Report

Amity Point SEMP Implementation Plan

Redland City Council

11 December 2020

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Project Details

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11 December 2020

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Via email Alistair.Michell@redland.qld.gov.au

Dear Alistair

Amity Point SEMP Implementation Plan

We are delighted to present you with the draft Amity Point SEMP Implementation Plan.

This report contains a summary of the Amity Point SEMP, a Community and Stakeholder Engagement Plan, a technical review of the SEMP, an emergency rock source and supply study, a financial analysis as well as a discussion of possible implementation pathways and a recommended way forward.

This final version 07 also includes the review comments from the public, Council and State.

We would like to thank Council's project team and the Community for the invaluable assistance in putting this plan together.

Yours sincerely,

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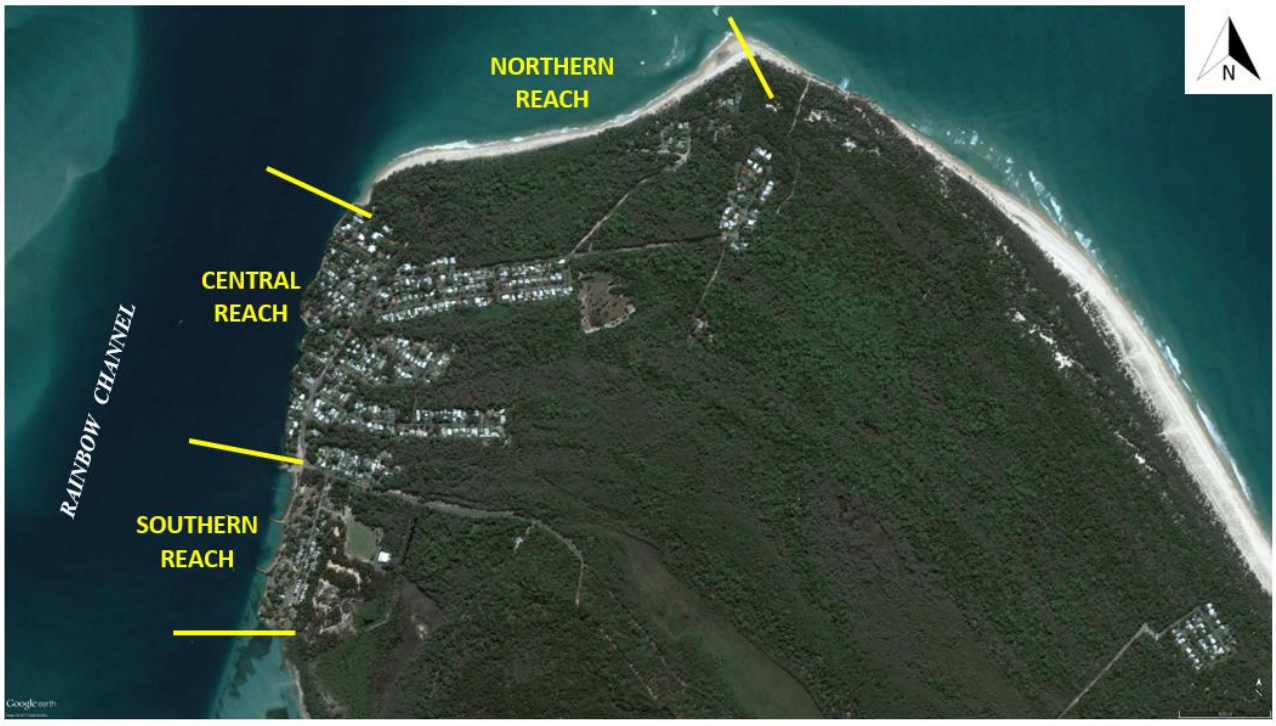
EXECUTIVE SUMMARY

The Amity Point Shoreline Erosion Management Plan (SEMP) was endorsed by Redland City Council in 2019. In consultation with stakeholders, including foreshore landowners, this Implementation Plan for the SEMP recommendations was prepared for the Southern, Central and Northern Reaches of Amity Point:



Southern Reach – Camping Ground Foreshore

The SEMP recommendations for the Southern Reach were:

- Structural audit of the existing groynes and seawalls.
- Construction of additional seawalls.
- Beach nourishment within the beach pockets.

The financial analysis showed that there is a positive benefit to cost ratio to implement the works. This means that there is a benefit in following the recommendations from the SEMP despite the initial costs for the works. There are no technical or legal hindrances in implementing the works. It is therefore recommended to implement the Amity Point SEMP recommendations. Implementation of the works will need to be organised by the body that benefits from the works. Ongoing consultation is needed between Council and QYAC on the implementation of the recommended works. It is noted that the recommended works will principally protect the campgrounds, but there is also a community interest in the works where they facilitate public access to the foreshore and where there is Council land and assets.

