat
- Maintenance burden that Council will have for what is an unseen public asset.

Water quality is not considered to be a significant threat due to the nature of the waterway and the developed contributing catchment. If additional development is to occur in the industrial area high sediment loads may become a concern.

5.2.2 Improvement Actions

The following are priority actions that will develop the current values of the creek. It has been assumed that the new developments will be conditioned with the policy principles.

Action	Action	Type	Detail	Responsible authority	Priority
M.1	Continue vegetation program	On-ground	The revegetation program in the upper catchment has been very successful. The continuation of this on the lower reach will be beneficial to stabilisation, water quality and corridor connectivity.	Council	High
M.2	Supplement the habitat in the corridor	On-ground	Strategic placement of logs and rock both in the creek and within the corridor. The construction of a range of nest boxes for birds and mammals.	Council (may also engage TAFE and schools with nest box construction)	High
M.3	Investigate the creation of a formal access path between the Mitchell River and the Morass	Social Infrastructure	In line with the Council 'Trails Plan' consideration of the value of a link from the Mitchell River to McLeod Morass along the creek	Council (with potential external funding)	High
M.4	Monitor vegetation	Monitor	Establish photo monitoring points at key locations to document changes.	Council	High
A.4	Encourage the use of rainwater tanks on houses	Policy/ education	Rainwater tanks reduce the effect of the increase of impervious surfaces within the catchment,	Council	Low

			especially the smaller rainfall events.		
M.5	Remove the two barriers	On-ground	The two barriers in the creek significantly affect the ecological values. Investigation and feasibility of removal is a priority before the soon to be planted vegetation becomes established.	Council (and maybe East Gippsland Water)	High
M.6	Sediment basins and/or raingardens at the piped outlets to the creek	On-ground/ policy	Some degree of pollutant control to the waterway will facilitate an improvement in water quality	Council	Low

5.3 Goose Gully, Eastwood – Bairnsdale

5.3.1 Site History

Goose Gully is a tributary of the Mitchell River in Lucknow, north of Bairnsdale (Figure 5-11). The focus of this investigation is the area in Council management south of Eastwood Road (Figure 5-12), actions however will consider the whole catchment.

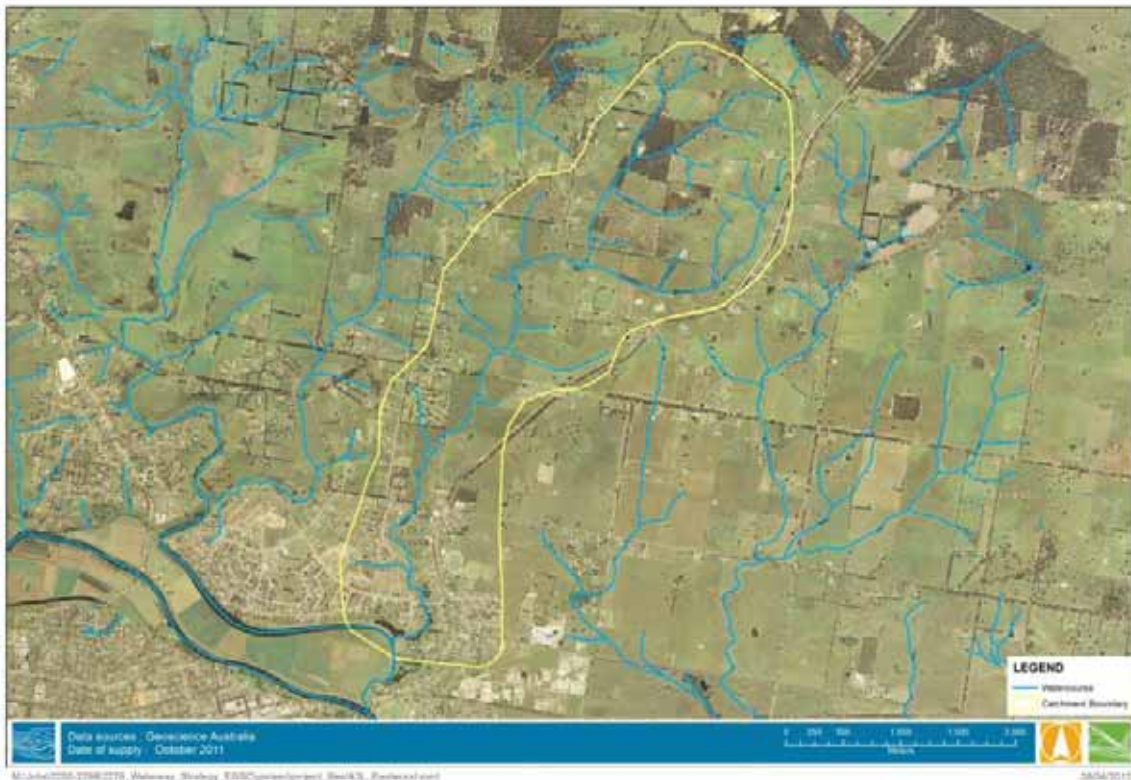


Figure 5-11 Goose Gully Catchment

Goose Gully has been the site of significant land development over the past 10+ years. The residential land release adjoining the creek has incorporated landscaping and waterway improvement works. These works have included re-vegetation, stabilisation, social infrastructure and end of line wetland works.

Due to the topography of the land development there are wide corridors adjoining the creek. The landscaping works within the development have been primarily focussed on the creation of open space and there are areas that have been planted with exotic deciduous species (Figure 5-13).



Figure 5-12 Developed area of Goose Gully



Figure 5-13 Sparse open space with exotic tree species

5.3.2 Channel morphology

The main trunk of the creek appears to be a natural incised channel with a silty substrate. The reach immediately below Eastwood Road is relatively steep. There are a number of

man-made controls (rock) on the channel that prevent excessive erosion and deeper pools that create potentially permanent habitat for fish (Figure 5-13). The channel is stable along the entire reach with no evident requirements for further stabilisation works. Dense exotic grasses dominate the banks and riparian areas, these have provided additional stability.

