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East Gippsland Shire Council
Urban Waterway Guidelines

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EAST GIPPSLAND
SHIRE COUNCIL

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.

These guidelines identify the key considerations in the management of urban waterways and recommends policy principles for consideration in sub-divisions that incorporate open space corridors along waterways.

This ‘Urban Waterway Guidelines’ document provides advice on considerations to progress towards a best practice approach to the management of waterways in the urban environment. It has been prepared with a companion ‘Management Strategy’ document that aims to assist Council in implementing works along waterway assets in its care and control.

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.

To ensure that all waterway assets in the East Gippsland Shire Council local government area meet the needs of the community and the environment guidance on the following aspects has been provided for incorporation into subdivisional conditions:

- Waterway barriers;
- Channel stabilisation;
- Vegetation;
- Flood protection;
- Fire protection;
- Habitat;
- Infrastructure provision;
- Social amenity;
- Hydrology;
- Stormwater quality; and
- Industrial and commercial developments.

The consideration of these conditions will enhance the ecological attributes of the waterways in the urban environment as well as reducing the negative aspects of urban development of the receiving waterways of Gippsland.

Table of Contents

List of Figures

List of Tables

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.

These guidelines identify opportunities to provide guidance in relation to the rehabilitation of urban waterways in a strategic and prioritised manner. This document should be read in conjunction with the companion 'Urban Waterway Management Strategy'.

This document outlines a range of potential guiding directions that may assist in the improvement of waterways that are subject to future development and identifies measures that may improve the health of waterways across the local government area.

In the context of these guidelines '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 aim of these guidelines and the companion Management Strategy 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 document examines the Council responsibilities and opportunities in the prevention of harm and enhancement of waterways when new development progresses therefore 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 A. 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. Urban Development threats to waterway health

It is widely reported and recognised that the health of a waterway is compromised as urban development progresses. In the case of the urban areas within the Shire of East Gippsland the risks associated with the development influence both the local waterways and, in many cases, the broader receiving waters of the Gippsland Lakes or other estuaries.

The cost to the community in restoring a waterway is significant. The more degraded a waterway is the more costly it is to restore to a degree of health. As such it is important to identify at all levels of planning, prioritisation and implementation that prevention of degradation has a cost saving in the long term. The hierarchy of stream health works therefore is;

- Protect
- Rehabilitate
- Rebuild

During the construction of a development there are a number of initial threats that can influence the long-term health and resilience of the waterway. These can include the physical modification of the waterway, enlarging the channel capacity for flood conveyance or drainage, construction of infrastructure within or adjoining the waterway and sediment runoff from the catchment during the bulk earth works/housing construction.

The ongoing post-development phase influences the physical characteristics of the waterway (hydrology, channel form and function), the water quality (sediments, nutrients, toxicants and litter) and habitat (terrestrial vegetation, in-waterway vegetation, large wood, channel diversity and connectivity).

Typical results of urbanisation are most evident in a change to the waterway hydrology whereby a greater volume of runoff occurs after rain in a shorter duration due to the impervious catchment and the direct connectivity of the pipe network. The altered hydrology influences the channel morphology and stability which in-turn increases sediment transport. If the waterway carries high volumes of sediment, either from the catchment during development or from erosion within the channel it can smother plants and habitat as it progresses to the receiving waters.

Elevated concentrations of nutrients and contaminants, which in a natural landscape would be retained in the soils and taken up by vegetation, are now piped direct to the waterway. This increase in the nutrients in particular causes secondary issues associated with excessive algal growth and conditions that may favour weed species, both of which can reduce biotic richness.

3.1 Opportunities from development

Not all aspects of urban development need to be negative. In many circumstances urban development is occurring in land that has been intensively farmed. The impacts of farming on waterways can be significant and the transference of land to urban development provides an opportunity to enhance the waterway health.

Improving the ecological health of the waterway can be achieved through revegetation, treatment of stormwater (hydrology and water quality), removal of previous pressures (e.g. grazing, barriers, dams), provision of structural habitat and, importantly, enabling access to the community to enable the asset to be appreciated and maintained.

3.2 Multi-use corridors mean compromise

Where an urban waterway differs from a rural or natural waterway in form and function is the provision of infrastructure and community amenity. An urban waterway may have many positive attributes in terms of ecological value but there will always be some compromises due to the surrounding land-use and the pressures that are associated with that. For example, creating habitat corridors for threatened marsupials may be compromised by domestic pets; revegetation of the entire corridor width may prevent long-term maintenance access to infrastructure; flood mitigation infrastructure may create barriers to the movement of fauna.

Urban waterways will typically be the location of critical infrastructure that supports the needs of a development. In most cases the location of sewer infrastructure will be in the corridor as well as recreational infrastructure such as shared pathways.

It also has to be recognised that the waterway corridor must function in terms of drainage and conveyance of floodwater. The compromise here is to maintain/improve the ecological function of the waterway whilst also conveying floodwater. The outcome of this could be the requirement of a wider corridor that reduces the developable area.

The important consideration in the development of a management plan for a waterway is to identify the current and potential values and develop a clear set of objectives. It is these weighted, prioritised objectives that provide guidance on which components the compromise favours.

For Council as the waterway land manger in an urban area it is easier to mitigate the negative effects of a development in the planning phase than fix up a degraded waterway after the fact. Conditioning a development and adopting a guiding set of planning principles is an effective starting point in negotiating a compromise.

4. Policy Principles

This chapter of the strategy outlines a number of key principles that will enhance the ecological, social and financial values of urban waterways. During the development of a subdivision there are often requirements on a site to modify a waterway, set-back from a natural waterway or build infrastructure in or near the waterway.

To ensure that multiple objectives are met in waterway corridors the following policy principles should be considered in the review of sub-division development applications. These policy principles should also apply in consideration of the application to build or upgrade infrastructure such as roads or sewers.

It is proposed that the core principle of the East Gippsland Shire Council urban waterway guidelines is that it broadly follows the Victorian Native Vegetation Framework; that is to:

1. **Avoid** adverse impacts, particularly through vegetation clearance, additional pollutant loading, barrier construction or structural change to the waterway;
2. If impacts cannot be avoided, **minimise** impacts by careful planning, design and management; and
3. If clearing or significant modification of the waterway must occur, the works should be **offset** through provision of financial contribution or in-kind work to the Council to significantly enhance other values of the waterway.

The following sections of this chapter identify potential risks and values in urban waterways that require consideration in the development process and provide guidance that should be incorporated into planning permits.

4.1 Waterway barriers

4.1.1 Justification

Waterways and their associated vegetation corridors provide valuable conduits for the movement of fauna throughout the catchment. The construction of any infrastructure across the waterway affects the effectiveness of the corridor for any species that require migration as part of their life cycle or movement to reduce the likelihood of genetic isolation of populations.

Barriers include those in the waterway that prevent the movement of fish and other aquatic organisms. These include road crossings, retarding basins, farm dams, constructed wetlands and pipes.

The majority of urban waterways are minor tributaries of larger rivers and are classed as ephemeral waterways, they only flow occasionally. Whilst this is the case they still provide valuable habitat for fish and other fauna. Maintaining or enhancing connectivity as development progresses provides opportunities to maintain the biodiversity of the region.

