3 Pine Rivers Park

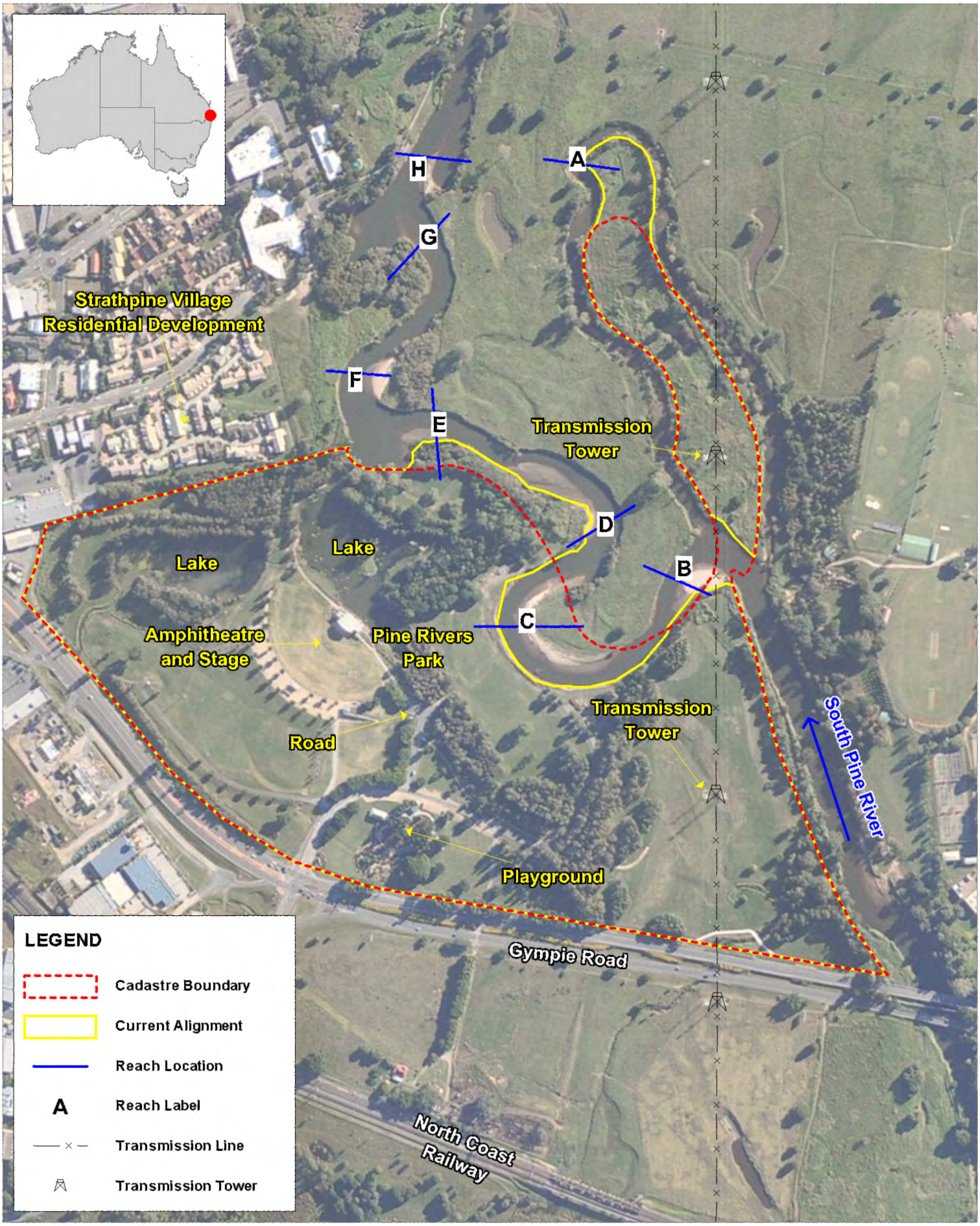
3.1 Background

Pine Rivers Park is the most significant Council asset threatened by bank erosion within this SPRSEMP. The park is located between Gympie Road and the South Pine River immediately downstream of the Gympie Road Bridge. The South Pine River bounds this key recreational asset. Erosion on an outside meander bend (Reach ‘C’ in Figure 3-1) along the boundary of the park has led to a loss of functional park area and damage/loss to park infrastructure. As such, Council is concerned about the management of river bank erosion in the vicinity of the park.

Cadastral boundaries indicate that the park area is approximately 36Ha. However, these lot boundaries are based on a historical river alignment. Considering the current alignment of the river bank (based on 2013 aerial photography), river morphological changes have resulted in the park area decreasing to 32Ha on the southern bank of the South Pine River, with an isolated 3.5Ha ‘island’ of land located off a breached meander bend on the northern bank of the South Pine River (breach is located adjacent to Reach ‘B’ on Figure 3-1). This change in the alignment of the park boundary is shown in Figure 3-1. It is not known when the cadastral boundary division was defined, but thought to be in the early 1900’s. Thus, over the last century there has been little change to the overall area of the park. However, the changing river bank alignment provides a challenge for management of park infrastructure, particularly at Reach ‘C’.