The reach from just above Flinns Road to the connection with Blackwater River, adjoining the Mitchell River, has a lesser gradient and a wide poorly defined channel. The vegetation is dominated by *Phragmites* upstream of the road, indicating a pooling of water, and densely planted *Melaleuca* forest downstream creating a very stable shallow and wide channel (Figure 5-14).



Figure 5-14 Dense Melaleuca planting across the channel

The remaining channel has been modified to encompass a constructed wetland and lake (Figure 5-15).



Figure 5-15 Constructed wetland lake

The western tributary in the development is a formed drainage line with a trapezoid form (Figure 5-16) and occasional ponds. This tributary has a large on-line retarding basin on it prior to discharging to the main channel, Figure 5-17.



Figure 5-16 Stable formal drainage lines



Figure 5-17 On-line retarding basin

5.3.3 Previous works

As noted above the creek has been the subject of landscaping works over a number of years. The most intensive works have been associated with the construction of the on-line wetland, the formalisation of the western drainage line and the retarding basin. A formal walking track has also been incorporated into the corridor and, based on feedback from the residents, is heavily used.

This creek differs from the other waterways assessed in this study in that the re-vegetation program has not been the primary focus of the works and the implementation has not been led by Council.

5.3.4 Future development/planned works

Council has no current plan to change the management of the corridor. The residential development is on-going in the Eastwood Estate and the Brookfield Lakes development, upstream of Eastwood Road, will commence within 12 months. The Brookfield Lakes development incorporates a comprehensive revegetation program, water quality wetlands and raingardens.

5.3.5 Values/condition summary

Table 5-3 below provides a summary of the key values and condition Eastwood.

Table 5-3 Values/condition summary

Waterway barriers	There are significant barriers at the constructed wetland. These prevent the free movement of fish up into Goose Gully from Blackwater River. The feasibility of ameliorating this will need to be considered in light of the operation of the constructed wetland.
Channel stabilisation	No locations of channel instability were identified. The channel is diverse in form and provides good habitat values.
Vegetation	Vegetation between Blackwater River and Flinns Road is in good condition with dense planted native vegetation well established. There is a significant outbreak of <i>Myriophyllum aquaticum</i> (water milfoil/parrots feather) that threatens the aesthetics and values of the wetland. This is being monitored by Council. Between Flinns Road and Eastwood road the in-waterway and emergent vegetation is of high value. The terrestrial vegetation however is dominated by grasses and a few recently planted exotic trees. Upstream of Eastwood Road there is agricultural land that has been cleared. On the western tributary the re-vegetation of canopy trees appears to have been unsuccessful. This may be due to the non-replacement of top-soils after the major drainage works were undertaken. This has resulted in trees being planted directly into clay sub-soils that are less suitable for tree establishment. A small number of remnant canopy trees are providing hollows.
Flood protection	All houses are elevated away from potential flood levels due to the incised nature of the floodplain.
Fire protection	There are buffers between the houses and the creek vegetation. The Council's Municipal Fire Prevention Officer should be consulted for comment on risk.
Habitat	The creek contains a diversity of channel form and many areas that are suitable habitats for native fauna. The wetlands are a significant refuge

	for native birds and, presumably, fish. The lack of significant vegetation corridor and structural habitat significantly diminishes the habitat values that could be derived from the corridor. Continual mowing of the reserve will impact upon amphibians and reptiles.
Social amenity	Walking paths, bridges and viewing areas provide a significant social asset and the corridor is very well used. Shade trees would enhance the values over summer periods and some education/interpretation materials would also assist.
Infrastructure provision	No sewer infrastructure was noted in the site investigation. It would be advantageous to undertake a dial-before-you-dig (Ph: 1100) prior to preparing a comprehensive planting plan.
Hydrology	The hydrology will have altered compared to “natural” due to the clearing of vegetation in the overall catchment for agriculture. The impacts of the urbanisation in the lower reach will be tempered somewhat by the on-line wet retarding basin and wetland that effectively acts as a buffer for many of the smaller flows. The planned upwaterway Brookfield Lakes development has also incorporated off-line treatment wetlands and rain-gardens that will mitigate the effects of the frequent smaller events.
Stormwater quality	There are few major sources of metals and hydrocarbon pollutants in the catchment (main roads). The key pollutants of concern will be nitrogen from the directly connected urban areas and sediments during the construction phase. Minor quantities of gross pollutants were observed during the field inspections. The primary source of pollutants of concern is from the rural catchment and un-fenced waterways. The more recently developed areas had incorporated sedimentation basins at the piped discharge points.
Education	There are no educational resources present along the creek corridor.



Figure 5-18 Valuable habitat pools with some good fringing emergent macrophyte vegetation

5.3.6 Objectives

Based on the values presented above priority objectives are presented below. These objectives guide the prioritisation of the actions after the key threats are considered.

- Create a terrestrial corridor link between the Mitchell River and remnant vegetation at the top of the catchment
- Prevent any significant changes to the hydrological character of the creek for the frequent smaller flows
- Maintain the channel form and diversity
- Educate the community on the values of the creek and manage expectations of vegetation management
- Protect the creek from adverse water quality impacts in the rural areas.

5.3.7 Threats

- Lack of structure and density of the vegetation along much of the waterway is compromising many of the potential ecological values
- Poor water quality in the rural catchment may negatively affect the health of the wetland which is surrounded by dwellings
- 'Management' of vegetation by residents and the proximity of pets may undermine Council efforts to create a high value ecological asset
- Wetland barrier is preventing any native fish making it into the creek.

5.3.8 Improvement Actions

The following are priority actions that will develop the current values of the creek. It has been assumed that the new developments will be conditioned with the policy principles.