Native fish in particular are unable to swim through high velocity water; this prohibits them from swimming through pipes, culverts and over structures. There are many guides available and implemented on the design of infrastructure that allows for the passage of fauna. Figure 4-1 below is from the Melbourne Water waterway crossings design guide and incorporates crossing space for both terrestrial and aquatic fauna.

Figure 4-1 Fish friendly crossing (Melbourne Water, 2011)

4.1.2 Policy principles

Policy principles for incorporation into sub-division development permits for waterway barriers are:

- Infrastructure should not be constructed in a waterway that prevents the free movement of fish, reptiles and/or frogs where habitat for such fauna exists upstream and downstream of the structure.

4.2 Channel stabilisation

4.2.1 Justification

A natural waterway that is not confined in bedrock has inherent instability, it is this instability that creates pools and other habitat features, and therefore not all instability is bad. There are commonly areas of erosion, sediment transport and sediment deposition in a natural waterway; all of which are functions of the channel size, shape, gradient, substrate and the hydrology.

Clearing a catchment of native vegetation for agriculture, or the incorporation of urban development, has an influence on the hydrology by increasing the frequency of larger flows and the potential for excessive erosion. In particular it is the change in the frequency from natural flows in the 3 month to 1 year ARI. Minimisation of the changes in these flows during a development can assist in reducing the impact of development on a waterway.

Where excessive erosion occurs in the channel there are consequences on both built assets and natural ecosystem values. At the point of the erosion/instability on the channel of the waterway may pose a threat to infrastructure such as sewer pipes, footpaths, bridges and roads. Identifying where these locations of erosion may occur aids the planning of stabilisation works.

A second form of channel instability is where there is an interface between infrastructure and the waterway. This is normally associated with the piped inflows of stormwater to the waterway. A lack of stabilisation in the immediate vicinity of the infrastructure will lead to the potential failure of that piece of infrastructure.

For the natural environment the excessive erosion of a channel can create issues for downstream ecosystem values. Eroded fine colloidal sediments create a turbid water column which limits the ability of light to reach aquatic plants. Coarser sediments may move through the waterway and smother aquatic vegetation, fill in habitat features such as pools or create in-filling of rivers and estuaries. The issues associated with urban waterway erosion in the East Gippsland Shire Council area are particularly acute in terms of the Gippsland Lakes with their high ecological value. It is also important however to consider the value of the urban waterways themselves. There are many species of estuarine fish that use small tributaries for periods of their life cycle and as such require a diversity of habitat types and persistence of these habitat features.

Channel instability can be addressed through mitigation works such as rock armouring of the bed and banks, creating sediment ponds to trap the sediment, revegetation of the channel or manipulation of the hydrology.

The method employed to stabilise a waterway needs to be assessed on the merits of the individual site characteristics. Information on techniques can be found at:

http://www.water.vic.gov.au/environment/rivers/guidelines/waterway-management

4.2.2 Policy principle

Policy principles for incorporation into sub-division development permits for channel stabilisation are:

- The design of natural channels in a subdivision should consider the stability of the channel and the potential for erosion. Where excessive erosion may occur stabilisation measures should be considered.

4.3 Vegetation corridors and management

4.3.1 Justification

The structure of vegetation adjoining a waterway is important in the functioning of a corridor. Vegetation is the key to a healthy waterway;

- Canopy trees provide shading that regulate water temperature, nutrients to the waterway and structural habitat for terrestrial fauna.
- Understorey vegetation provides habitat values and sources of food for small birds and mammals and reduces the potential for erosion adjoining the waterway.
- Floodplain grasses, sedges and reeds provide stability, habitat for amphibians & reptiles and enhance sediment & nutrient trapping efficiency.
- In-waterway vegetation provides bio-films for the reduction of nutrients whilst increasing habitat for macro-invertebrates, frogs and fish.

The diversity of the vegetation is as important as the structure. Exotic trees, such as willows and poplars reduce the diversity of understorey, cause blockages & erosion, and the leaf drop in autumn can de-oxygenate the water leading to fish kills. Exotic mid storey and groundcover species out compete native species leading to reduced diversity and habitat values.

Well managed control and removal of exotic species is beneficial to the ecological health and aesthetic of waterways.

The width and type of vegetation recommended are dependent on the objectives of the waterway corridor. There are many studies and policies through Australia that have identified the optimal corridor width of waterways in urban areas Figure 4-2. Unfortunately few provide firm defendable guidance that can be enforced across the board. A preferred approach is to identify the potential values of each waterway and set corridors based on the available land and the values that exist, or could realistically exist, within the waterway/corridor.

The development of a core vegetated zone with a multi-use buffer zone creates an ecological corridor and community amenity (Figure 4-2).

Clause 14.02-1 - Catchment Planning and Management of the Victorian Planning Policy Framework contains the following strategy in relation to buffer zones ‘retain natural drainage corridors with vegetated buffer zones at least 30m wide along each side of a waterway to maintain the natural drainage function, stream habitat and wildlife corridors and landscape values, to minimise erosion of stream banks and verges and to reduce polluted surface runoff from adjacent land uses’.

4.3.2 Policy principle

Policy principles for incorporation into sub-division development permits for vegetation corridors and management are:

- Revegetation near waterways should enhance bank stability, habitat corridors or water quality buffers if feasible.
- Proposed corridor widths and vegetation structure must consider the ecological values identified for that waterway. These should include; regional connectivity between critical habitats, channel stability, water quality and floodplain connectivity.
- Revegetation programs should correspond with the appropriate Ecological Vegetation Class and source local provenance plants.

- Corridor widths should be broken into management areas. The core riparian vegetated areas directly adjacent to the waterway should have all infrastructure and recreational pathways excluded from the majority of the length. A second zone (buffer) can include pathways and infrastructure with canopy vegetation and an open recreation zone beyond this.