Central Reach – Rock Flow Slide Barrier

The SEMP recommended strategy for the Central Reach includes the following actions:

- Support and enhance the existing flow slide barrier.
- Annual monitoring of the flow slide barrier.

The technical review confirmed this strategy as appropriate. The rock sourcing study showed that sufficient rock supply is available on the Island for use in the flow slide barrier. The financial review highlighted that there is a substantial cost benefit in maintaining the flow slide barrier compared to the 'do nothing' option. However, there may be issues in regard to ownership, tenure, access, rock supply and cost sharing arrangements.

The implementation plan for the Central Reach is based on extensive stakeholder consultation that was performed with Council, State and the freehold land owners to ensure that the implementation plan provides a sensible way forward and does not pose an unreasonable level of obligation, responsibility or liability on any party involved.

The following recommendations are made to implement the SEMP recommendations in the Central Reach:

- Continued individual ownership and responsibility of the flow slide barrier rather than Council controlled. This means that each individual landowner (be it State, Council or private) is responsible to maintain the Flow Slide Barrier fronting or within their site boundaries. This means that any works will need to be funded by the individual landowner, including but not limited to the costs involved to prepare and gain approvals, covenants and easements, as well as performing and paying for maintenance, including rock supply, transport and placement. This is also in line with how the flow slide barrier was managed in the past.
- Formal approval of the flow slide barrier is required to ensure continuous maintenance. It is recommended for Council to obtain a preliminary/variation approval for the whole flow slide barrier to seek in-principle approval of the structure, followed by the individual property owner obtaining detailed approval for their section of the structure.
- The establishment of a covenant is required by the landowners to implement maintenance obligations on current and future landowners. A covenant is a voluntary agreement and signature from both parties, the covenantor (owner of freehold land) and the covenantee (State or Local government) is required.
- Easements are required in some locations to ensure access to the flow slide barrier for maintenance activities. Easements would need to be established by the landowners.
- Council to continue to make available rock from the Council quarry in line with the emergency rock supply procedure and to work towards providing rock for proactive maintenance in the future by executing the actions in relation to rock supply. Noting that there might be circumstances where Council cannot guarantee rock supply due to statutory and technical complexities to the operation of the quarry.
- Adopt an emergency works procedure to ensure timely and smooth action in a flow slide event before all recommended strategies are implemented.
- Allow all available transport and placement contractors on the island to access rock from the quarry and perform transport and placement activities.
- Annual bathymetric survey of Rainbow Channel and structural audit of the flow slide barrier is to be undertaken by Council. The outcomes of the structural audit will need to be shared with all affected property owners and should contain clear instructions should pro-active maintenance be required

Those recommendations require the following actions to be undertaken:

1. Request Owners Consent from DNRME.

2. Council to prepare an application to seek a preliminary/variation approval for in-principal support for the whole flow slide barrier and advice on Marine Park permits.
3. Council to seek pre-lodgement advice from SARA.
4. Council to provide detail of the variation approval and pre-lodgement advice to assist landowners as they prepare site specific development applications and Marine Park Permits.
5. Individual landowners to prepare and submit a development application for the section of the flow slide barrier protecting their property following approval of a variation/preliminary approval (or as otherwise required by legislation).
6. Council to consult with all affected properties to establish covenants for ongoing maintenance of the flow slide barrier. It is the responsibility of the landowner to action the covenant.
7. Individual landowners to continue maintaining the section of the flow slide barrier protecting their land as provided for in their development approvals or the emergency management procedure.
8. Council to consult with all affected properties to determine the exact location of easements. It is the responsibility of the landowner to action the easements.
9. Landowners to assist with the formalization of access to the flow slide barrier for maintenance activities by the granting of easements as necessary.
10. Council to take all reasonable steps to ensure to the best of its ability that the relevant sales permits and access arrangements are in place to facilitate the continued supply of rock from Councils quarry.
11. Council to establish and communicate emergency works procedure with all affected freehold landowners.
12. Council to take reasonable steps to provide access to rock from Councils Quarry for landowners to undertake emergency repairs. (Noting that there might be circumstances where Council cannot guarantee rock supply due to statutory and technical complexities to the operation of the quarry.)
13. Landowners to follow emergency works procedure including any necessary notifications and approvals.
14. Council to make available inductions and standing agreements with all available transport and placement contractors on the island.
15. Council to undertake annual bathymetric survey and structural audit.
16. Share findings with all affected freehold landowners.

Northern Reach – Amity Beach

The SEMP recommended strategy for the Northern Reach is:

- 3-year Monitoring Survey Program.
- Coastal process assessment to determine necessity for erosion mitigation strategy.
- Following conclusion of the assessment, continuation of the Monitoring Survey Program.

It is recommended that Council start implementing these works as no technical or legal barriers have been identified in pursuing this strategy.

Council has been in ongoing dialogue with University of Queensland staff to conduct additional research at Amity Point and will continue to do so.