Action	Action	Type	Detail	Responsible authority	Priority
E.1	Vegetation program	On-ground	There is an expansive corridor for Council to maintain with mowing. The long-term costs of planting the corridor will be lower than the on-going mowing contracts and create higher quality ecological and social outcomes.	Council	High
E.2	Supplement the habitat in the corridor	On-ground	Strategic placement of logs and rock both in the creek and within the corridor. The construction of a range of nest boxes for birds and mammals.	Council (may also engage TAFE and schools with nest box construction)	Medium
E.3	Monitor the vegetation	Monitor	Establish photo monitoring points at key locations to document changes.	Council	High
E.4	Community involvement in re-vegetation	Engagement	A Council supported local Landcare group established specifically for the creek corridor will actively engage the	Council and CMA	High

			new residents. School planting days, water quality monitoring and fauna monitoring will document progress.		
E.5	Interpretative signage	Education	Signage on the current fauna and catchment characteristics will facilitate support in the revegetation effort.	Council	Medium
E.6	Sediment basins and/or raingardens at the piped outlets to the creek	On-ground/ policy	Construct sediment basins at locations where piped discharge occurs directly to the main channel of the creek (not including western tributary).	Council	Low
E.7	Top-soil replacement	Policy	Ensure that future major landscaping/earthworks stockpile and replace the topsoil prior to revegetation occurring.	Council	High
E.8*	Work with landholders up the catchment in the development of a vegetation corridor		The length and nature of the creek provides opportunities that are not evident in the other creeks investigated during this study. Working with landholders to fence and revegetate the creek to the top of the catchment will enhance the in-coming water quality and the overall asset condition.	Council	High
E.9	Explore whether fish passage can be restored	Investigate	The construction of the wetlands has created a barrier to fish passage. If there is a mechanism for altering the design of the wetland to cater for the passage of fish it would be a worthy incorporation into the overall plan.	Council	Low

**this action has a high potential of attracting external Federal Government Biodiversity funding*

5.4 Lake Bunga

5.4.1 Site History

The un-named creek draining to Lake Bunga is the smallest and steepest of the creeks assessed in this study. The majority of the catchment is urbanised or soon to be developed. Reach 1 adjoining the lake has a large stand of native vegetation and has been the subject of significant re-vegetation and stabilisation works by Council.

Reach 2, the upper portion of the creek, has been cleared of all native vegetation and presumably has a history of grazing.

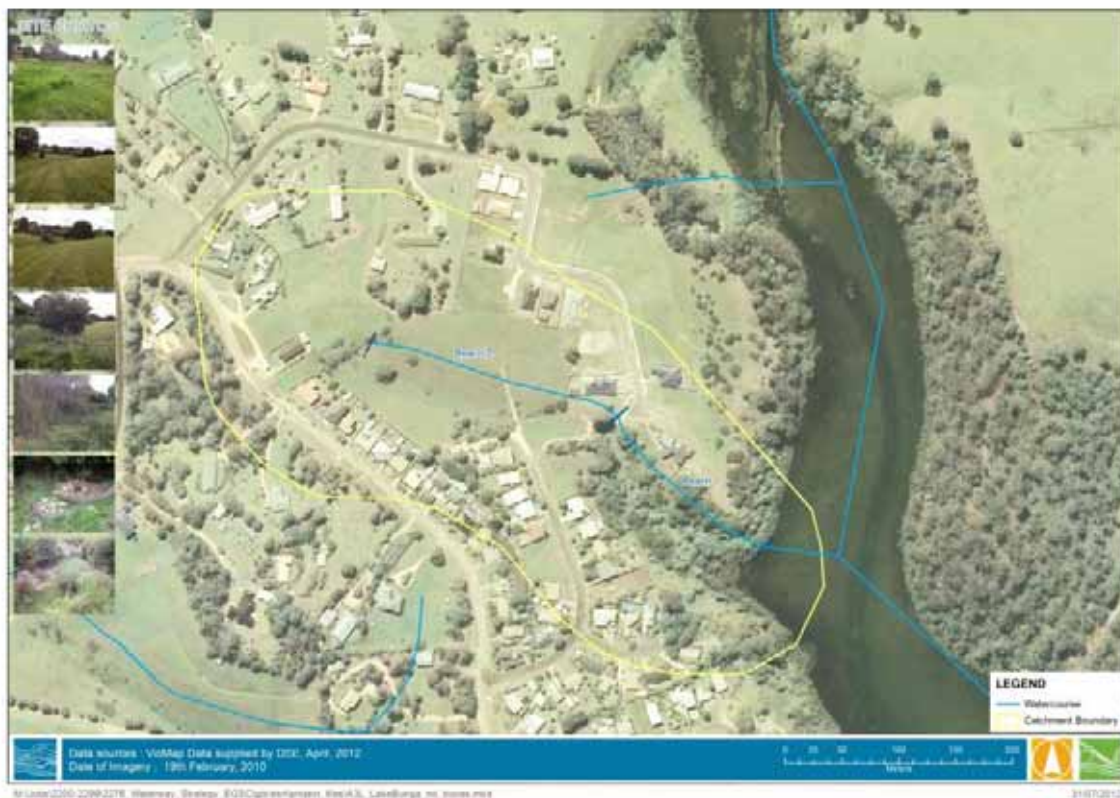


Figure 5-19 Lake Bunga Creek Catchment

5.4.2 Channel morphology

Reach 1 is an ephemeral gully with little to no defined creek channel. There are small areas of erosion that are discontinuous in form and are largely stabilised by the planted sedges and grasses (Figure 5-21). There is minor erosion apparent immediately downstream of the piped discharge points where rock armour sizing was inadequate to cater for the high velocity flows. Council staff have used compacted coconut fibre 'eco-logs' (Figure 5-20) to provide stabilisation whilst vegetation establishes.

An on-line drainage basin has been constructed at the head of the gully and discharges to the gully through a 600mm pipe, it is unclear whether the basin serves to attenuate major flows.

Reach 2, the upper section of the creek (Figure 5-22), has a defined channel with bed and banks. The channel is stable and overlies a silty soil substrate and there is a ford footpath crossing over the channel. The density of the introduced grasses in the channel are serving

to reduce the velocity of any flows, trap sediment and maintain a stable channel. There are few defined channel features that would provide any significant habitat.