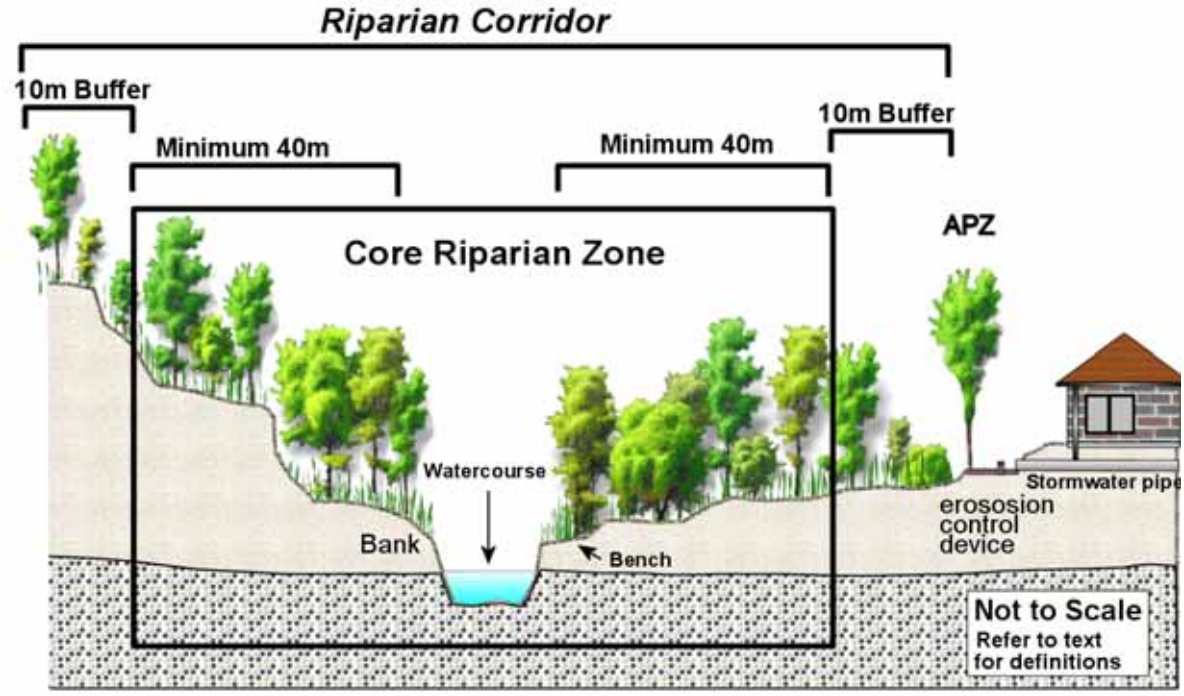

Figure 4-2 Proposed corridor uses and zones (Ku-Ring-Gai Council, 2004)

Note: Clause 14.02-1 of Victorian Planning Policy Framework refers to a 30m minimum vegetated buffer zone along each side of a waterway.

4.4 Flood protection

4.4.1 Justification

Flood plains are resources of great value. Historically, many towns and cities have been situated adjacent to rivers, streams and estuaries. The floodplains associated with these waterways have provided many of the natural resources to support the well-being and productivity of the townships and industries located in proximity to these waterways. The continued health and function of floodplains is directly linked to the viability of many ecosystems, including sensitive wetlands, fresh water swamps, riparian zones and estuarine systems. As residential and industrial developments look to utilise areas of lower lying ground within the extended floodplains of river systems, there is an increased risk of flood related damage and injury to residents, property and infrastructure.

The aim of floodplain management (and flood protection) is to reduce the effects of flooding on landowners of properties at risk from flooding, and to reduce private and public losses of property and infrastructure. Floodplain management also aims to recognise, value and safeguard the social, economic and ecological functions of a healthy floodplain environment.

There are typically four main options for floodplain management available, these are usually defined as:

- Structural flood mitigation works;
- Land use planning and control;
- Development and building controls; and

- Flood emergency actions.

Best practice principles for flood protection include:

- Standardised flood risk terminology to describe flood risks and hazards;
- Appropriate flood depth and flood extent mapping of vulnerable areas; and
- Educating and increasing the awareness of the community in regards to flooding of their local area.

As outlined in the Victorian Planning Provisions, there are four types of flood provisions within the available to describe the nature of flooding risk in an area. These are the Urban Floodway Zone (UFZ), Floodway Overlay (FO), Land Subject to Inundation (LSIO) and Special Building Overlay (SBO). The UFZ is applied to urban areas with a high flooding risk and effectively prohibits most uses and development. The FO similarly represents a high flooding risk, but is typically applied to known water courses within reserve areas where flood depths are often significant. The LSIO identifies land with a lower flood risk (shallow depths and slower velocities) where development options may be possible with appropriate design and risk management. The SBO is typically used for areas that are impacted by heavy rainfall induced short term flooding, or so called 'flash flooding' from flows that exceed the capacity of piped infrastructure. At this stage only the LSIO exists within the East Gippsland Shire Council Planning Scheme. Referral to the regional floodplain manager (EGCMA) occurs for issuing of planning permits within flood prone land.

Figure 4-3 provides a useful depiction of the definitions commonly applied to flood prone land.

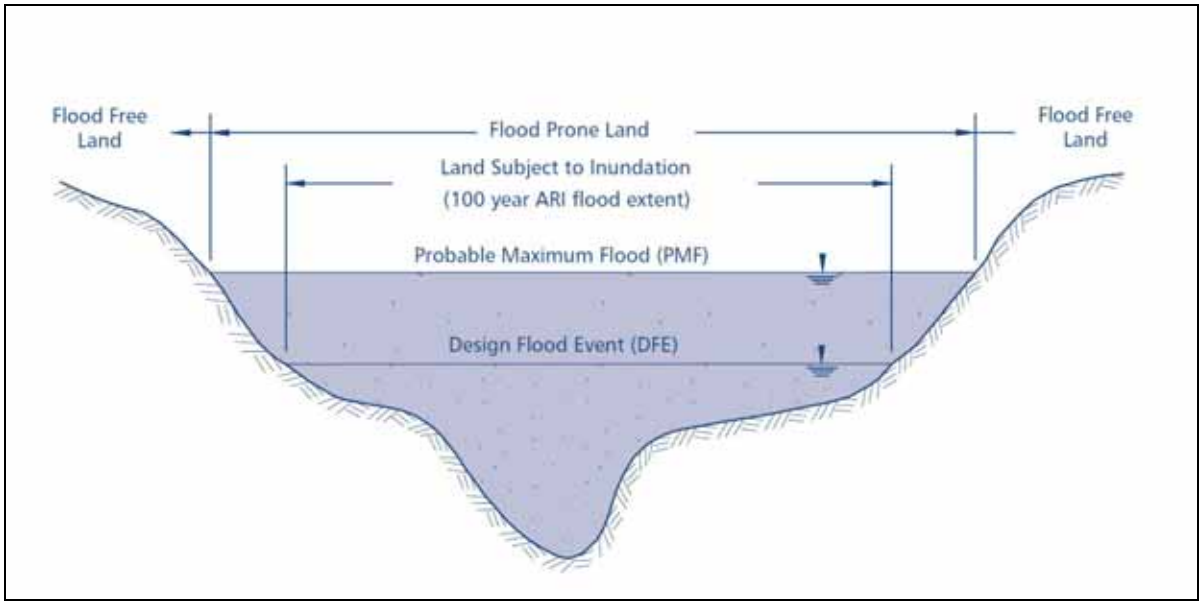

Figure 4-3 Flood Prone Land Definitions (source: Figure 1. VPP Practice Note: Applying the flood provisions in planning schemes, DPCD, 2000)

Figure 4-4 provides an overview of the allocation of flood zones (FO / LSIO etc.) within the design flood event extents. Typically the 100 year ARI event is used as the design flood.

