3 Generic Management Options

3.1 Generic Option Considerations

3.1.1 Overview

A range of generic management options are available for consideration, which may be classified in terms of their consistency with natural river and environmental processes and the natural character and values of the river bank as follows:

"Soft" Options: Options which restore and/or preserve the natural character, behaviour and values of the river system. These will ensure the sustainable existence and natural character of the South Pine River estuary such that future erosion, both during short term floods and over the longer term, can be accommodated in a buffer zone without threat to development requiring protective works.

Soft options may include works such as riparian revegetation within the South Pine River waterway corridor or planning solutions that require development to be outside the zone of potential erosion (buffer zone), including:

- Regulatory controls on building in undeveloped areas; and
- Removal controls on building in developed areas.

"Hard" Options: Options that involve construction of works either to form a barrier to natural bank erosion to protect development (e.g. Concrete revetment) or to alter the natural processes to change the way in which the river behaves.

'Hard' options are generally expensive, and can potentially have adverse side effects on the natural geomorphic processes. Ongoing maintenance requirements must be considered in both the design and financing. Experience indicates that careful design in full cognisance of the prevailing geomorphic processes and the short and longer term effects is essential for success and cost-effectiveness of such works.

For example, construction of hard engineered structures in areas of high erosion risk may give protection to assets, though may also restrict the ability of a river to achieve this equilibrium in certain areas, sometimes causing increased erosion risk in adjacent areas.

Combinations of options or "hybrid" management approaches are often the most suitable where existing development lies within the erosion prone area. For example, works options such as terminal protection (riprap) are sometimes combined with partial set-back of development, or may be augmented with riverbank revegetation, stabilising the riverbank in front of the hard engineered protection and also offsetting associated deleterious environmental and recreational amenity impacts. In addition, most options need to be supplemented with relevant amendments to local planning controls.

Thus, engineering works options for the South Pine River may include 'soft' or 'hard' solutions, or a combination of both.

Potential management options to be considered in the SPRSEMP will be identified, described and assessed as part of the SPRSEMP Stage 2 assessment. These will include, but will not be limited to:

- No action;
- Regulatory controls;
- Retreat options;
- River bank re-profiling;
- Revegetation; and
- Structural erosion prevention systems.

A general description of these options is provided below; a more detailed discussion will be presented in the SPRSEMP Stage 2 assessment.

3.1.2 Regulatory Controls

3.1.2.1 Development Controls

One effective way to accommodate bank erosion and maintain a natural looking bank is to provide space for erosion to occur without threatening property or infrastructure; i.e. a buffer zone. This has the advantage of keeping development back from the bank, thus eliminating the need for protective measures, as well as allowing space for vegetation to establish to assist bank stability during floods. Also, if damage or loss of bank/vegetation does occur during a flood, then there is guaranteed access for revegetation activities. This is synonymous with the erosion prone areas classification in the QCP.

3.1.2.2 Boat Operation Restrictions

Most bank erosion caused by boat wash is caused by larger vessels travelling at speed, with a secondary impact being at the time of vessel acceleration and deceleration. The determination of appropriate speed restrictions is complex and is related to both the type of vessel and environment in which it is operating. This makes policing difficult and therefore speed restrictions are often applied because of their simplicity.

'Blanket' speed restrictions are a simple enforceable mechanism but are likely to inconvenience many recreational craft that are not contributing to erosion. Alternatively, operational guidelines could be developed for several generic vessel types and recreational activities and be accompanied by an education program about critical wave generation scenarios. These would need to be developed in conjunction with the Department of Transport and Queensland Police and involve considerable public consultation. Subsequent policing would become more difficult because of the increased complexity of the criteria i.e. not speed but energy related, which will require specific details for each different hull and loading combination (engine and/or passengers etc.).

3.1.3 Retreat Options

The intent of retreat options is to remove the development under threat and allow the river bank to behave in the natural manner, thus restoring and retaining the natural character and amenity of the river as the bank recedes. The planned retreat option acknowledges that erosion is an ongoing phenomenon and seeks to address the issue by removal of threatened facilities rather than trying to protect them.

On some river banks, there may be scope for setting back (retreating) some assets. Generally there are two different approaches to planned retreat which essentially relate to the ownership of the land and the responsibility for removal of structures. There are substantial differences between these options in terms of cost, who pays, likelihood of success and ultimate ownership of the river bank as discussed below.