Figure 5-20 Stabilisation works with 'Eco-logs'



Figure 5-21 Re-vegetated down waterway reach



Figure 5-22 Up waterway Reach

5.4.3 Previous works

The works undertaken on this creek are limited to vegetation management and some minor stabilisations works. This is commensurate with the values of the creek. The re-vegetation has achieved the key goals and provides a stable substrate and habitat values for terrestrial fauna. Weed control works have been very successful with very few weeds apparent during the site visits.

5.4.4 Future development/planned works

There is a small planned subdivision adjoining the upper reach of the creek on the northern side. The proximity of the rear of some of the lots seems to be within a metre of the channel at the closest point; this will create a maintenance issue for Council mowing contractors accessing the rear of the properties and may require the construction of an additional creek crossing.

Council plans to continue the maintenance of the vegetation in the gully.

5.4.5 Values/condition summary

Table 5-4 below provides a summary of the key values and condition of the un-named creek at Lake Bunga.

Table 5-4 Values/condition summary

Waterway barriers	Whilst there is an on-line basin there is unlikely to be negative consequences due to the lack of a persistent watercourse or habitat for fauna that require migration.
Channel stabilisation	The upper channel is very stable and no works are recommended. The revegetated gully section of the creek has areas of minor incision and erosion. Whilst there is nothing to be concerned about at present there is the possibility, with more impervious areas in the catchment, that a significant erosion head could develop. Any erosion that does occur will mobilise sediment to the lower part of the creek. This is not considered a

	major threat and deposition would most likely be on the adjoining floodplain rather than discharging to the lake. Localised scour at the discharge point of the pipes requires some minor remedial action with the placement of larger rocks (D^{50} of 300mm).
Vegetation	The vegetation in the lower section of the creek is in excellent condition with few weeds. The multiple strata of vegetation are providing significant habitat values and there are hollow baring trees and structural habitat features on the ground. This contrasts with the upper reach where the vegetation is very poor. All but a couple of trees have been removed and the channel is dominated by introduced grasses. There are Willows and Blackberry in the un-mown areas.
Flood protection	All houses are elevated away from potential flood levels due to the incised nature of the floodplain and the very small catchment.
Fire protection	There are buffers between the houses and the creek vegetation. The Council's Municipal Fire Prevention Officer should be consulted for comment on risk.
Habitat	The steep ephemeral nature of the creek precludes any in waterway aquatic habitat. Where water does persist there are frogs present, this was limited to the upper reach where the gradient was lower. Terrestrial habitat in the lower reach is very good with vegetation structure providing habitat for birds and mammals. On the ground there was sufficient native leaf cover and vegetation for small reptiles, invertebrates and amphibians. Fallen timber is abundant and tree hollows were apparent.
Infrastructure provision	No infrastructure was located in the corridor. There was evidence of a sewer main crossing at the head of the gully but this is outside the area of works.
Social amenity	A set of stairs has been provided into the gully (Figure 5-23). There is then an informal path to the shoreline of the lake and some discussion on formalising this. Upper areas are used by the immediate adjoining residents for recreation.
Hydrology	Whilst the hydrology in the catchment is being modified through the on-going development of residential lots the risks to assets are minor. There will have been an increase in the volume of runoff as a result of the roads. Based on a visual assessment however many of the houses, existing and proposed, will have roof water and surface runoff directed towards the creek overland. This will mitigate the negative influences as they are not directly connected via the pipe network.
Stormwater quality	Poor water quality will not negatively impact on the creek as the persistence of the water is not common. The critical components are high sediment loads, from the soon to be developed area, and nutrients that may favour exotic species in the gully. Sediment will be efficiently trapped in the basin at the top of the gully and nutrient loads will be minor based on the nature of the landuses in the catchment and the densely grassed upper channel.
Education	There are no current educational or interpretive resources on the creek.



Figure 5-23 Formal access way into the gully

5.4.6 Objectives

Based on the values presented above priority objectives are presented below. These objectives guide the prioritisation of the actions after the key threats are considered.

- Maintain the condition of the high value vegetation
- Facilitate the regional movement of birds
- Enhance community access

5.4.7 Threats

- Re-infestation of the high value areas with weeds
- Lack of sediment and erosion controls in the small subdivision could export large volumes of sediment to the creek
- Pedestrian access to the gully may initiate erosion and loss of important vegetation cover

5.4.8 Improvement Actions

The following are priority actions that will develop the current values of the creek. It has been assumed that the new developments will be conditioned with the policy principles.

Action	Action	Type	Detail	Responsible authority	Priority
B.1	Develop a terrestrial canopy link	On-ground	Linking the high quality vegetation in the gully to the top of the creek/Lake Bunga Beach Road with canopy and understorey vegetation will provide connectivity with another	Council	Medium

			vegetation patch and create shade in the reserve.		
B.2	Maintain existing works – especially exotics such as Bridal Creeper and Blackberry	On-ground	Continue weeding work in the gully and control Blackberry and Willows in the upper reach of the creek.	Council	High
B.3	Monitor the stability of the channel in the gully and vegetation	Monitor	Establish photo monitoring points at key locations to document changes.	Council	Medium
B.4	Pathway construction	On-ground	The current pathway in the gully follows the main flow line of the creek. It would be beneficial for stability and vegetation to move this away from the inundated area as it will become an preferential flow-path and may initiate scour.	Council	High

5.5 Eagle Point

The Creek at Eagle Point is a 1.8km un-named tributary that flows directly to Lake King (Figure 5-24). The catchment is currently dominated by grazing land and rural residential. Land releases are underway in the north of the catchment which have the potential to significantly alter the hydrology of the creek. There are half a dozen houses adjoining the creek where it discharges to Lake King.



Figure 5-24 Eagle Point location map and catchment

5.5.1 Site History

The creek has a history of grazing pressure and has been cleared of all native vegetation in the lower 50% whilst the upstream vegetated areas have been fenced from stock for some time.

The main changes to the creek in recent time is the release of land for sub-division within the catchment. Works on bulk earthworks and road construction have commenced and over the next 5-10 years the catchment will be largely residential north of the Paynesville road.