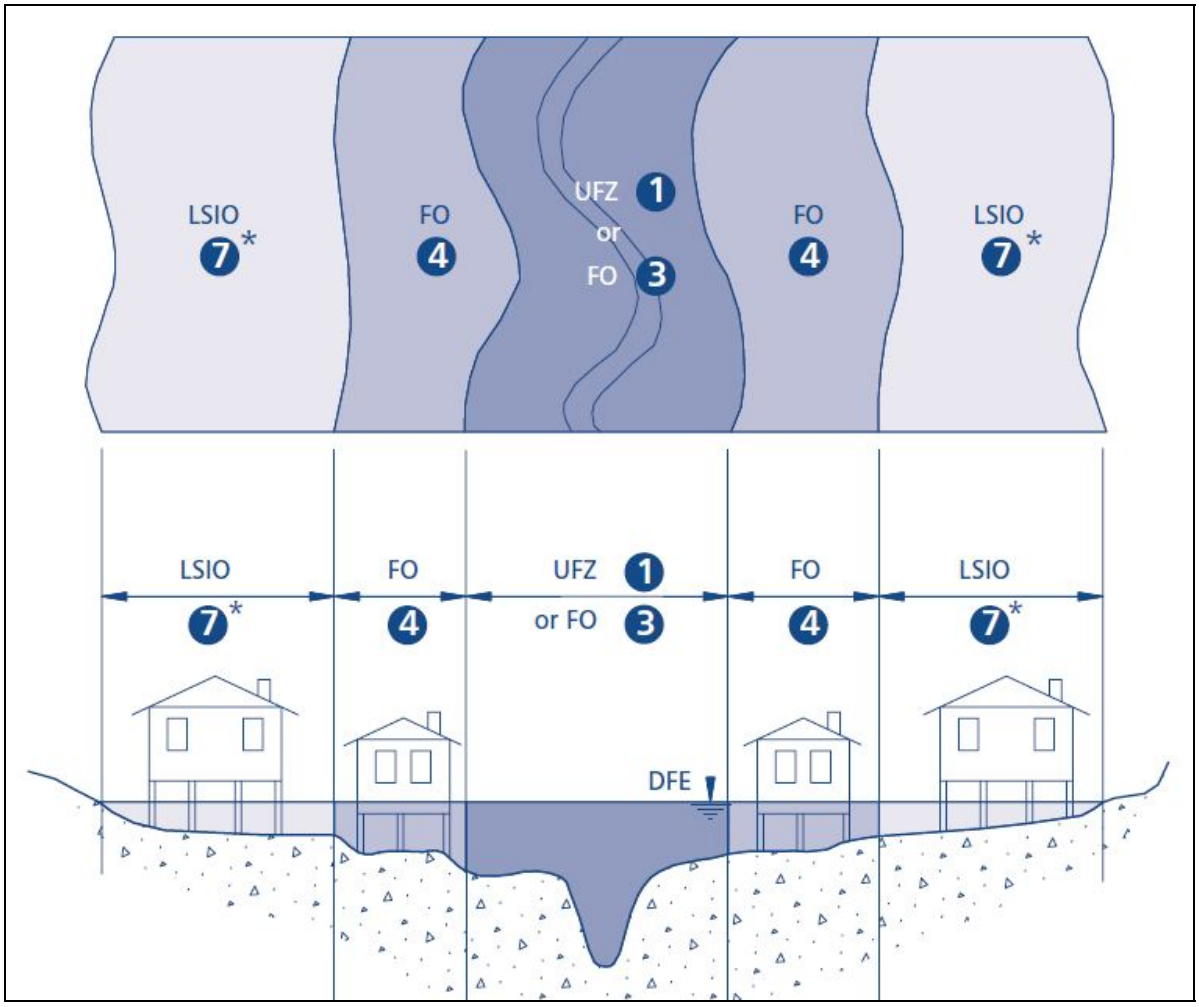

Figure 4-4 Flood Zone Definitions (source: Figure 2.3 VPP Practice Note: Applying the flood provisions in planning schemes, DPCD, 2000)

4.4.2 Policy principles

Policy principles for incorporation into sub-division development permits for flood protection are:

- Development proposals should provide a potential flood impact report/study which details recommendations/conclusions and incorporates areas where development should be avoided.
- Where portions of the proposed development are subject to flooding, development proposals shall provide appropriate flood mapping with flood risk areas defined, all new lots should be outside the 100 year ARI flood extent.
- Where flood modelling work is required to be performed, waterway modelling shall adopt a roughness value that represents fully vegetated riparian zones and associated buffer areas.

4.5 Fire protection

4.5.1 Justification

There is a considerable level of concern in the community about the proximity of native vegetation and the risks associated with bushfires. Common reference has been made in terms of riparian areas being a 'wick' that can facilitate the risk of fire adjoining property. Whilst little has been published on the role of riparian zones in urban areas and the risk of fire, existing bushfire guidelines present an appreciation of the degree of risk that may be associated with a narrow riparian area in an urban setting.

When considering the risk of bushfire and the activities associated with revegetation it is prudent to consider the potential for risk and the mitigation measures that are available. For example, proximity to fire fighting services, mains water, the structure and type of vegetation and the ability to access the vegetation if a fire were to occur all serve to reduce the risk associated with a bushfire. Designing a sub-division to have the roads adjoining the waterway further reduces the potential risk by setting dwellings back from a potential fire.

When assessing the risks associated with riparian corridors they should be reviewed in light of the East Gippsland Fire Management Plan, CFA Planning for Bushfire in Victoria Guideline, Victorian Fire Risk Register, Municipal Emergency Management Plan and Community Emergency Risk Assessments and should be assessed by the East Gippsland Shire Council Municipal Fire Prevention Officer

Of these, the 2012 *Planning for Bushfire* Victoria Guideline has been designed to support the implementation of the Bushfire Management Overlay following the 2009 Bushfires Royal Commission. The planning document outlines the potential risks of developing in a bushfire prone area and identifies clear strategies to mitigate risks to future developments. Mitigation measures include design guidelines, setbacks from fire prone vegetation, management of buffers and a design code to enable firefighting activities should a fire eventuate.

It is important to note that the Bushfire Planning Guidelines do not prohibit the development in areas where there is an acceptable level of risk. Equally, the Guidelines do not prohibit the development of vegetation corridors, as long as the level of risk is considered in the planning of such corridors.

Where a proposed subdivision adjoins or encompasses a waterway, consideration of the setbacks for bushfire protection are to be considered with the provision of a vegetated riparian zone adjoining a waterway. This shall be the case whether there is an existing vegetated corridor there, or one is to be planted. This consideration of the final form of the waterway at the planning stage will mitigate the loss of ability to enhance the ecological value at a later stage due to the level of risk associated with vegetation adjoining a development.

4.5.2 Policy principle

Policy principles for incorporation into sub-division development permits for fire protection are:

- In new subdivisions setbacks for fire protection should consider the future riparian corridor in its vegetated state (even though there may not be vegetation there at the time of development).
- Subdivision layout should consider the benefits of adjoining roads/access alongside riparian corridors to mitigate the risk of fire on properties.
- Reference should be made to the provisions in the Planning for Bushfire Victoria guidelines.

4.6 Habitat

4.6.1 Justification

Urban waterways provide a considerable range of habitats for native fauna. The corridors have the ability to sustain large populations of terrestrial and aquatic fauna in many cases connecting larger areas of vegetation to catchment boundaries. Whilst there are obvious limitations in terms of larger fauna species a well designed and implemented corridor can add significant value to the region and create a natural landscape that is easily accessible to the community.