The evolution and migration of the river bank along the park is as follows:

- Reach ‘B’ has migrated in a manner that has resulted in a breach of the meander in this location. Reach ‘A’ is now an anabranch forming an island, with the main river bypassing Reach ‘A’ at Reach ‘B’. Observations of historical aerial photography suggest that this breach occurred between 2002 and 2009, and became more substantial subsequent to flooding in January 2011 (see Stage 1 report – BMT WBM, 2014).
- The cadastral boundaries suggest that there has been a small amount of migration of the northern river bank at Reach ‘A’. The river width at Reach ‘A’ has decreased due to deposition on the inside bend. This has led to a more pronounced migration of the southern bank.
- Reach ‘C’ has migrated in a south western direction, cutting into the park and reducing the park area. A beach has formed on the inside of this meander on the opposite bank from the park.
- Reach ‘D’ to ‘E’ has migrated in a north easterly direction, compensating for the ‘lost’ park area at Reach ‘C’.
- Reach ‘F’ has migrated in a westerly direction, undercutting an access path to the park.



Title:

Pine Rivers Park Layout

Figure: 3-1

Rev: A

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3.2 Site Issues

The trajectory of migration of Reach 'C' is of primary concern for the Pine Rivers Park. Erosion on the outside bend of this meander has already undermined a sealed bikeway (see Figure 3-2). This meander will continue to cut into the park, placing additional park infrastructure at risk of being washed away as well as reducing the size of the park (considering land on the opposite bank as being 'lost'). Recent erosion rates are estimated to be between 2.5m/year and 3.5m/year (BMT WBM, 2014) at Reach 'C'.

Figure 3-2 Damage to Sealed Bikeway at Pine Rivers Park

The trajectories of Reach 'B' and 'D' suggest that a breach will ultimately occur between these two reaches. This will render Reach 'C' as an anabranch. It is expected that this breach could occur within as little as 20 years (BMT WBM, 2014). Thus, erosion mitigation works on Reach 'C' may become redundant in future.

Another item of infrastructure in this area is a transmission tower located 70m from the outside bend of Reach 'B' on the 'island' (see Figure 3-1). The current projection of Reach 'B' is northwards towards this transmission tower. Therefore, the integrity of the tower and the transmission line it is supporting is at risk.

3.3 Options Considered

3.3.1 Option A – Do Nothing

If nothing is done to manage bank erosion in the Pine River Park area, the park area will continue to recede as Reach 'C' migrates in a south westerly direction. The implications are that:

- The parking area and park road in the vicinity of Reach ‘C’ is at risk of being lost or damaged.
- Park lawns adjacent to Reach ‘C’ will be lost.
- The Pine Rivers Park Stage and surrounding infrastructure are approximately 150m from Reach ‘C’. Therefore, there is not an immediate threat to this infrastructure, but there may be a risk in future.
- A park road providing access to the Pine Rivers Park Stage is approximately 100m from Reach ‘C’. Therefore, there is not an immediate threat to this infrastructure, but there may be a risk in future.
- The transmission tower near Reach ‘B’ may become undermined in future.

3.3.2 Option B – Monitor and Defer

This option is essentially the default option under this SEMP – see Section 2. It builds on Option A, whereby no protection works to the river banks is implemented at this stage. However, the river migration is monitored and given a set tolerance for movement. When the river migrates beyond this tolerance, another management option is triggered. The migration tolerance is set considering:

- Location of key assets that are to be protected.
- Buffer zone in front of key assets to ensure their long term integrity, considering:
    - Implementation time of ‘triggered’ management option;
    - Bank erosion rate and stability; and
    - Any limitations in the effectiveness of the triggered management option.

This option requires a monitoring programme to be put in place along with an action plan for when the tolerance line is breached. The tolerance has been set in this SEMP in accordance with the overarching management strategy (see Section 2). The river bank migration should be monitored on a regular basis (say before and after every wet season) and subsequent to a large infrequent flood event.

Erosion of the river bank has already moved into the Soft Erosion Protection Zone illustrated in Figure 2-1 and Figure 2-1-2. Thus, this management option is not suitable, as the soft erosion protection trigger has already been breached.

3.3.3 Option C – Soft Engineering

As shown in Figure 3-2, there are sections of channel bank where erosion has led to steep, unstable channel banks. In some areas, erosion has led to undermining and slumping failure of the bank. This presents an opportunity to rehabilitate the channel banks, by profiling the banks to a stable slope. The exposed re-profiled banks would be covered in a ‘soft’ erosion protection system. This may be in the form of a geotextile consisting of a woven mat, roll or bag of natural fibre or synthetic material. Additional protection of the toe of the embankment may be required; e.g. using coir rolls or a ‘harder’ protection such as rock roll if required. It is envisaged that this will provide erosion protection in the short to medium term. The erosion protection would be augmented by vegetation; the re-profiled banks should be seeded/planted with appropriate tidal and non-tidal riparian vegetation to promote vegetation colonisation. This will provide natural, long term erosion protection to the channel bank.

This option is commensurate with the recommendation by Alluvium (2011), for which a typical section of their proposal is shown in Figure 3-3.