5.5.2 Channel morphology

The channel morphology can be described in three distinct reaches. The first short reach between the lake and Bay Road (Reach 1) is a minor cut channel between houses. This area would have presumably been wetland prior to the development taking place and the drainage channel being cut. This reach has a very low gradient and discharges to the beach (Figure 5-25).

Upstream of Bay Road (Reach 2, Figure 5-26) the channel is cleared of vegetation and heavily grazed. The channel is of low gradient and not well defined. Connectivity to the floodplain has ensured that scour has not been excessive within the channel. This reach would be classified as severely degraded. The uppermost extent of reach 2 has a

pronounced sand slug adjoining the development that is currently under construction (Figure 5-27).



Figure 5-25 Creek adjoining beach



Figure 5-26 Cleared reach of creek subject to grazing



Figure 5-27 Sediment from land development is a major threat to this creek



Figure 5-28 Vegetated channel with high habitat values in-waterway and on bank

The upper vegetated reach 3 is incised into a gully and has a pool riffle sequence (Figure 5-28). The pools appear to be permanent and provide high value habitat. During the site investigation native fish were observed. An on-line dam/sediment basin had been constructed within the upper reach 3.

5.5.3 Previous works

A local Landcare group has been undertaking some weed control and re-vegetation works in the area adjoining the main Paynesville Road. There were no other creek rehabilitation works identified.

5.5.4 Future development/planned works

There are plans in place to modify the creek as part of the ongoing development process and this includes the construction of a large retarding basin at Bay Road to reduce flooding of the two houses downstream.

The main change to the waterway will eventuate as the catchment develops towards residential. This will occur over 10-15 years and will place pressure on the current values in the creek.

At some point in the future the creek corridor will become a Council asset.

5.5.5 Values/condition summary

Table 5-2 below provides a summary of the key values and condition of the Eagle Point creek.

Table 5-5 Values/condition summary

Waterway barriers	There is one main barrier under Bay Road. This drop structure and culvert is impassable to fish in all but major floods when the road is overtopped. It is possible to create a crossing that would not act as a barrier if deemed a priority. The second barrier is the on-line constructed sediment basin/dam on the juncture between Reach 2 and 3. This is a temporary structure. The proposed retarding basin planned as part of the development will become a significant barrier.
Channel stabilisation	The upper reach 3 is very stable and required no work for stabilisation. The mid reach 2 has been negatively impacted by grazing and is in very poor condition. Removal of the grazing pressure would enable vegetation to establish and the channel would be stable without significant intervention. The key concern for channel stability is with the large sediment inputs as a result of the poor sediment and erosion controls in the residential subdivision. This sediment will fill any pools in the channel removing potential habitat. It will also reduce channel capacity and increase flood risk to downstream residents.
Vegetation	Vegetation in the lower reach is dominated by introduced pasture grasses and the occasional native sedge. The upper vegetated area has a diverse understorey of native grasses, sedges and herbs. There is also a diverse mid storey and canopy. There are high ecological values in this small patch of vegetation and whilst there are a few weed species of concern (Blackberry) the density is low and would be easily controlled.
Flood protection	Flooding is a concern adjoining this creek. The two houses that bound the creek on the lake foreshore almost certainly have a high flood risk already. One of the two has undertaken measures to prevent floodwaters entering their property by diverting flows to the neighbour's property. The capacity of the channel adjoining the houses is significantly smaller than that in the rest of the creek and in a couple of locations almost unidentifiable. The increase in the development density in the catchment will increase the frequency of flooding in this location without significant attenuation. A

	retarding basin will be required to attenuate a range of flood events as more frequent flows, those smaller than the Q100, as these will be causing inundation and will also require attenuation. Consideration of other options for the house mainly at risk may be more cost effective than the proposed basin.
Fire protection	There are buffers between the houses and the creek vegetation. The Council's Municipal Fire Prevention Officer should be consulted for comment on risk.
Habitat	There are few to no habitat values in the lower reach beyond some damp areas for frogs. The upper reach has pools, emergent macrophytes, aquatic macrophytes, diversity of bed form, overhanging vegetation, hollows, large woody debris (in-waterway and terrestrial), leaf litter and dense grasses. The habitat values in the upper reach are good and could be used as a template for other creeks in the region.
Infrastructure provision	There is a sewer line crossing the creek near the Paynesville Road. No other infrastructure was located.
Social amenity	The creek is currently in private ownership and there is no provision for access to the community.
Hydrology	The hydrology at the present is reasonable. There is a farm dam at the head of the creek that may reduce flows but this is countered by a small number of houses. There will be major changes of the next 10-15 years as the creek catchment becomes urbanised.
Stormwater quality	Water quality in the creek will be very poor due to the majority of the creek being un-fenced and grazed. The lack of sediment and erosion controls in the adjoining sub-division works are also contributing large quantities of sediments.
Education	There is no current education program or materials

5.5.6 Objectives

Based on the values presented above priority objectives are presented below. These objectives guide the prioritisation of the actions after the key threats are considered.

- Protect the values in the upper reach
- Mitigate or remove the flood risk to the residential properties adjoining the creek
- Create a vegetated and community access corridor
- Minimise the negative water quality impacts associated with development on the creek

5.5.7 Threats

- Sediment from the adjoining development filling in the habitat features on the site
- Frequency of flooding to the two properties in Reach 1
- Long term water quality from the sub-division
- Creation of a barrier further isolating fish populations
- Potentially a focus on 'landscaping' the creek as opposed to creating a multiuse corridor with high ecological and social values

5.5.8 Improvement Actions

The following are priority actions that will develop the current values of the creek. It has been assumed that the new developments will be conditioned with the policy principles.