In the interim, property owners are able to investigate possibilities for erosion mitigation options. For example, beach nourishment and beach re-profiling can be undertaken with the relevant approvals in place. Residents can also consider building their own coastal protection works within their lot - provided they are granted the

necessary approvals for such works. A communal approach regarding the design and construction of such a structure is highly recommended to reduce costs and increase effectiveness.

Actions:

1. Council to start the 3-year Monitoring Survey Plan this financial year.

2. Undertake coastal process assessments after conclusion of the 3-year monitoring program

3. Continue dialog with UQ

4. Council to support residents in the approval process should they choose to pursue their own protection works.

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1 INTRODUCTION

The township of Amity Point enjoys a rich diversity of seascapes and landscapes - providing extensive recreational and lifestyle opportunities that are considerably enhanced by local cultural, heritage and environmental values. The development is concentrated at the shoreline to enjoy the coastal views and activities. However, coastal processes cause erosion which threatens essential infrastructure as well as the coastal values of Amity Point.

Redland City Council (RCC) recognises the threat of shoreline erosion to Amity Point and adopted the Amity Point Shoreline Erosion Management Plan (SEMP, Water Technology 2019) in June 2019. The SEMP investigated coastal processes and determined the most cost-effective solutions to manage the foreshore. This plan provides a framework for sustainable management of the vulnerable foreshore for a 20-year planning horizon.

To implement the recommendations from the SEMP, RCC commissioned Water Technology to prepare an Amity Point SEMP Implementation Plan. The implementation plan is required to analyse how recommendations from the SEMP can be delivered, considering several legal issues and various land tenures. The implementation strategy will also consider that there is no disproportionate burden to any of the involved parties. The purpose of the Implementation Plan is to investigate possible implementation pathways and to recommend a plan for all stakeholders based on a consideration of effectiveness, technical and legal matters, an equitable allocation responsibility and the preferences of landowners.

The project is undertaken in several stages as outlined in Figure 1-1. A stakeholder and community engagement plan was prepared to identify all key stakeholders and to ensure their involvement in this study. This was followed by a review of management options, emergency response rock supply study, financial review and implementation scenario analysis. All stages of the project are then brought together in the Implementation Plan. This report also follows this structure.

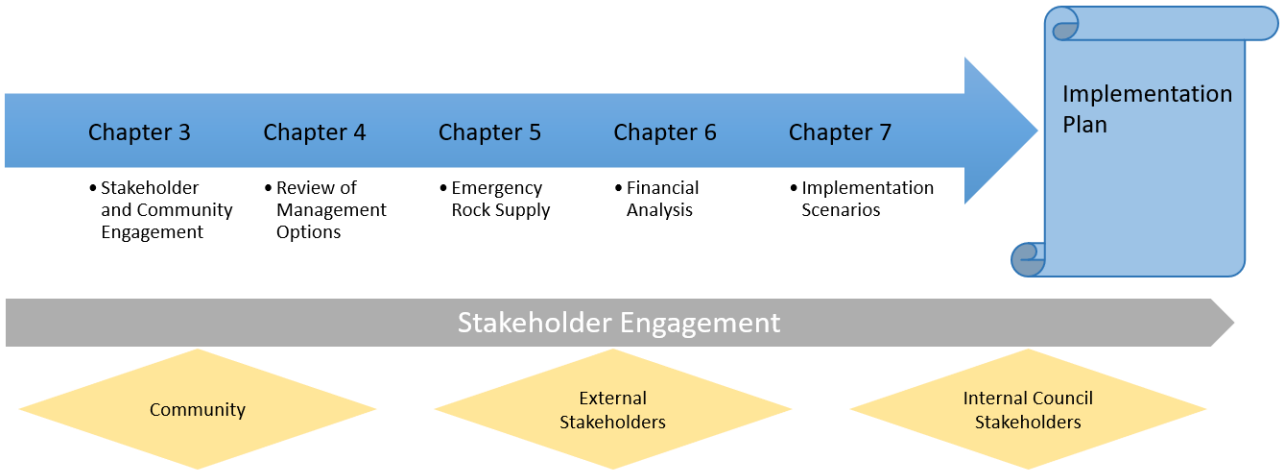


FIGURE 1-1 DELIVERABLES OF THE AMITY POINT IMPLEMENTATION PLAN

The recommendations of the report are put forward to Council for their consideration and are not Council policy until adopted by Council.

2 BACKGROUND

Amity Point is located at the north-western tip of North Stradbroke Island (Island) within Moreton Bay near Brisbane, see Figure 2-1. The township is within the Redland City Council Local Government Area (LGA) and has been subject to substantial erosion, due to migration of the Rainbow Channel and re-occurring retrogressive flow slide events at the foreshore. Because of this, the community has been challenged by the significant costs associated with erosion mitigation, along with concerns regarding the appropriateness and long-term viability of such works.