3.1.3.1 Retreat under Public Ownership

This option involves the upfront transfer of ownership of all land with an erosion risk to the Crown so that it is under public ownership as recession occurs. Key factors for consideration of planned retreat under public ownership are as follows:

- Transfer of ownership to the Crown should be controlled and implemented via a voluntary acquisition process by government;
- 100% of the affected properties must be obtained in any one river bank location for this option to be effective;
- Once implemented, a need would subsequently arise to address the erosion threat of the “new erosion prone area” (as the river bank continues to migrate) and this may entail further significant expenditure to purchase. Unless this land was also purchased, all previous money spent on acquisition could be wasted; and
- At some locations, this retreat option could provide opportunities to establish or enhance public access to and along the river as land ownership is transferred to the Crown.

3.1.3.2 Retreat under Private Ownership

This option involves the land remaining in private ownership as recession occurs. Key factors for consideration of planned retreat under private ownership are as follows:

- The affected land (currently privately owned) would remain in private ownership when it is lost to erosion and private individuals would be responsible for their own planning in terms of loss of buildings, infrastructure and relocation.
- This option would require regulations to prevent implementation of erosion protection structures by private property owners that comprise principles set out in the QCP.
- Ad-hoc loss of private property to erosion typically causes significant adverse visual impacts.
- As a public river bank progressively erodes, the river bank could become private property, which could privatise access to and along the river.

- In terms of equity, it is relevant that the river bank allotments were historically created by the community (i.e. their representative being the government of the time) for residential use, prior to recognition of the erosion hazard.
- Residents may be reluctant to leave their river front locations and may utilise legal and practical means to protect their properties.

3.1.4 River Bank Re-profiling

River bank re-profiling, generally involves one of two processes:

(i) Relocating alluvium from the lower part of the bank or from a nearby location within the river system to the upper bank using mechanical equipment.

(ii) Rebuilding the river bank with material imported from outside the active river system.

River bank re-profiling can be used to restore river amenity and can temporarily improve the protection of adjacent assets by increasing the bank width. When material is imported, this effectively replaces the loss of material from the system and/or the deficit in the supply of alluvium that caused the erosion. In this way a natural river and its associated values are returned and maintained while providing a buffer of material to accommodate natural bank fluctuations and protect the assets and facilities behind. Such works are relatively inexpensive and can be implemented quickly. The main short coming of bank re-profiling as an erosion control measure is that it needs to be repeated periodically and may only offer limited bank protection.

River bank re-profiling would usually be undertaken in combination with installation of a ‘soft’ structural erosion protection system and/or revegetation of the river bank to improve the longevity of the re-profiling works.

3.1.5 Revegetation or Bank Regeneration

Riparian vegetation increases river bank stability in three ways:

(i) The roots of the vegetation help to reinforce the soil it grows in;

(ii) Vegetation retards flow, thus reducing the erosive forces on the river bank; and

(iii) Vegetation cover armours the underlying soil from the erosive forces of the river.

Thus, one option for improving bank stability and resilience is to re-establish riparian vegetation in areas where vegetation has been removed. This may be done in combination with regeneration of the bank through re-profiling. Benefits and limitations associated with this option are listed in Table 3-1.

Table 3-1 Natural Bank Reinforcement Benefits and Limitations

Benefits	Limitations/Challenges
• Relatively inexpensive to employ. • Improves the river bank habitat and general waterway health. • Provides an aesthetically pleasing outcome.	• Vegetation may not grow in the active river, thereby leaving the toe of the embankment susceptible to scour. • Vegetation may be hard to grow in some areas. • May lead to localised increases in river levels during flooding. • Difficult (more costly) to implement when river bank access is limited.

This option is less reliable for retaining the river bank alignment than 'hard' structural protection options, and is thus not promoted (in isolation) for protection of critical infrastructure that is in close proximity to an actively eroding river bank.

3.1.6 Structural Erosion Protection Systems

Structural protection systems provide protection of assets against ongoing erosion by shielding the river bank from erosive forces. They are options that could be considered in the event that retreat, bank re-profiling or revegetation options are not viable. However, there are some drawbacks of such an approach, as they are generally:

- More expensive to install;
- Require ongoing inspections and maintenance; and
- May reduce the amenity and ecological functioning of the river bank.