Action	Action	Type	Detail	Responsible authority	Priority
EP.1	Monitor the stability of the channel in the gully and vegetation	Monitor	Establish photo monitoring points at key locations to document changes.	Council	High
EP.2	Review proposed basin	Planning	Explore whether other options to the large on-line retarding basin are viable taking into consideration the basin will need to attenuate the flows between at least 5 year and 100 year ARI to reduce risk to the two houses.	Council	High
EP.3	Follow policy principles for new developments as outlined in 'Policy' document	Planning	As a new development there is the option to incorporate the core principles of best practice stream management to this creek.	Council/ Developers	High
EP.4	Sediment basins and/or raingardens at the piped outlets to the creek	On-ground/ policy	Where the new pipes are already being installed (or about to be installed) at the development have them discharge to sediment basins prior to the outfall to the creek. Not like Figure 5-27.	Developer	Medium
EP.5	Enforce sediment and erosion controls	Enforcement	There is a requirement that developments do not allow excessive sediment loads to a waterway. This can be enforced by council.	Council	High

6. Summary conclusions and recommendations

The following section summarises the key outputs of the strategy, recommendations, actions and priorities. The costs presented in Table 6-1 are based on an estimate of the area of the works outstanding and an understanding of the average square meter cost to implement revegetation works of this nature and the cost to construct other works. Other costs are estimated based on author experience on the scope of consulting work. There are a range of external funding mechanisms that would enable East Gippsland Shire Council to implement these actions. This includes grant funding from the Catchment Management Authorities, the Victorian Department of Sustainability and Environment and Federal Government Grants that typically focus on larger projects with regional connection potential or those that protect high value assets such as the Gippsland Lakes.

Table 6-1 lists the key actions in a priority order. The priorities are based on the principle of protecting the existing high value assets/investment with minimal cost through to improving a degraded asset.

Key points from the strategy to take forward to the management of council waterway assets:

1. Supplement vegetation management with habitat creation
2. Avoid the creation of new barriers across waterways
3. Maintain a core habitat corridor within a wider multi-use corridor
4. Manage channel form as a dynamic system (don't insist on a completely stable uniform channel)
5. Ensure sufficient access is catered for to enable maintenance of reserves
6. Enable community access and provide passive educational resources and infrastructure
7. Minimise the direct pipe connectedness of hard surfaces to waterways

The costs presented in Table 6-1 are based on an estimate of the area of the works outstanding and an understanding of the average square meter cost to implement revegetation works of this nature and the cost to construct other works. Other costs are estimated based of author experience on the scope of consulting work. There are a range of external funding mechanisms that would enable East Gippsland Shire Council to implement these actions. This includes grant funding from the Catchment Management Authorities, the Victorian Department of Sustainability and Environment and Federal Government Grants that typically focus on larger projects with regional connection potential or those that protect high value assets such as the Gippsland Lakes.

Table 6-1 Prioritised action list with costs for the assessed waterways

Reference ID	Action	Creek Priority	Approximate anticipated cost
EP.3	Follow policy principles for new developments as outlined in 'Policy' document	High	N/A (Planning)
MH.1	Continue vegetation and weed program (include removal of geotextile)	High	\$180,000 (plus on-going maintenance)
M.5	Remove the two barriers	High	Requires detailed investigation to cost
B.2	Maintain existing works – especially exotics such as Bridal Creeper and Blackberry	High	\$5,000 p/a
M.3	Create a formal access path between the Princes Highway and the Morass	High	\$140,000
EP.5	Enforce sediment and erosion controls	High	Partially self-funding education/enforcement officer
MH.7	Enforce sediment and erosion controls during development	High	Partially self-funding education/enforcement officer
EP.2	Review proposed basin	High	\$5,000
M.2	Supplement the habitat in the corridor	High	\$15,000
E.4	Community involvement in re-vegetation	High	\$30,000 p/a
E.3	Monitor the vegetation	High	\$2,000 p/a
M.4	Monitor vegetation	High	\$2,000 p/a

Reference ID	Action	Creek Priority	Approximate anticipated cost
M.1	Continue vegetation program	High	\$80,000 plus on-going maintenance
E.1	Vegetation program throughout the developed areas with community input	High	\$150,000
E.8	Work with landholders up the catchment in the development of a vegetation corridor	High	\$220,000
B.4	Pathway construction	High	\$10,000
MH.5	Monitor the stability of the channel in the gully and vegetation	High	\$3,000 p/a
EP.1	Monitor the stability of the channel in the gully and vegetation	High	\$3,000 p/a
B.3	Monitor the stability of the channel in the gully and vegetation	Medium	\$2,000 p/a
E.5	Interpretative signage	Medium	\$5,000
MH.2	Supplement the habitat in the corridor	Medium	\$10,000
E.2	Supplement the habitat in the corridor	Medium	\$10,000
MH.4	Sediment basins and/or raingardens at the piped outlets to the creek	Medium	\$40,000
EP.4	Sediment basins and/or raingardens at the piped outlets to the creek	Medium	\$5,000 - \$10,000 each
B.1	Develop a terrestrial canopy link	Medium	\$25,000
All.1	Encourage the use of rainwater tanks on existing houses	Low	Dependant on scale
E.7	Top-soil replacement/enhancement	Low	
E.9	Explore whether fish passage can be restored	Low	\$5,000 (potentially \$80,000 to implement)
A.4	Encourage the use of rainwater tanks on houses	Low	
M.6	Sediment basins and/or raingardens at the piped outlets to the creek	Low	Approximately \$5,000 each

Reference ID	Action	Creek Priority	Approximate anticipated cost
MH.6	Provide formal steps and access to the creek with interpretive signage	Low	\$15,000
E.6	Sediment basins and/or raingardens at the piped outlets to the creek	Low	\$20,000

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Web resources:

<http://www.dpi.nsw.gov.au/fisheries/habitat/rehabilitating/road-crossings>

http://www.epa.vic.gov.au/water/stormwater/stormwater_clause56.asp

<http://www.cityofsydney.nsw.gov.au/Environment/documents/GuidelinesforErosionandSedimentControl.pdf>