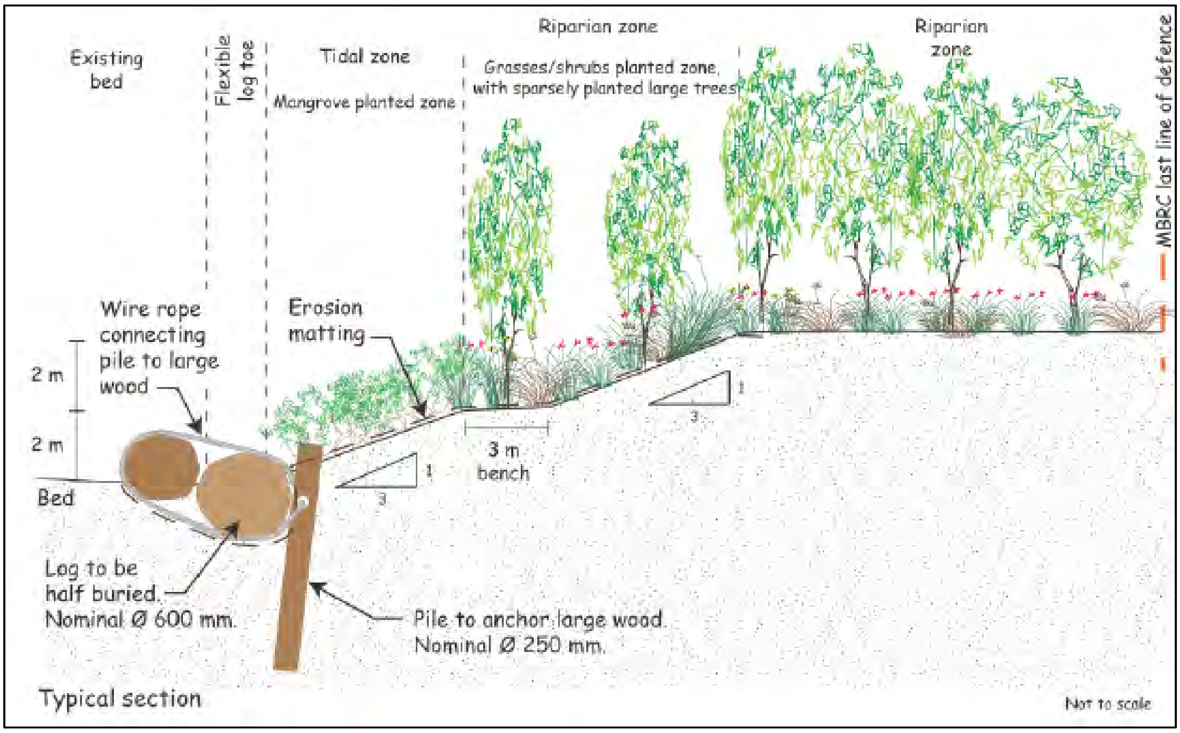

Figure 3-3 Example 'Soft' Engineering Solution (Alluvium 2011)

3.3.4 Option D – Hard Engineering

Hard engineering options will effectively halt the migration of Meander 'C' through the use of hard erosion protection materials such as rock and concrete. The following hard engineering options are applicable to the site:

- Re-profiling the bank and lining with rock. This approach has been used successfully further downstream along Learmonth Street to protect residential property (see Figure 5-2).
- Re-profiling the bank and lining with rock filled gabion mattress.
- Re-profiling the bank and lining with interlocking concrete blocks.
- Installing rock filled gabion basket retaining structure. This approach has been employed in a pocket of bank scour at Normanby Way (see Figure 4-3).

3.3.5 Option E – Diversion

3.3.5.1 Overview

It should be noted up front that river diversion is an invasive option that may have unforseen adverse impacts on the river functioning. Given the uncertainties of the outcome, and that Council may be held accountable for any adverse impacts, this option is considered too risky to implement. Nevertheless, since this report aims to canvass potential options, diversion has been discussed as one potential solution for completeness.

The morphology of this reach of the South Pine River has been active historically, as evidenced by numerous channel scars across the floodplain. The river is expected to continue to move across the floodplain in response to natural shifts in rainfall patterns and sediment transport processes. This active morphological response may support the option to divert the South Pine River, especially if the diversion is made along a forecasted natural channel alignment.

However, diversion of the river is an intrusive mitigation approach, which would result in sudden changes to the surrounding environment. Natural morphological changes would result in more gradual changes to the environment. As such, river diversion may impose a drastic disturbance on the natural environment, and may be constrained by environmental legislative limitations.

Diversion of the river channel may also be cost prohibitive: due to costs of environmental assessments, design and construction. Also, the potential diversion lines cross land in Brisbane City Council’s jurisdiction, which may be difficult to acquire or be granted the necessary rights for implementing the diversion.

Although many challenges related to river diversion have been outlined above, it is still a potential option for mitigating bank erosion to Council’s assets. Therefore, the river diversion option has been tabled in this SPRSEMP. Further discussions on the feasibility are made in later sections of this report.

It should be noted that the diversion of the waterway is not supported by DAFF due to the high risk.

3.3.5.2 Diversion Option 1

The natural migration of Reaches ‘B’ and ‘D’ will, in time, act to form a breach between these reaches. This process could be mimicked and accelerated by constructing an 80m long diversion channel between Reach ‘B’ and Reach ‘D’ (see Figure 3-4).