Frogs, fish, reptiles, birds and mammals require a diversity of vegetation strata and structural habitat to thrive. Creating a diverse range of habitats increases the likelihood that there will be fauna present.

In-waterway timber (large woody debris) creates a location for many fish species to spawn, cover for fish to shelter from predators, basking sites for turtles and in many cases creating localised scour and persistent pools. Grazing macro-invertebrates also feed of the bio-films that grow on timber and in-turn are predated upon by fish.

Maintaining the connectivity of a waterway to a floodplain, even if it is inset in a macro-channel, enables other habitats disconnected from the main channel. These wet habitats can be important for frogs which may breed in ephemeral pools.

Terrestrial timber (fallen logs and trees) and rocks provide very important shelter for reptiles and lizards in particular. Maintenance or creation of these habitats are important in maintaining a degree of balance of fauna.

Hollows in old trees are highly valued features by arboreal mammals and birds. Where these are not present consideration to the installation of nest boxes is recommended.

4.6.2 Policy principle

Policy principles for incorporation into sub-division development permits for habitat are:

- The design of the natural channel should demonstrate that habitat values in the waterway have been considered in the design of channel features such as pools, vegetation, floodplain connectivity and large woody debris (the latter may require stability calculations to mitigate risks to infrastructure in larger rivers).
- The design of revegetation or rehabilitation plans should consider the incorporation of physical habitat values for terrestrial fauna such as hollows, nest boxes, terrestrial timber (fallen logs) and rock.

4.7 Infrastructure provision

4.7.1 Justification

Large corridors set-aside for recreation, natural values and drainage are also suitable locations for the provision of the infrastructure that services the development. The most common infrastructure in the corridor is the gravity fed sewer. Whilst this is a complementary use in the corridor there are occasional conflicts with the other intended values.

Sewers require maintenance from time to time and provision of vehicle access to the maintenance points shall be considered in the locating of vegetation and pathways to ensure adequate access is achieved.

During the construction of the sewer (or other underground infrastructure) there will undoubtedly be a requirement to cross the waterway. Depending on the methods employed this has the potential to initiate instability. Risks to the long term health of the waterway must

be considered in the decision as to whether the waterway should be trenched or direct drilled for the crossings.

4.7.2 Policy principle

Policy principles for incorporation into sub-division development permits for infrastructure provision are:

- During the provision of underground infrastructure in a waterway corridor consideration should be given to the minimisation of the number of required crossings of the waterway. A risk assessment of the approach to mitigate environmental consequences of a crossing and detailed designs of the remediated channel are required.
- The locating of underground infrastructure should consider the maintenance access requirements and be incorporated into the landscape and recreational infrastructure plans.

4.8 Social amenity

4.8.1 Justification

Urban waterways have been considered purely in terms of drains for the majority of the last 100 years of development. They have been considered of little ecological or social value and as such have often been places of anti-social behaviour and dumping of garden waste.

Recognising the corridors as a social asset is a first step in improving the perceptions of the corridor of a valued part of the community infrastructure. Turning a development to face a waterway is now considered best practice and recognises the waterway and corridor as an integral component of the social infrastructure. Sub-divisions with corridors are frequently marketed as having the natural values and are sold at a premium.

Frequent points of access and a continuous walking track on at least one side of the waterway is desirable and limiting the rear lot access to the corridor to a maximum of one side increases community safety and reduces the prevalence of dumping.

4.8.2 Policy principle

Policy principles for incorporation into sub-division development permits for social amenity are:

- Waterways are treated as social assets within a development. Where possible and deemed appropriate, access tracks are to be incorporated within the corridor. Unless unavoidable houses should not back onto waterway corridors on both sides, open roadside access is to be maintained on at least one side of the corridor.

4.9 Hydrology

4.9.1 Justification

Floodplain and flood protection policy is addressed in Section 5.4 of this document. Flood protection is typically centred on understanding and mitigating the potential adverse impacts of the 100 year ARI event. It is also important however, to recognise that alterations to the hydrological regime for events up to and including the 100 year ARI can have significant adverse impacts on waterway erosion, waterway habitat and structure, and the ecosystems that depend on the waterway for survival. Significant reductions in the 1 year ARI flows for example, will act to reduce the available water in localised pools and deeper section of channel that are likely to support permanent populations of aquatic flora and fauna. Similarly, increases in frequent event flows will (over time) alter the location, frequency and holding capacity of the permanent pools and deeper channel areas, with research indicating

that a change in the imperviousness of a catchment by greater than 10% noticeably impacts the diversity of macro-invertebrates.

In geomorphological terms, increased flows resulting from urbanisation of waterways leads to a series of dramatic changes over time in channel form, including:

- Increased stream power, leading to increased channel and bank erosion;
- Straightening of the stream and elimination of meander bends leading to increased flow velocities and further erosion;
- Increased sediment load in the waterway and infilling of deeper pool areas with entrained sediment; and
- Reduction in light penetration into the water profile due to increased turbidity.

The aims of stormwater management with regard to urban waterways should therefore centre on the prevention of undue erosion of waterways and riparian slopes, and the minimisation of waterborne sediment loads. These actions will serve to protect the existing natural hydrological regimes and the ecosystems that depend on them. The effective management of runoff from urbanised / industrialised areas to reduce peak flows to pre-development conditions by using localised detention where practical, and minimising impervious surface areas within the development.

4.9.2 Policy principle

Policy principles for incorporation into sub-division development permits for hydrology are:

- Development proposals should demonstrate that the post development discharge volumes and peak flow rates will be maintained relative to the pre development conditions within the catchment.
- Where potential adverse impacts are considered likely, the design of the urban waterway and buffer areas must demonstrate that an acceptable post development hydrological regime will be maintained for all events up to and including the 100 year ARI event.
- Development proposals should avoid direct discharge of stormwater flows into waterways. Appropriate energy dissipation devices should be utilised to minimise erosive potential.
- Rainwater tanks should be incorporated into new and existing developments to minimise changes to hydrology.

4.10 Stormwater quality

4.10.1 Justification

There are two phases of a development that contribute pollutants to a waterway; during and post construction. During construction the greatest threat to the health of the waterway is excessive sediment supply from exposed soils. Once in the waterway this sediment covers plants, in-fills habitat pools, reduces light to aquatic plants and can eventually find its way to receiving waterways such as the Gippsland Lakes or other estuaries. Depending on the sediment particle size the sediment can take many years to work through a waterway and causes damage all the way. Excessive sediment deposition can also alter flood levels.

Sediment and erosion control during development is vitally important. A sediment and erosion control plan should identify proposed locations of temporary sediment basins, sediment fencing, stockpile containment, and bare soil treatments (e.g. mulch, sterile grasses and jute matting).

Figure 4-5 Example of high sediment load to a natural waterway

Completed developments contribute nutrients, metals, oils, toxicants, litter, pathogens, organic material (including seeds) and sediments to waterways. In a natural environment potential pollutants are trapped in vegetation, infiltrate into soils and are absorbed by plants. An urban development is highly efficient in transporting these materials from the hard surfaces (roads, roofs, footpaths) through pipes to the waterway.