<http://www.water.vic.gov.au/environment/rivers/guidelines>

Appendix A

Site Maps

Merrangbaur Heights Creek – Lakes Entrance

Magees Gully - Bairnsdale

Goose Gully – Eastwood

Lake Bunga Gully – Lake Bunga

Eagle Point Creek – Eagle Point

Nicholson Gully - Nicholson

Livingstone Creek - Omeo

Shady Gully - Mallacoota





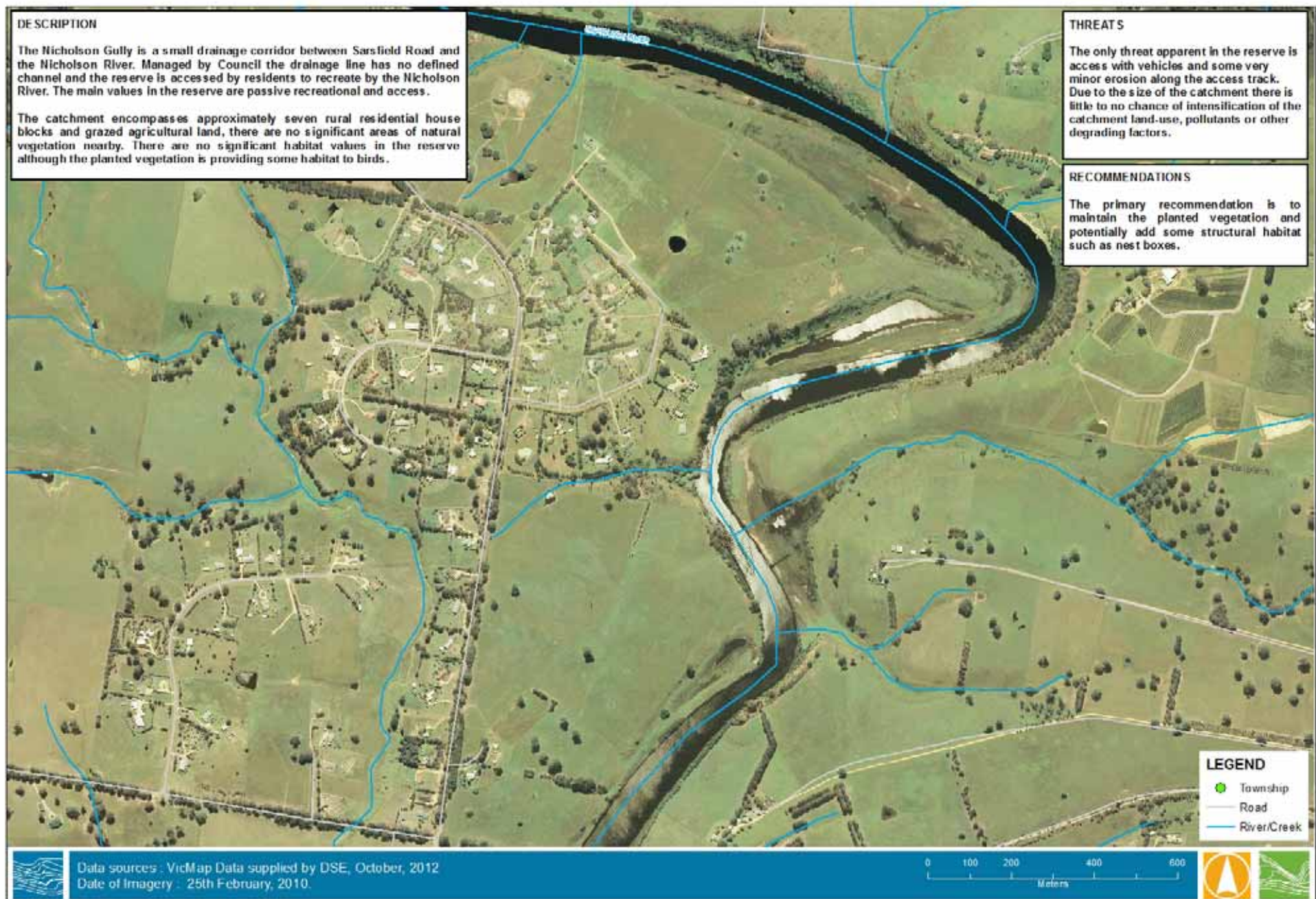


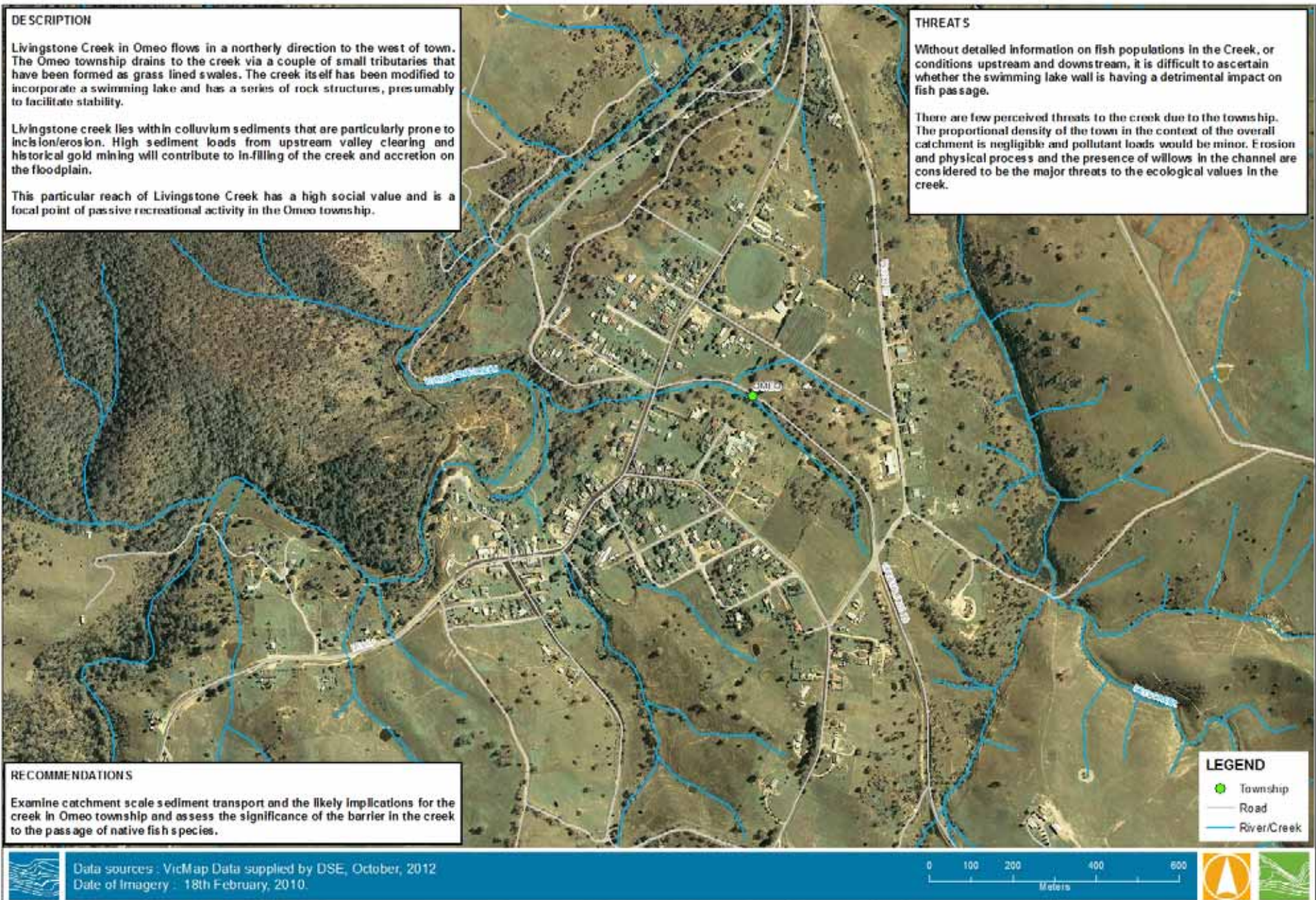