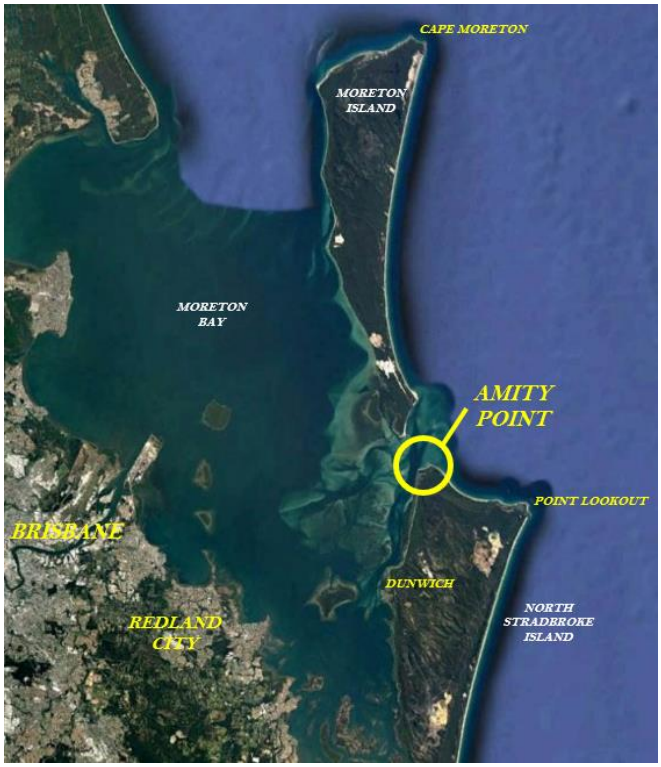


FIGURE 2-1 LOCALITY PLAN

Dominant coastal processes causing the erosion are explained in the SEMP prepared by Water Technology (2019). The SEMP has been developed to provide a framework for sustainable use, development and management of the vulnerable foreshore. The outcomes of the SEMP are envisaged to provide information to contribute to the development and adaptation of an Implementation Plan for future shoreline management.

The SEMP recommends a shoreline erosion mitigation strategy for three distinctive areas along Amity Point foreshore, the Southern, Central and Northern Reaches, see Figure 2-2.

The Southern Reach extends from the southern end of the campground to the boat ramp and includes a 355 m long beach frontage with groynes and a 215 m long rock-armoured seawall. The Central Reach is along the rock armoured foreshore from the boat ramp near Claytons Road to the northern end of Millers Lane, the rock armoured foreshore is approximately 955 m long. The Northern Reach includes 1.4 km of the sandy foreshore of Amity Beach.

FIGURE 2-2 THREE AREAS: SOUTHERN, CENTRAL AND NORTHERN REACH

A Shoreline Erosion Study of the area had previously been carried out by BMT WBM (2013). This study investigated the local coastal processes and considered a range of social, environmental, cultural and economic values; and identified a range of erosion management options. The preferred erosion mitigation strategies for each of the precincts considered above were:

- Southern Reach: beach nourishment was the recommended management strategy for this precinct. This would *"provide added protection to the assets and minimise the need for other structural protection measures in the future"* and would *"retain natural processes and provide an improvement to the beach amenity"*.
- Central Reach: planned retreat was the recommended strategy for this precinct as it was considered to have the *"highest likelihood of success, lower cost and will leave the foreshore in a natural State"*.
- Northern Reach: The *"do nothing"* option supported by monitoring of the *"location of the shoreline"* was the recommended strategy for this precinct.

The subsequent SEMP notes that the planned retreat for the Central Reach (i.e., along the frontage of Amity Township) met with considerable opposition from the local community.

2.1 Recommendations of the Amity Point SEMP

The recommended erosion mitigation strategy from the SEMP is outlined below, each reach is considered separately.

2.1.1 Southern Reach

The SEMP recommends undertaking a structural audit of the most southern existing rock-armoured seawall located to the south of the three beach compartments to confirm its future effectiveness as a foreshore defence structure. The beaches are backed by an existing seawall in some areas along the Southern Reach and construction of an additional approximately 165m of seawall is recommended to fill the gaps: 55m within the northern beach compartment and 110m in the southern compartment. Also, beach nourishment of approximately 5,000 m^3 of sand between the groynes is recommended, with the actual characteristics of the works to be determined by detailed coastal engineering design. It is also recommended that the performance of the beach nourishment be monitored by annual surveys of the foreshore profile; and to implement renourishment campaigns as required to reinstate beach widths. A summary of the erosion mitigation strategies is presented in Figure 2-3 below.

FIGURE 2-3 RECOMMENDED EROSION MITIGATION STRATEGY – SOUTHERN REACH, SOURCE SEMP (2019)

2.1.2 Central Reach

The SEMP confirmed that the existing flow slide barrier has been effective in preventing the development of retrogressive flow slides at the Central Reach. Therefore, it is recommended to seek formal approval of the existing barrier as substantially completed tidal works and to consider it as necessary coastal protection works required to manage the erosion threat.