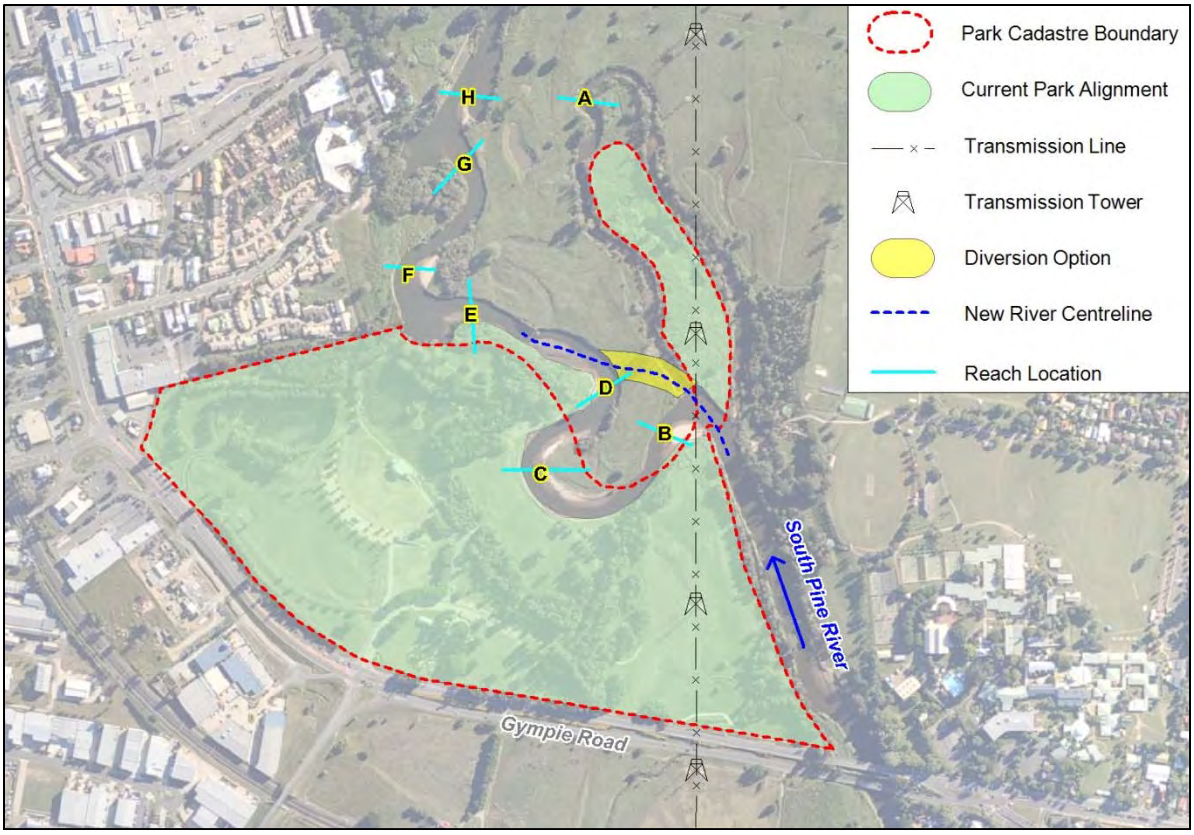

Figure 3-4 Pine Rivers Park Diversion – Option 1

This approach would render Reach 'C' an anabranch of the South Pine River, receiving substantially lower flows than currently. As such, the migration of Reach 'C' towards south-west would slow substantially. The sediment transport processes may reverse, leading to accretion to the bank and/or bed levels. One drawback to this option is that the straighter river channel could result in less energy losses to flow in the main diverted channel. Thus flow in the main river may accelerate and increase the erosive forces on the outside bend of Reach 'F'. This would, in turn, expedite the migration of the meander at this reach, increasing the rate of bank erosion in front of the Strathpine Village development located on Mecklem Street. So rather than eliminate the erosion problem at Pine Rivers Park, this diversion option may simply move the problem elsewhere. As such, this option would need to be supplemented with a comprehensive assessment of the potential impacts and potentially construction of an erosion protection system on the outer bank of Reach 'F'.

This option does not mitigate the threat to the transmission tower.

3.3.5.3 Diversion Option 2

Due to the concern that diversion option 1 may cause an erosion problem elsewhere, a second diversion option has been listed. This diversion option would divert the main river up the Reach 'A' anabranch (along a length of 470m), and then cut through the floodplain in a north-west direction back to the main river (forming a 210m long diversion channel) upstream of Bob Bell Park (see

Figure 3-5). This would render the current South Pine River channel along Pine Rivers Park and Pitonga Way as a smaller anabranch, thus reducing bank erosion risk to Council assets. It is noted that this diversion does not mimic the natural river migration.