Pollutants can be from anthropogenic sources such as cars, fertilizer use, industrial sources and litter, or from natural sources including atmospheric nitrogen and animal faeces. The critical factor is that they are delivered directly to the receiving waterway where they may cause a deleterious effect on ecological function.

Each pollutant has a potential effect on the waterway.

Pollutant	**Effect**
Nutrients	Encourage growth of algae and introduced species.
Metals	Bio-accumulative toxicity in fish, molluscs and other animals.
Oils	In sufficient quantities oils can prevent surface oxygen exchange reducing the amount of dissolved oxygen in the water that can lead to fish kills. Oils are also potentially toxic to macro-invertebrates, an essential part of the food chain.
Toxicants	Herbicides and pesticides have toxicity to non-target species. Many pesticides are particularly toxic to aquatic biota.
Litter	Unsightly for residents. Can be ingested by fauna. Breakdown of materials can lead to toxic leaching.
Pathogens	Overflows from sewers and faecal matter from animals may contain bacteria and viruses that may persist in the aquatic environment. These can be detrimental to recreational users or shellfish for human consumption (e.g. in Wallis lake in NSW).
Organic material (including seeds)	Garden waste can be high in nutrients and contain seeds. When large quantities of organic waste enter the waterway

	they begin to break down. The biological organisms that break the materials down consume oxygen. This high biochemical oxygen demand can lead to fish kills.
Sediments	Cover plants, in-fills habitat pools, reduces light to aquatic plants and can eventually find its way to receiving waterways. Excessive sediment deposition can also alter flood levels.

The level of potential pollutants that make it to the waterway is directionally proportional to how connected (piped) the catchment runoff is to the channel. Treatment of stormwater runoff through a sediment basin, wetland, swale or rain garden minimises the risk to the waterway. Whilst best practice targets nutrients and sediments as a measure the treatment methods are efficient in also removing other pollutants.

4.10.2 Policy principle

Policy principles for incorporation into sub-division development permits for waterway barriers are:

- A detailed stormwater management must be developed prior to site works commencing. This plan must have details how the prevention of sediment from the sub-division and the individual allotments will be prevented from entering the waterway.
- All developments must deliver Best Practice.
- Water quality treatment infrastructure should be located outside the core riparian zone.

4.11 Industrial and commercial developments

4.11.1 Justification

Industrial and commercial developments are similar to residential developments in that they increase the volume of runoff to the waterway. This runoff increases the likelihood of erosion in the waterway and accelerates channel change. The frequent smaller events are those that are altered the most.

These commercial and industrial developments also have the potential to export large quantities of gross pollutants, metals and oils. Treatment by filtration (rain gardens) is an effective method to reduce the likelihood of these pollutants making it to the waterway.

Large rainwater capture and storage is a very effective way to reduce the negative effects of excessive run-off and has additional benefit to the occupiers of the premises in reduced water consumption.

Due to the commercial nature of these developments council has a role in the auditing of site practices. It is illegal to discharge any pollutants to the stormwater system. This can happen through cross connections between sewer and stormwater or general poor site management practices. Auditing of existing and developed industrial and commercial premises, in conjunction with the provision of education programs, can have immediate benefits to the health of a waterway.

4.11.2 Policy principle

Policy principles for incorporation into sub-division development permits for industrial and commercial developments are:

- Industrial sub-divisions must demonstrate that they meet best practice water quality targets.

- Site runoff is to be managed in a way that minimises the changes in the frequency and duration of flows up to and including the three month ARI.

5. 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)

5.1.1 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.

5.1.2 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.

5.1.3 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*"

5.1.4 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).

5.1.5 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.

5.1.6 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.

5.1.7 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.

5.1.8 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 (**140.2-2**);
- 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.

5.1.9 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.

5.1.10 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.

5.1.11 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.

5.1.12 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).

5.1.13 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.

5.1.14 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.

5.1.15 East Gippsland Shire Council Trails Strategy (2012)

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 lack of 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.

5.1.16 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.

5.1.17 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.

5.1.18 Links between policy principles and existing planning documents

Table 5-1 below links the policy principles (from Section 4) to the existing planning documents.

Table 5-1 Policy principles summary and links to existing planning documents

Policy topic	Principle	EGSC Environmental Sustainability Strategy 2008 - 2013	EGSC Urban Stormwater Management Plan 2003	EGSC Council Plan 2009 - 2013	Gippsland's Water Quality Action Plan (EGCMA, 2005)	Victorian Stormwater Action Program Final Report (EPA, 2007)	Infrastructure Design Manual (IDM, 2011)	WSUD Engineering Procedures (Melbourne Water)	EGSC Planning Scheme (2012)	Victorian Planning Provisions (DPCD, 2012)	VPP Practice Note: integrated Water Management (DSE, 2006)	Floodplain management: principles & guidelines (CSIRO, 2000)	VPP Practice Note: flood provisions in planning schemes (DPCD, 2000)	East Gippsland Regional Catchment Strategy 2012-2018 (DRAFT)	East Gippsland Regional River Health Strategy 2005-10 (EGCMA)	EGSC Trails Strategy 2012	Victorian Waterway Management Strategy (DRAFT DSE, 2012)	Planning for Bushfire Victoria (CFA, 2012)
Waterway barriers	Infrastructure should not be constructed in a waterway that prevents the free movement of fish, reptiles and/or frogs where habitat for such fauna exists upstream and downstream of the structure.	Section 2.3					Clause 20							Table 4-2	Table 3-3		Chapter 11	
Channel stabilisation	The design of natural channels in a subdivision should consider the stability of the channel and the potential for erosion. Where excessive erosion may occur stabilisation measures should be considered.	Section 2.2 Section 2.3	Table 4-4 Table 4-5 Table 4-8 Action 3 & 4 Table 5-3 Action 3	General links Also Strategic Objective	Section 4.3	General links	Clause 20	Numerous detailed links	Section 19.03-3 Section 56.07-4	Clause 56.07-4 & 56.08-1	General links			Table 4-2	Table 3-3		Chapter 11	
Vegetation	Revegetation near waterways should enhance bank stability, habitat corridors or water quality buffers if feasible. Proposed corridor widths and vegetation structure must consider the ecological values identified for that waterway. These should include; regional connectivity between critical habitats, channel stability, water quality and floodplain connectivity. Revegetation programs should correspond with the appropriate Ecological Vegetation Class and source local provenance plants. Corridor widths should be broken into management areas. The core riparian vegetated areas directly adjacent to the waterway should have all	Section 2.1 Section 2.3	Table 4-5	General links Also Strategic Objective 2	Section 4.3		Clause 22	General links	Section 11.03-2 Section 12.01 Section 13.05					Table 4-2	Table 3-3		Chapter 9 Chapter 11 Chapter 14 Chapter 16	Section 1 Section 3