It is important to continue repairs and improvements to the flow slide barrier and to reinstate the foreshore whenever flow slide events occur. A Safety Management Plan (SMP) – Flow Slide Barrier has been presented with the SEMP. The emergency rock source study (defined in this report) will supplement the technical specifications for such work.

Regular bathymetric surveys have been recommended by the SEMP to identify emerging vulnerabilities to potential flow slide events and to detect structural reinforcement and repair needs. Consequently, a formal maintenance regime should be put in place to mitigate the threat of flow slides. Once approved, where this is within the footprint of the existing structure it can be considered as maintenance works required to preserve the integrity and function of the flow slide barrier.

Special attention must be given to the foreshore near Old School House Park as there is merit in adopting a proactive strategy of reinforcing the existing flow slide barrier at this location - by placing approximately 45 m^3/m of additional armour rock.

2.1.3 Northern Reach

The recommended erosion mitigation strategy along the Northern Reach is to implement a Monitoring Survey Program to obtain detailed knowledge of shoreline behaviour. There is benefit in further investigations to better understand local processes and to predict emerging threats. It is recommended that the following monitoring aspects be included in the strategy for erosion mitigation on the Northern Reach:

- Monitoring Survey Program: Stage 1: 3D survey during low spring tide, twice yearly for three years, with extra surveys undertaken as soon as possible after major erosion events on Amity Beach.
- Coastal Processes Assessment: upon completion of three years Stage 1 monitoring survey program.
- Following outcomes of the Coastal Processes Assessment – Monitoring Survey Program: Stage 2: likely to entail yearly 3D surveys.

Necessity of any erosion mitigation strategy for the Northern Reach would be addressed by the Coastal Processes Assessment.

Individual property owners along the foreshore of the Northern Reach can undertake interim maintenance work such as beach re-profiling or beach nourishment - provided the relevant approvals are in place.

3 COMMUNITY ENGAGEMENT

The SEMP recommends development of a process to implement management options that are mutually beneficial, and which do not overly burden any party or stakeholder. Molino Stewart was subcontracted by Water Technology to facilitate community engagement throughout the project to assist in achieving that objective. Stakeholder and community engagement is a critical component of the project to develop the final Implementation Plan. Engagement needs to be built on trust and community involvement.

The SEMP indicates that there will be difficulties and challenges to engage the local community. Challenges include deciding with the local community and other stakeholders on how to facilitate physical works and how to implement erosion mitigation strategies. This includes sourcing and placing of materials, how to fund placement and what governance arrangements are needed to manage these activities.

These combined complexities and the range of stakeholders with varying perspectives have the potential to cause discord and non-acceptance of the implementation plan. Therefore, there is a need to develop and implement a stakeholder and community engagement plan to highlight issues, sensitivities and risks and how they can be overcome by engaging with the relevant stakeholders. The stakeholder and community engagement plan for the Implementation of the Amity Point SEMP is included in Appendix A.

Northern and Central Reach Community Engagement Activities

Two workshops were held with both the Northern Reach and Central Reach communities. The first workshop was held on 15 Oct 2019 at Amity Point to discuss the status of the Implementation Plan and the second on 27 Nov at the Cleveland library to present the Draft Implementation Plan.

In addition to the workshops one on one phone interviews were undertaken with the majority of the affected residents.

All feedback gained during those workshops has been incorporated in the development of the Implementation Plan.

Southern Reach Community Engagement Activities

Council undertakes a number of projects where consultation with QYAC is required. Therefore, to streamline consultation efforts Council is directly engaging with QYAC with regard to the Implementation Plan for the Southern Reach.

State Agencies Engagement Activities

All relevant State agencies were consulted during development of the SEMP Implementation Plan, namely:

- Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP)
- Department of Agriculture and Fisheries (DAF)
- Queensland Parks and Wildlife Service (QPWS)
- Department of Natural Resources, Mines and Energy (DNRME)
- Department of Environment and Science (DES)

Their feedback has been incorporated in the development of the Implementation Plan. While all effort was undertaken to align the implementation plan with preferences from the departments, in some instances there were contradicting inclinations. In those cases, all stakeholder preferences (e.g. State Departments, Community and Council) were considered together to develop a plan that aligns with most stakeholders.

All State agencies should be presented with the Draft Implementation Plan before it is finalised. A pre-lodgement meeting should be scheduled to progress with the development application for the flow slide barrier.

4 REVIEW OF MANAGEMENT OPTIONS

A review of the management options proposed by the SEMP has been undertaken as part of this commission to develop an Implementation Plan. A technical review was undertaken, focussing on the technical aspects to ensure that implementation of the works is suitable and feasible. A legal review was undertaken, focussing on environmental, planning, property and tort law to assess whether the recommendations of the SEMP are manageable for all involved stakeholders and do not pose an unreasonable level of obligation, responsibility or liability on any one party. The legal review supports the recommendations in this Implementation Plan.