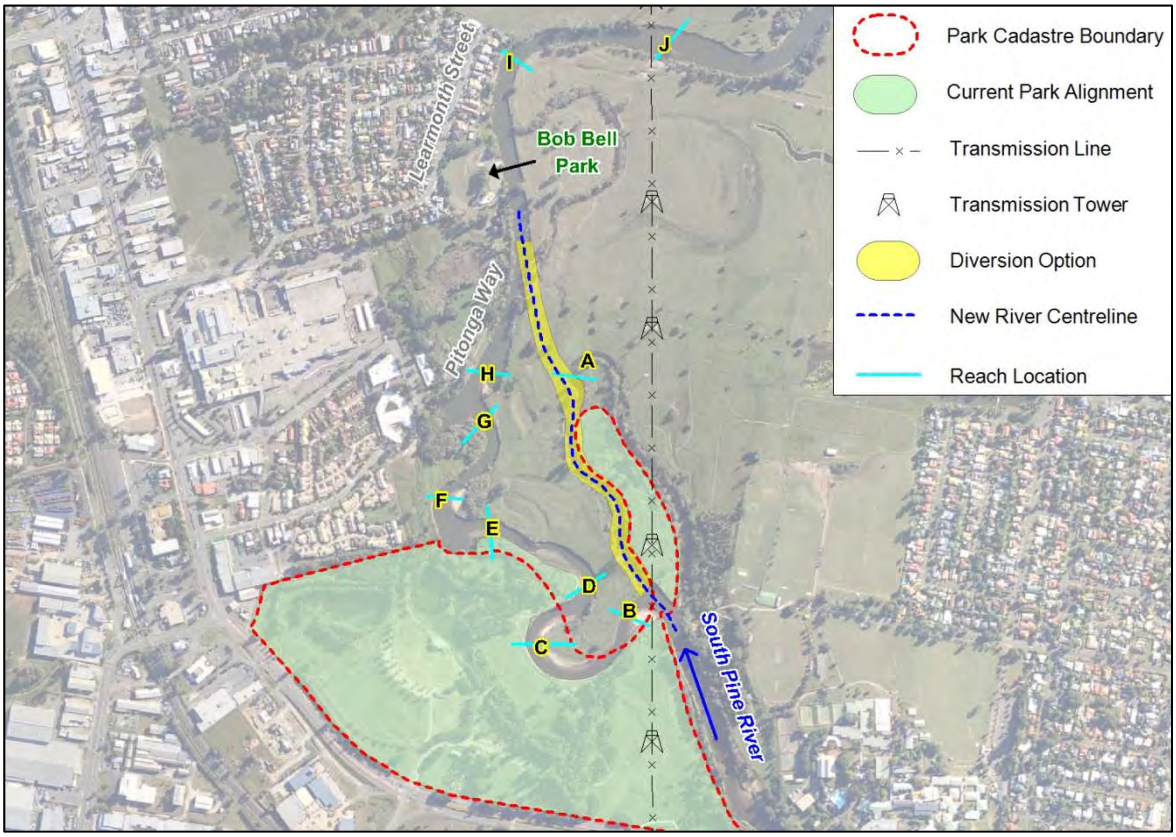

Figure 3-5 Pine Rivers Park Diversion – Option 2

The advantage of this option over the diversion option 1 is that:

- It moves the river channel further from established development over a longer stretch of river.
- It does not increase the erosion risk at Reach 'F'.
- By following the natural alignment of the Reach 'A' anabranch, the transmission tower is on the inside bend of a small meander. Thus, reducing the bank erosion risk in the vicinity of the transmission tower.

This option may increase the erosive forces on the outside bend at Learmonth Street (Reach 'I'). This area has existing hard engineered erosion protection in place to protect private residential property. This diversion option may need to be supplemented by maintenance of the existing erosion protection structures on Learmonth Street.

3.3.5.4 Legislative Considerations

When considering a river diversion it is important to consider the effect the diversion will have on the property and jurisdictional boundaries related to the river. Under the *Land Act 1994* and *Land*

Title Act 1994 a large number of properties adjoining to watercourses have their boundary at the high water mark. This is an ambulatory boundary between the land and water. The diversion of a river will impact on this boundary, causing the loss or gain of land.

Since the investigated diversion options would cause the South Pine River to flow through freehold land within Brisbane City Council jurisdiction, it would be critical to achieve their consent on a river diversion prior to taking any action. This is also necessary in relation to the landowners who will lose or gain land as a result of the diversion.

In terms of approval, the diversion of the river will trigger both State and local development permit requirements. An operational works application would be required for Prescribed Tidal Works and for the removal of marine plants (if required). The works may also trigger the requirement for an operational works permit under the local planning scheme (for works above the high water mark), and a permit for waterway barrier approval under the *Sustainable Planning Act 2009* (*SPA*) and *Fisheries Act 1994*.

In assessing development at a local level, it is important to identify which jurisdiction the development will occur within. If the development occurs solely within one jurisdiction, only one planning scheme and application will apply. However, where works span across multiple jurisdictions, it may be necessary to seek a coordinated approvals process through the State Government with each local government providing concurrence agency responses.

The relevant codes for compliance of each local planning scheme to shoreline erosion works are identified in Section 2.4.1.1 of the Stage 1 Report and are summarised below:

Pine Rivers Plan

- Major Flood Events Overlay Code (for operational works in a major flood area);
- Erosion Prone Areas Overlay Code (for operational work in an erosion prone area); and
- Acid Sulfate Soils Overlay Code (for excavating or removing $100m^3$ or more of soil or sediment).

Brisbane City Plan 2000

- Filling and Excavation Code (filling or excavating of more than $100m^3$ or material);
- Acid Sulfate Soil Code (filling or excavating of more than $100m^3$ of material); and
- Wetland Code (for works in the Wetland Overlay).

3.3.6 Option F –Reverse Breaching

The breach at Reach ‘B’ has led to a ‘short circuiting’ of the river path through the Pine Rivers Park area in recent years, thus reducing the amount of energy dissipation that occurred previously. Therefore, it is likely that the breach has led to an acceleration of the erosion at Reach ‘C’. The breach has also placed the transmission tower at heightened risk of undermining by bank erosion.

This management option considers reversing the breach by constructing an obstruction across the river. This would force the river path to be redirected along its previous path at Reach ‘A’. The concept is illustrated in Figure 3-6 by the ‘reconstructed bank’. This would essentially restore a pre-existing river alignment.