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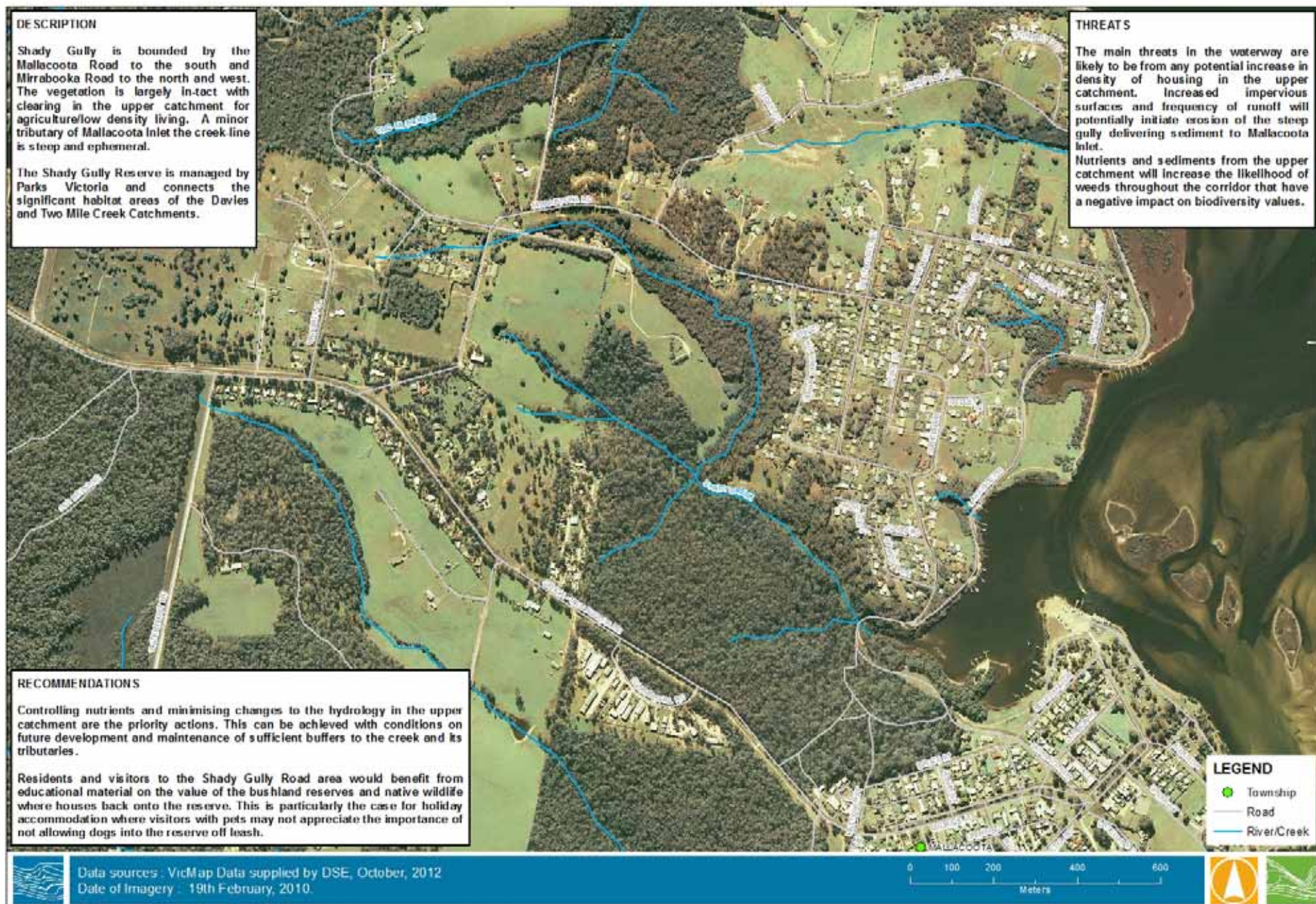
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Appendix B

Department of Sustainability and Environment community attitudes to waterways

http://www.water.vic.gov.au/_data/assets/pdf_file/0006/127554/DSE1271-MyVictorianWaterway.pdf

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