4.1 Coastal Technical Review

The complete technical review can be found in Appendix B, performed by Dr. Andrew McCowan, an internationally acknowledged expert in the fields of coastal engineering, flood hydraulics and water quality. The following discussion highlight the key outcomes of Dr. McCowan's technical review.

The purpose of the present SEMP is to set out *"an agreed framework and management strategy for responding to existing erosion problems and possible future erosion threats"* at Amity Point. It has been developed through consideration of *"the physical coastal processes"* occurring in the area *"in conjunction with the environmental, cultural, social and economic values of the shoreline"*.

The reviewer agrees with the overall methodology used in its development. A key consideration for the purposes of this review is that the SEMP is a relatively short to medium-term management plan with a 20-year planning horizon. This provides an opportunity for monitoring and review of the effectiveness of the plan before committing to longer-term management strategies.

The SEMP reviews the Guiding Principles for shoreline erosion management and describes the main non-structural and structural options available for managing erosion at Amity Point. An assessment is then carried out to determine the most appropriate management option for each of the coastal Reaches under consideration.

4.1.1 Southern Reach

"*The recommended erosion mitigation strategy along the Southern Reach is to undertake beach nourishment within each of the three existing beach compartments; and to construct cut-off seawalls behind each beach where an appropriate structure does not already exist"*

This strategy includes beach monitoring (through annual beach surveys) and maintenance of the nourished beaches on an as needs basis. It also includes annual bathymetric surveys to monitor the rate at which Rainbow Channel is migrating eastward and thereby potentially increasing the risk of flow slides adversely affecting the foreshore.

A minor point missing from the strategy is that there is no contingency for the possible need to reinstate part or all of a groyne should it become affected by subsidence due to a flow slide.

The recommended strategy is consistent with the recommendations of the previous Shoreline Erosion Study carried out by BMT WBM (2013).

4.1.2 Central Reach

"The recommended erosion mitigation strategy for the Central Reach is to support and enhance the effectiveness of the current erosion management practice of repairing damage to the existing flow slide barrier whenever necessary following flow slide events - by placing additional rock armouring."

This strategy includes monitoring the continued structural adequacy of the existing flow slide barrier, through regular bathymetric surveys to identify emerging vulnerabilities to potential flow slides - and to inform structural reinforcement and repair needs.

The recommended strategy is, however, at odds with the "planned retreat" approach that was the recommended in the previous Shoreline Erosion Study carried out by BMT WBM (2013). The main source of the discrepancy is that the earlier work of BMT WBM (2013) considered that a structural solution would require "the design and construction of a full rock revetment at an estimated cost of $15M" and that there would be "the expectation that this will need to be extended in the future as Rainbow Channel continues to realign".

The strength of the current SEMP is that it recognises the value of the existing rock wall for providing a barrier to further subsidence caused by flow slides. This provides a relatively low-cost option for maintaining the existing coastline, at least for the medium-term.

4.1.3 Northern Reach

"The recommended erosion mitigation strategy along the Northern Reach is to maintain the existing strategy of non-intervention, but to monitor future shoreline behaviour."

This strategy includes detailed twice-yearly beach surveys for the first three years. This is to be followed by a Coastal Processes Assessment to determine future monitoring requirements and the need (or otherwise) for the development of an erosion mitigation strategy.

The recommended strategy is consistent with the *"monitoring coastal processes"* recommendation of the previous Shoreline Erosion Study carried out by BMT WBM (2013). The outcome of the monitoring will provide a long-term strategy for this Reach.

4.1.4 Conclusion

The main conclusions of the technical review of the SEMP are as follows:

- For a 20-year planning horizon, the recommendations provided in the SEMP are appropriate and manageable and (subject to the findings of the legal review) should not place unreasonable obligations on any involved stakeholders.
- A potential issue for the implementation of the strategy for the Southern Reach is the need for a suitable source of sand for beach nourishment and for a suitable source of rock for seawall construction.
- A great strength of the current SEMP is that it recognises the value of the existing rock wall as a "flow slide barrier" for providing a low-cost option for reducing the risk of further subsidence caused by flow slides along the Central Reach.
- The implementation of the recommended strategy for the Central Reach will, however, be dependent upon:
  - The development of maintenance obligations on foreshore property owners to maintain the integrity of the Flow Slide Barrier;
  - The development of an appropriate funding arrangement for future maintenance works;
  - The development of formal agreement between foreshore property owners to provide access that may become necessary for future repair work to the flow slide barrier; and
  - The availability of suitable rock for emergency repair works and the ability to carry out these works as soon as possible after a flow slide event.
- The inclusion of the Coastal Processes Assessment after the first three years of the implementation of the Northern Reach strategy will provide an opportunity to review the situation, based on more detailed data provided by the monitoring program. Interim maintenance work can be undertaken by individual property owners with relevant approvals in place.