Modelling has shown that reversing the breach causes an increase in the peak flow velocities along Reach 'A'. This is expected, as this anabranch is reformed as the main river. Model results show that peak flow velocities decrease along Reach 'C'. For the spring tide scenario, velocities have been estimated to decrease by 0.2m/s to 0.3m/s for a significant portion of Meander 'C' and by more than 0.3m/s in some areas. These velocity fluctuations are likely to be significant in terms of their influence on erosion rates on the bare (unvegetated) banks.

This option essentially resets the river alignment to a prior condition. The river would subsequently attempt to re-establish the breach; i.e. there would be erosive forces acting on the proposed barrier. Therefore, the barrier may require ongoing maintenance to resist a future breach. This option will also halt the current migration trend towards a future breach across Reach 'B' and 'D', which is an adverse effect in terms of erosion management for the park as this potential future breach would reduce erosion along Reach 'C'.

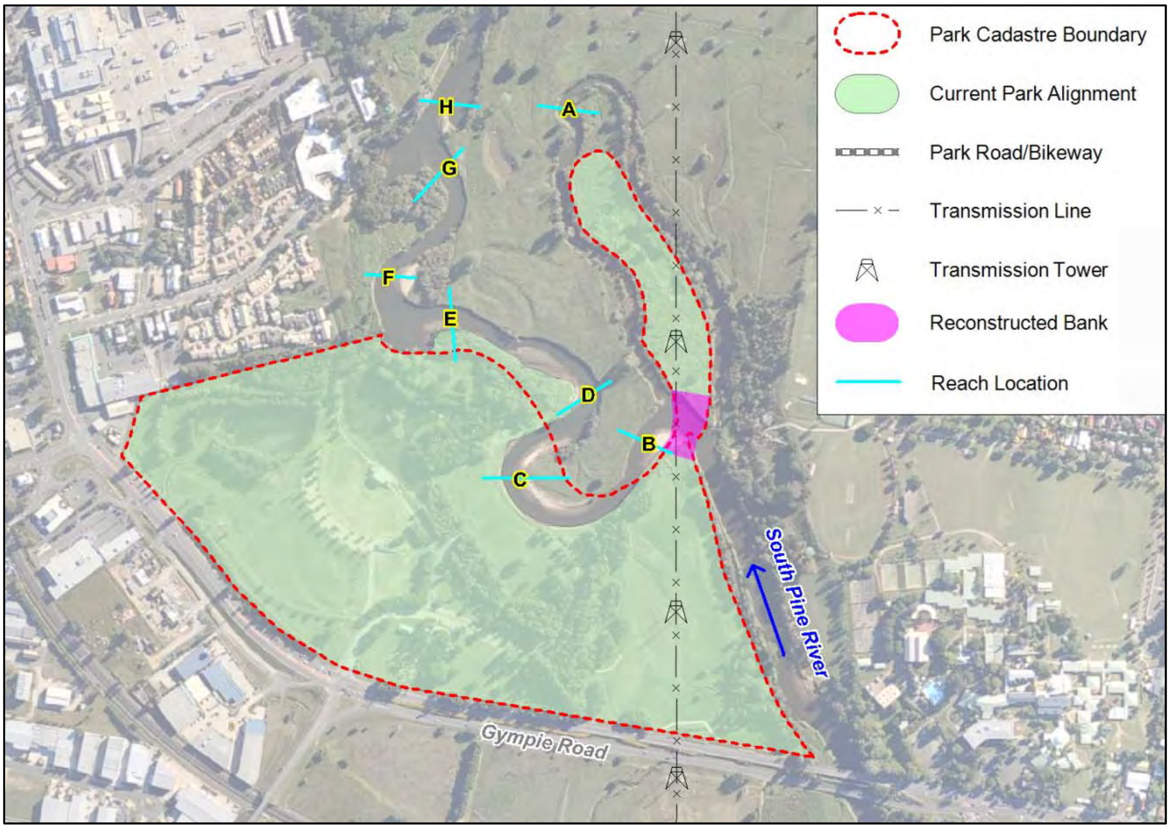

Figure 3-6 Pine Rivers Park Breach Reversal

3.3.6.1 Legislative Considerations

Similar issues identified in Section 3.3.5.4 above regarding the diversion of the South Pine River would also apply in regards to a breach reversal. Notably, however, the proposed area for reclamation is wholly within MBRC's jurisdiction. It would still be advisable for MBRC to seek Brisbane City Council's consent on this matter to prevent any potential legal claims; e.g. increased erosion at Reach 'A'.

3.4 Discussion

A discussion on the advantages and disadvantages of the six options considered above is listed in Table 3-1. Recommendations, which are based on this discussion, are presented in the following section.