Policy topic	Principle	EGSC Environmental Sustainability Strategy 2008 - 2013	EGSC Urban Stormwater Management Plan 2003	EGSC Council Plan 2009 - 2013	Gippsland's Water Quality Action Plan (EGCMA, 2005)	Victorian Stormwater Action Program Final Report (EPA, 2007)	Infrastructure Design Manual (IDM, 2011)	WSUD Engineering Procedures (Melbourne Water)	EGSC Planning Scheme (2012)	Victorian Planning Provisions (DPCD, 2012)	VPP Practice Note: integrated Water Management (DSE, 2006)	Floodplain management: principles & guidelines (CSIRO, 2000)	VPP Practice Note: flood provisions in planning schemes (DPCD, 2000)	East Gippsland Regional Catchment Strategy 2012-2018 (DRAFT)	East Gippsland Regional River Health Strategy 2005-10 (EGCMA)	EGSC Trails Strategy 2012	Victorian Waterway Management Strategy (DRAFT DSE, 2012)	Planning for Bushfire Victoria (CFA, 2012)
	infrastructure and recreational pathways excluded from the majority of the length. A second zone (buffer) can include pathways and infrastructure with canopy vegetation and an open recreation zone beyond this.																	
Flood protection	Development proposals should provide a potential flood impact report/study which details recommendations/conclusions and incorporates areas where development should be avoided. Where portions of the proposed development are subject to flooding, development proposals shall provide appropriate flood mapping with flood risk areas defined, all new lots should be outside the 100 year ARI flood extent. Where flood modelling work is required to be performed, waterway modelling shall adopt a roughness value that represents fully vegetated riparian zones and associated buffer areas.		Table 5-3 Action 3				Clause 16 (16.4-16.7 & 16.18)	General links	Section 13.02	Clause 56.07-4 & 56.08-1	General links	Section 3.5 Section 3.6 Appendix F	Table 1				Chapter 11 Chapter 15	
Fire protection	In new subdivisions setbacks for fire protection should consider the future riparian corridor in its vegetated state (even though there may not be vegetation there at the time of development). Subdivision layout should consider the benefits of adjoining roads/access alongside riparian corridors to mitigate the								Section 13.05								Chapter 15	Section 1 Section 3

Policy topic	Principle	EGSC Environmental Sustainability Strategy 2008 - 2013	EGSC Urban Stormwater Management Plan 2003	EGSC Council Plan 2009 - 2013	Gippsland's Water Quality Action Plan (EGCMA, 2005)	Victorian Stormwater Action Program Final Report (EPA, 2007)	Infrastructure Design Manual (IDM, 2011)	WSUD Engineering Procedures (Melbourne Water)	EGSC Planning Scheme (2012)	Victorian Planning Provisions (DPCD, 2012)	VPP Practice Note: integrated Water Management (DSE, 2006)	Floodplain management: principles & guidelines (CSIRO, 2000)	VPP Practice Note: flood provisions in planning schemes (DPCD, 2000)	East Gippsland Regional Catchment Strategy 2012-2018 (DRAFT)	East Gippsland Regional River Health Strategy 2005-10 (EGCMA)	EGSC Trails Strategy 2012	Victorian Waterway Management Strategy (DRAFT DSE, 2012)	Planning for Bushfire Victoria (CFA, 2012)
	risk of fire on properties. Reference should be made to the provisions in the Planning for Bushfire Victoria guidelines.																	
Habitat	The design of the natural channel should demonstrate that habitat values in the waterway have been considered in the design of channel features such as pools, vegetation, floodplain connectivity and large woody debris (the latter may require stability calculations to mitigate risks to infrastructure in larger rivers). The design of revegetation or rehabilitation plans should consider the incorporation of physical habitat values for terrestrial fauna such as hollows, nest boxes, terrestrial timber (fallen logs) and rock.	Section 2.1 Section 2.2 Section 2.3	Table 4-5	General links Also Strategic Objective	Section 4.3		Clause 22	General links	Section 12.01 Section 12.04-1					Table 4-2	Table 3-3		Chapter 8 Chapter 9 Chapter 10 Chapter 11 Chapter 14 Chapter 16	
Infrastructure provision	During the provision of underground infrastructure in a waterway corridor consideration should be given to the minimisation of the number of required crossings of the waterway. A risk assessment of the approach to mitigate environmental consequences of a crossing and detailed designs of the remediated channel are required. The locating of underground infrastructure should consider the maintenance access requirements and be incorporated into the		Table 5-3				Clause 16 general links										Chapter 14	Figure 24

Policy topic	Principle	EGSC Environmental Sustainability Strategy 2008 - 2013	EGSC Urban Stormwater Management Plan 2003	EGSC Council Plan 2009 - 2013	Gippsland's Water Quality Action Plan (EGCMA, 2005)	Victorian Stormwater Action Program Final Report (EPA, 2007)	Infrastructure Design Manual (IDM, 2011)	WSUD Engineering Procedures (Melbourne Water)	EGSC Planning Scheme (2012)	Victorian Planning Provisions (DPCD, 2012)	VPP Practice Note: integrated Water Management (DSE, 2006)	Floodplain management: principles & guidelines (CSIRO, 2000)	VPP Practice Note: flood provisions in planning schemes (DPCD, 2000)	East Gippsland Regional Catchment Strategy 2012-2018 (DRAFT)	East Gippsland Regional River Health Strategy 2005-10 (EGCMA)	EGSC Trails Strategy 2012	Victorian Waterway Management Strategy (DRAFT DSE, 2012)	Planning for Bushfire Victoria (CFA, 2012)
	landscape and recreational infrastructure plans.																	
Social amenity	Waterways are treated as social assets within a development. Where possible and deemed appropriate, access tracks are to be incorporated within the corridor. Unless unavoidable houses should not back onto waterway corridors on both sides, open roadside access is to be maintained on at least one side of the corridor.		Table 5-5	General links Also Strategic Objective													Part 1 pg7, 8 & 10	Chapter 7 Chapter 14	
Hydrology	Development proposals should demonstrate that the post development discharge volumes and peak flow rates will be maintained relative to the pre development conditions within the catchment. Where potential adverse impacts are considered likely, the design of the urban waterway and buffer areas must demonstrate that an acceptable post development hydrological regime will be maintained for all events up to and including the 100 year ARI event. Development proposals should avoid direct discharge of stormwater flows into waterways. Appropriate energy dissipation devices should be utilised to minimise erosive potential. Rainwater tanks should be incorporated into new and existing developments to	Section 2.3 Action 2.3-04	Table 3-2 Table 4-4 Table 4-6 Table 4-8 Action 3 & 4 Table 5-3			General links	Clause 16 (16.4-16.7 & 16.18)	Numerous detailed links	Section 13.02 Section 14.02 Section 19.03-3 Section 56.07-4 & 56.08-1	Clause 56.07-4 & 56.08-1	General links	Section 3.5 Section 3.6 Appendix F	Table 1	Table 4-2			Chapter 8 Chapter 11 Chapter 14	