5 EMERGENCY RESPONSE ROCK SOURCE AND SUPPLY

There are two rock quarries on Stradbroke Island, the Council-operated Council Quarry (Lot 1 on SP304064) and a Private quarry (Lot 101 on SP299983) that is operated under private ownership (and is also known as the 'old Meithke quarry') which is now subject to an exclusive native title determination. In the past, rock from these two Island-based quarries has been used to progressively build a flow slide barrier along the foreshore of the Central Reach. The private landowners along that foreshore have non-written agreements in place to communally protect their bayside frontages from flow slide events by dumping rock on the foreshore.

However, recent native title consent determinations have affected the sourcing of rocks on the island. Consequently, there is a need to secure a reliable rock supply to maintain the effectiveness of the flow slide barrier. The SEMP recommends having rock ready to be placed during or soon after retrogressive flow slides occur, either stockpiled at a location near Amity point or at an Island-based quarry.

This chapter discusses rock specifications and the volume of rock required for placement during or shortly after a retrogressive flow slide event. An investigation of different rock sourcing options is conducted, stockpile locations are investigated and methods for transportation and placement of rock is outlined to determine the best strategy for rock supply and placement.

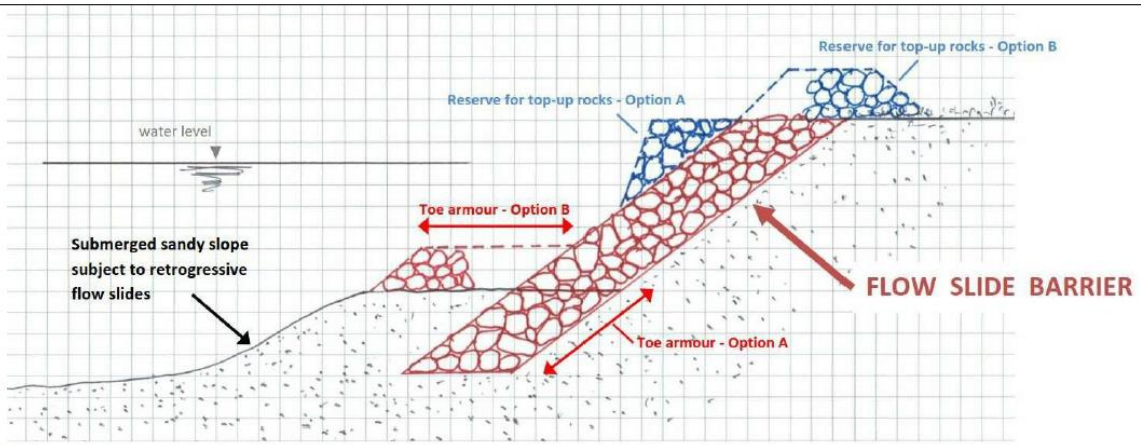
This rock source study builds on the technical specifications for works offered in the Safety Management Plan – Flow Slide Barrier (SMP) and the Concept Design for a Flow Slide Barrier, both from SEMP Water Technology (2019), Appendices G and H respectively.

5.1 Rock Specifications

The SEMP includes a conceptual flow slide barrier design (Figure 5-1) and specifies the rock material for emergency repairs to any damaged sections of the flow slide barrier. The suggested material specifications are:

- Specific Gravity of at least 2.60
- Armour Rock size between 50kg and 4 tonnes
- Rocks are well graded, clean, free from overburden, spoil, shale and organic matter
- Individual rocks shall be slightly weathered to fresh; durable; sound and suitable for use as armour in a marine environment
- All rocks must be free of any defects which would result in breakdown of individual stones in the foreshore environment of the works
- Rocks displaying cleavage planes and weak seams shall not be used

These specifications are used for the rock sourcing study. It is recommended to progress with a detailed design of the flow slide barrier to further refine rock specifications and requirements.



NOTES :

1. All armour rocks used in the Flow Slide Barrier are to have a nominal weight designed to withstand tide/flood currents, storm tides and storm wave action– comparable to the design standards for rock-armoured seawalls in Queensland. This will include the determination of minimum and maximum weights of armour rocks to ensure tight interlocking of all rocks within the armour matrix.
2. The thickness of the Flow Slide Barrier is to be such as to prevent the unrestricted growth of any flow slide that develops on the adjacent seabed slope. The minimum thickness is to be at least ten times (x10) the dimension of the smallest allowable rock armour size.
3. The gradient of all exposed rock slopes are to be no steeper than 1 horizontal : 1.33 vertical.
4. Two options are shown as acceptable arrangements for the placement of rocks in the lower toe area of the Flow Slide Barrier. The intent is to ensure that there are adequate rocks in this toe area to provide protection for the maximum expected scour level of adjacent seabed/channel features. In the case of Option A, this is achieved by armouring down to at least the expected level of seabed scour/lowering. In the case of Option B, this is achieved by having an adequate volume of rock to self-armour the slope below in the event of undercutting of this reserve of rocks as the seabed level drops.
5. Two options are shown as acceptable arrangements for the placement of rocks in the upper area of the Flow Slide Barrier that provide a reserve of top-up rocks. Such reserves are to mitigate any slumping or structural damage to lower regions of the Barrier that may be initiated by a flow slide. The intent is to ensure that there is a sufficient volume of top-up rocks to reinstate the form and function of the Flow Slide Barrier following any such slumping/damage.