Table 3-1 Pine Rivers Park Discussion of Options

Option	Advantage	Disadvantage	Compliance Matters
Option A – Do Nothing	Low initial capital investment.	Potentially higher remedial costs in future. Does not mitigate loss/damage of park area and infrastructure. Not commensurate with Council's objectives for Pine Rivers Park.	No immediate approval requirements
Option B – Monitor and Defer	Low initial capital investment. Allows natural morphological processes to occur within reasonable limits. Adaptive response avoids implementing redundant works (i.e. if migration trajectory or rates change)	Requires ongoing monitoring. Does not mitigate initial loss/damage of park area and infrastructure prior to trigger for further action. Relies on there being a system in place to instigate an appropriate action at a future point in time. Not suitable – further action already triggered.	No immediate approval requirements
Option C – Soft Engineering	Low whole life costs and lower long-term maintenance costs compared to hard engineered system. Environmental benefits of enhanced wildlife habitat, water quality improvement and aesthetics. Reduces flow velocities by dissipating energy and encourage sediment to accumulate on channel margins.	Can take some time for vegetation growth to fully establish. Can be washed away when subjected to high flow velocities. Higher day to day maintenance burden than 'hard' engineering option. Shorter design life than 'hard' engineering option. Still an emerging approach for which the limitations of different techniques are not always evident – may require some trial and error approaches to settle on an effective solution.	Potential requirement for development approval from State and/or local government Owners consent required
Option D – Hard Engineering	Robust and reliable approach to hold the bank alignment – limitations are well understood. Longer design life than 'soft' engineering options.	Alters the natural flow and morphological regime. High initial capital investment and maintenance cost (i.e. replacement at end of life). Poor aesthetics – difficult to integrate into the	Requirement for development approval from State and/or local government Owners consent required

Option	Advantage	Disadvantage	Compliance Matters
	Lower day to day maintenance burden than 'soft' engineering option.	natural environment. Reduces potential habitat for fauna and flora. May become redundant subsequent to potential future breach between Reaches 'B' and 'D'.	
Option E – Diversion	Will eliminate the erosion issue. Low maintenance cost. Maintains natural aesthetics.	Difficult to fully predict the response of the river, so may incur unexpected adverse impacts. High implementation cost. Triggers environmental legislation that may limit feasibility. Land acquisition difficulties may limit feasibility. May adversely influence erosive processes in other areas.	Requirement for development approval from State and/or local government Owners consent required Multiple local government jurisdictions involved, including questions over changes in land boundaries and ownership rights
Option F – Reverse Breaching	Reduces erosive forcing on the river bank. Returns river to a pre-existing natural state, with no works implemented along the river bank. Therefore, maintains the natural aesthetics and environmental functioning.	Difficult to quantify benefit – erosion will be slowed but unclear by how much. Erosive forces will continue to act on the reinstated bank. Thus ongoing maintenance may be required. May increase the erosive forces on Reach 'A'.	Requirement for development approval from State and/or local government Owners consent required Multiple government jurisdictions involved, including questions over changes in land boundaries and ownership rights

3.5 Recommended Strategy

Recommendations for the Pine Rivers Park area are summarised in Table 3-2.

Table 3-2 Pine Rivers Park Recommendations

Option	Adopt	Reason
Option A – Do Nothing	×	Results in loss of park area and damage to park infrastructure
Option B – Deferred Response	×	Further action has already been triggered
Option C – Soft Engineering	✓	Commensurate with park environment and erosion tolerance
Option D – Hard Engineering	✓	To prevent failure of transmission tower
Option E – Diversion	×	Cost and other implementation constraints
Option F – Reverse Breaching	×	Uncertain outcome; potential high cost; requires ongoing maintenance; halts current, beneficial, migration trend.

It is recommended that a soft engineering erosion protection system is implemented along the outside bend of Reach 'C', similar to that suggested by Alluvium Consulting (2011). Given that Meander 'C' is expected to breach in future, the design life for the erosion protection system is expected to be 20 to 30 years.

For the promotion of tidal (mangrove) and non-tidal (riparian) vegetation establishment across the stabilised bank, a suitably qualified expert should be consulted to prepare an appropriate rehabilitation plan. This plan can then be used by Council to guide the implementation of revegetation strategies. Such a plan should include recommendations for site preparation, suitable species for revegetation, planting or seeding, monitoring and maintenance requirements. It is anticipated that the costs involved will be moderate, given the significant land area involved.

Failure of the transmission tower has more severe health and safety consequences to the community than loss of park area. While responsibility for protection of this asset does not lie with Council, a mitigation strategy has been presented in this document to highlight the issue. A more robust approach is required for protecting the transmission tower, and a hard engineered erosion protection system is recommended. It is envisaged that this would be through use of a structure such as a rock filled gabion basket retaining wall, similar to that shown in Figure 4-3. The performance of this system will need to be monitored regularly to ensure that the integrity of the transmission tower is not compromised by further erosion. There may also be constraints in construction of the structure due to the presence of the transmission lines and access difficulties given that the bank is located on an island.