There are a number of structural protection systems that can be installed to control bank erosion. Some examples are provided in Table 3-2.

Table 3-2 Example Structural Protection Systems

Description	Benefits	Limitations/Challenges
'Soft' Erosion Protection Systems Where the bank slopes are shallow, matting revetments can be used to reduce erosion risk using materials such as: • Natural materials, such as coconut or coir matting or rolls; • Asphalt matting; and • PVC soil reinforcement matting systems such as Enkamat. Where bank slopes are steep, 'soft' engineering retaining wall systems can be installed using systems such as timber piling.	• Relatively inexpensive to install. • Can be integrated with riparian vegetation regrowth. • Good amenity value, especially after vegetation has covered the matting.	• Short design life. • High maintenance burden. • More susceptible to damage by people and animals than 'hard' engineering systems. • Limited resistance to erosive forces during significant flood events. • Timber piling creates a hard edge and impacts the bank habitat. • Matting is not suitable for mooring and timber piling is only suitable for 'light' mooring.

Description	Benefits	Limitations/Challenges
Rock Armouring Rock armouring can protect the underlying river bank material. Rock size will depend on the erosive forces. If high velocities or steep bank slopes are encountered, rock filled wire mattresses can be used to improve the resilience of the system.	• Longer design life than the 'soft' engineering systems. • Capable of protecting banks against higher erosive forces than 'soft' erosion protection systems. • Moderate design life.	• Lower amenity value than 'soft' erosion protection systems. • Requires regular maintenance/inspection. • More expensive than 'soft' erosion protection systems.
Sacks Sacks filled with soil or sand-cement mixture stacked on river banks. These systems are usually used for emergency work after flood damage has occurred.	• Relatively inexpensive and easy to install. • Can be used on relatively steep slopes.	• Short deign life. • High maintenance burden. • Poor amenity value.
Blocks Interlocking concrete blocks can be used to line the river bank.	• Cast with openings to allow for drainage. • Openings also allow vegetation growth.	• Not suitable for steep slopes. • Lower amenity value than 'soft' erosion protection systems. • More expensive than 'soft' erosion protection systems.
Retaining Structures Retaining walls, using materials such as rock filled gabion baskets, steel sheet piling and concrete, can be used to line river banks. These systems provide hard edges to the river banks and are more durable than 'soft' engineering systems. Usually used to protect critical infrastructure.	• Long design life. • Low maintenance burden. • High resistance to erosive forces. • Facilitates mooring facilities.	• Expensive to install. • Low amenity value. • Hard edge degrades river bank habitat. • High replacement cost at end of life or subsequent to failure.

3.2 Decision Matrix

It is convenient to consider protection options in the broad terms of the matrix illustrated in . This matrix, in effect, represents a decision tool based on criteria relating to:

- 'Natural' versus 'Altered' character; and
- 'Non-works' (planning) versus 'Works' options.

Table 3-3 Matrix of Beach System Management Options

	Preserve Natural System Character	Accept Change to Natural System Character
Non-Works Options (planning, management and regulation)	Development free buffer zones via planning or land use regulation; Resumptions of erosion prone development; Set-back of buildings; and Building guidelines and controls; Land use guidelines and controls; Management including river bank care activities.	Accept development on vulnerable erosion prone land, but prevent any protection works (allow loss of buildings and facilities as erosion occurs).
Works Options	Revegetation of riparian zones.	Hard engineering to protect assets.

To be consistent with coastal management policy guidelines and the priorities generally adopted by the community in areas where amenity and ecological integrity is important, the options in the column headed 'Preserve Natural System Character' would normally have highest ranking in any assessment criteria. Consideration may also be given to other low cost temporary works options and hybrid options that combine the beneficial characteristics and offset deleterious characteristics of specific individual options.

The likelihood of success (or the risk of failure) is a key consideration in the selection of possible solution options. The options adopted involving expenditure of public funds should preferably be tried and proven techniques for dealing with river bank erosion problems. There are a number of other (generally lower cost) options that are commonly put forward, covering a wide range of operational modes and with various claims of success. Most of these options typically have limited theoretical backing, have limited potential for providing significant long term benefits and/or have generally not been proven as an effective means of bank stabilisation. Such options would be ranked as low feasibility of success and would not be recommended.