Policy topic	Principle	EGSC Environmental Sustainability Strategy 2008 - 2013	EGSC Urban Stormwater Management Plan 2003	EGSC Council Plan 2009 - 2013	Gippsland's Water Quality Action Plan (EGCMA, 2005)	Victorian Stormwater Action Program Final Report (EPA, 2007)	Infrastructure Design Manual (IDM, 2011)	WSUD Engineering Procedures (Melbourne Water)	EGSC Planning Scheme (2012)	Victorian Planning Provisions (DPCD, 2012)	VPP Practice Note: integrated Water Management (DSE, 2006)	Floodplain management: principles & guidelines (CSIRO, 2000)	VPP Practice Note: flood provisions in planning schemes (DPCD, 2000)	East Gippsland Regional Catchment Strategy 2012-2018 (DRAFT)	East Gippsland Regional River Health Strategy 2005-10 (EGCMA)	EGSC Trails Strategy 2012	Victorian Waterway Management Strategy (DRAFT DSE, 2012)	Planning for Bushfire Victoria (CFA, 2012)
	minimise changes in hydrology.																	
Stormwater quality	A detailed stormwater management must be developed prior to site works commencing. This plan must have details how the prevention of sediment from the sub-division and the individual allotments will be prevented from entering the waterway. All developments must deliver Best Practice. Water quality treatment infrastructure should be located outside the core riparian zone	Section 2.3 Action 2.3-04 Action 2.3-06	Table 3-2 Table 4-1 Table 4-2 Table 4-4 Table 4-5 Table 4-6 Table 4-8 Table 5-3		Section 4.3 Section 4.4	Numerous general Links	Clause 16 Clause 20 Clause 22	Numerous detailed links	Section 11.05-5 Section 12.01 & 12.02 Section 13.02 Section 14.02 Section 19.03-3 Section 56.07-4 & 56.08-1	Clause 56.07-4 & 56.08-1	General links			Table 4-2	Table 3-3		Chapter 10 Chapter 14	
Industrial subdivisions	Industrial sub-divisions must demonstrate that they meet best practice water quality targets. Site runoff is to be managed in a way that minimises the changes in the frequency and duration of flows up to and including the three month ARI		Table 3-2 Table 4-6 Table 5-3			General links									Table 3-3		Chapter 10 Chapter 14	

6. 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.

6.1 Vegetation

6.1.1 Revegetation

Revegetation involves the planting of native vegetation within the riparian zone to re-establish or enhance native vegetation indigenous to the site (Figure 6-1). 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/m^2 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 m^2 depending on planting densities, vegetation type, community involvement and whether mulch is required.

Figure 6-1 Revegetation works

6.2 Channel stabilisation

6.2.1 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 6-2 and Figure 6-3). 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.

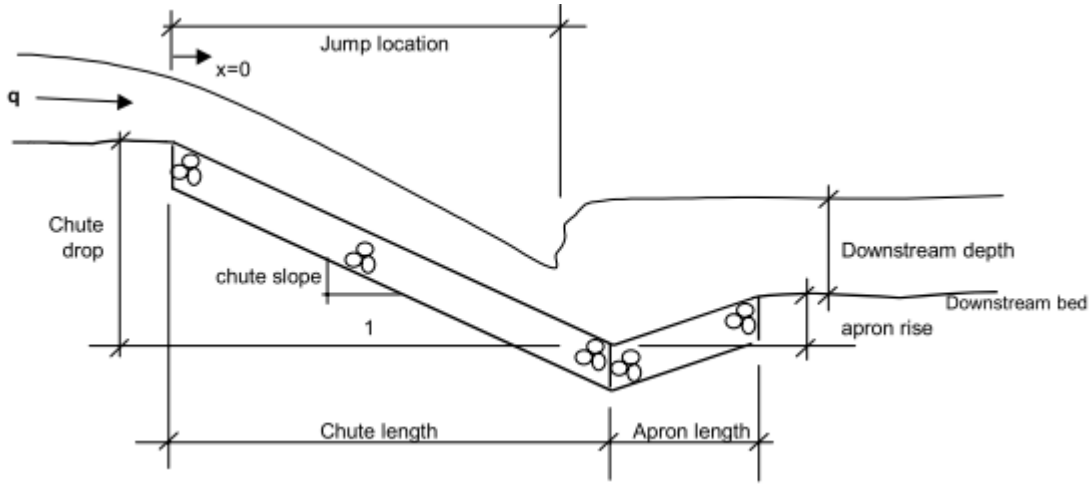

Figure 6-2 Schematic of a typical rock chute (Source: Keller (2003)).

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/m^3 of rock, supplied and placed.

Figure 6-3 Looking downstream at a rock chute

6.2.2 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 6-4 and Figure 6-5). 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.

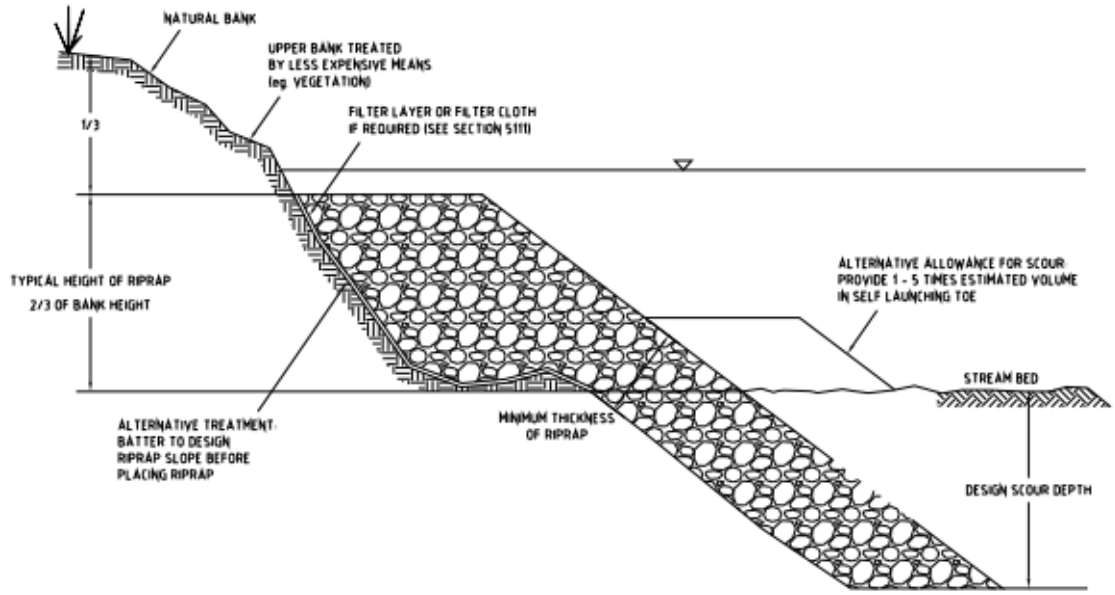

Figure 6-4 A typical rock beaching arrangement (Source: Department of Sustainability and Environment (2007)).

Figure 6-5 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 $100/$m^3$ of rock, supplied and placed.

6.3 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.

6.4 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 6.3).
- 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.

6.5 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.

6.6 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 6-6). The post has a cradle on the top to ensure the exact shot is replicated.

Figure 6-6 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.

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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 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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