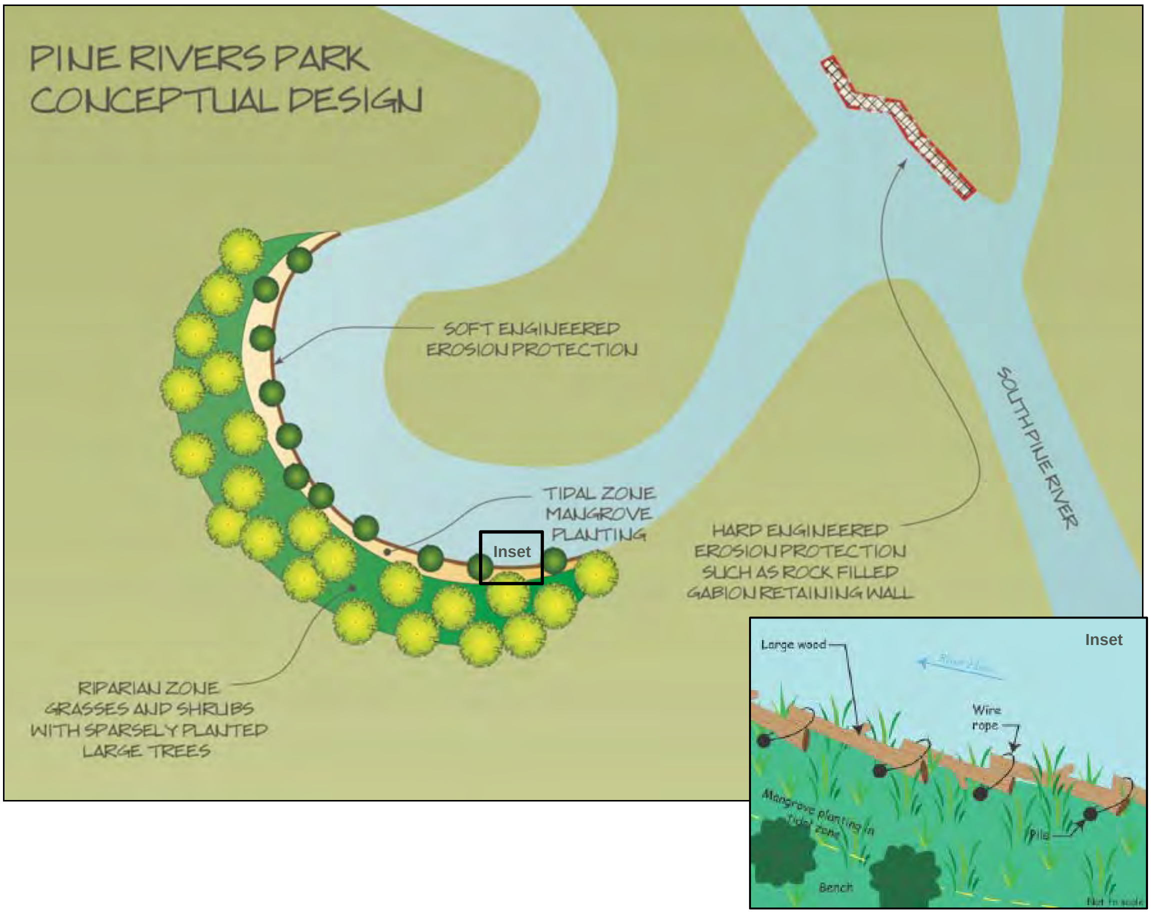

Figure 3-7 Pine Rivers Park Recommended Strategy (Inset from Alluvium 2011)

Implementation of soft and hard erosion control measures requires development approvals under the SPA, including owners consent, and can be processed under the Integrated Development Assessment System (IDAS). They do not require extensive consultation with cross-jurisdictional government agencies and are therefore less complicated and more streamlined than a number of other available options. Existing approval structures and legislative structures, therefore, favour these works.

3.6 Implementation and Cost

The costs associated with the soft erosion protection works in Pine Rivers Park will depend on the design approach. These types of works can vary substantially depending on aspects such as the materials used and amount of earthworks required. Costing of a previous proposed erosion protection system in the park, which included a 'hard' element being riprap at the embankment toe, amounted to $1.215 million. This was a comprehensive design, likely to be at the higher end of the spectrum of solutions. At the lower end, a cut down approach of primarily vegetating the banks with some re-profiling could be in the order of $300,000.

As a hard engineered structure, the proposed rock filled gabion basket retaining wall in front of the transmission tower will incur significant costs to design and construct. It is expected that the cost to design and build this structure will be approximately $200,000. This erosion protection is essential for maintaining the integrity of the transmission tower.

3.7 Approvals

Approvals are required under *SPA* for relevant works occurring in, on or above land under tidal water. Relevant works will require approval where they are 'tidal works' for the purposes of the *Coastal Protection and Management Act 1995* (*CPMA*). As the works are proposed in a local government tidal area, the works are also 'prescribed tidal works' under the *Coastal Protection and Management Regulation 2003* (*CPMR*). Prescribed tidal works must be compliant with prescribed tidal works IDAS code in Schedule 4A of the *CPMR*.

To the extent that soft engineering works require the development of some form of hard structure (e.g. rock rolls, coir rolls) to armour the bank toe, this may be classified as 'tidal works' and require approval under *SPA*. It is recommended that further guidance be sought from the Department of Environment and Heritage (DEHP).

Removal of marine plants as part of the installation of hard engineering structures will require a development permit under *SPA* except where such works are self-assessable. Self-assessable works include those required for restoration and rehabilitation of fish habitats, as noted in self-assessable code MP06. Where the works are not self-assessable, any disturbance of more than 25m^2 of marine plants will require an offset.

The agencies with jurisdictional interest in these activities include:

- MBRC Council Planning Division, as the assessment manager and manager of local government tidal area;
- Department of State Development, Infrastructure and Planning (DSDIP), for compliance with the State Development Assessment Provisions (SDAP);
- DEHP, for coastal and environmental issues;
- Maritime Safety Queensland (MSQ), for navigational matters;
- Department of Natural Resources and Mines (DNRM), for provision of owners consent for works on State land and for other land allocation matters; and
- Department of Agriculture, Fisheries and Forestry (DAFF), for the removal, destruction or damage of marine plants.

It may also be necessary to consult with Brisbane City Council prior to the development application and part of the assessment process to ensure their local government interests are being accounted for.