FIGURE 5-1 CONCEPTUAL FLOW SLIDE BARRIER DESIGN, SOURCE SEMP WATER TECHNOLOGY (2019)

5.2 Rock quantities

The SEMP indicates that flow slide events can occur anywhere along the Amity Point foreshore and can be of a varying size. Depending on the location of the flow slide event and the existence and condition of the flow slide barrier, rock quantities required for each event will vary. In order to estimate rock volume requirements for an emergency event, it is therefore useful to look at past events. Table 5-1 presents a summary of the amount of rock that has been used in various historical flow slide events. This list does not represent a complete inventory of all flow slide events that have occurred over the years, but does provide an overview of rock quantities that were used in those identified events.

TABLE 5-1 ROCK DUMPED AFTER FLOW SLIDE EVENTS, SOURCE RCC (2019) AND *ARUP (2018)

Event	Location	Amount of Rock Dumped [tonnes]
2006	Unconfirmed	741
2010	Unconfirmed	2,362
2011	Old School House Park	2,386
2017 - September	North of 9A Millers Lane	3,029*
2017 - November	North of 9A Millers Lane at the beach.	1,217*

Some of the listed events occurred at locations where the existing flow slide barrier was insubstantial (e.g. fronting Old School House Park during the event in 2011) or in locations where there was no previous rock

protection in place (e.g. North of 9A Millers Lane during the November 2017 event). Therefore, the rock quantities required to repair the flow slide barrier at those locations and for those events are possibly greater than what might be typical.

The size and location of a future flow slide event is unpredictable. The amount of rock required for placement during a flow slide event should be sufficient to respond to a substantial event. Based on the historical information, it is estimated that 1,000 to 3,000 tonnes of rock should be stockpiled for one significant flow slide event. The stockpile should be immediately restocked after a flow slide event - to ensure that there is sufficient rock available to respond to another event.

5.3 Rock Sources

There are two options regarding armour rock sourcing - firstly from the Island itself or secondly from the mainland. Both locations have advantages and disadvantages as outlined below. It is important to ensure that the supplied rock meets the material specifications defined in Section 5.1.

5.3.1 Island-based quarries

As discussed previously, there are two Island based quarries located at the north-eastern side of the Island as highlighted in Figure 5-2. These are the Private quarry (previously operated by Peter Meithke) and the Council quarry also known locally as 'Fisherman's Track quarry'. Both quarries have previously provided quality rock to Amity Point to mitigate the effects of flow slide events.

FIGURE 5-2 LOCATIONS OF TWO ISLAND BASED QUARRIES, SOURCE QLD GLOBE

Council Quarry

Groundwork Plus (2012) prepared a report for the Council-operated quarry, reviewing slope stabilities in the quarry and presenting a quarry development plan. Groundwork Plus indicates rock can be sourced at five development stages and more rock is available below +20m AHD. The report does emphasise that the quarry consists of an excellent source of quarry material - being suitable for use as high-quality aggregates as well as foreshore protection works. It is pertinent to note that sand suitable for beach nourishment purposes also exists within the confines of the approved quarry area.

About 20,000 m^3 rock has been blasted during activities in 2005 (Orica, 2005), at the time mostly smaller granules suitable for roadworks were desired and any larger rocks that resulted from blasting operations were put aside. Some of the larger rocks were later used to repair the flow slide barrier when significant events occurred. It is estimated that approximately 14,000 m^3 of rock is left on the floor of the quarry in various sizes. These could be loaded and transported to Amity Point in response to future flow slide events. The density of the rock is 2.7 kN/m^3 which is similar to the specific gravity of 2.6 that is specified for the flow slide barrier.

The Council-operated quarry is currently not actively operated but is reputedly in standby mode. This means that Council has no machinery in the quarry, and it would need to be brought into the quarry to sort and move the rock. Council currently has a Panel of Providers of earthmoving companies that have the required machinery and expertise that could be used to provide rock from the quarry in preparation for, and during, a flow slide event. In the past both Meithke Earthmoving and Mazzonis Plant Hire have been engaged to provide services to repair and enhance the flow side barrier.

The price for rocks from the Council-operated quarry has previously been costed at $10.40/ tonne. This includes blasting and sales permit royalties but does not include any handling or transport.

Private Quarry

The Private Quarry has previously been operated by Mr. Peter Meithke who, has over time, supplied the rocks for the ongoing construction of the flow slide barrier. The quarry is now within an exclusive native title declaration, which could have further legal implications for providing emergency rocks.

Nevertheless, the rock will have to be tested to confirm the technical specifications as outlined in chapter 5.1. Even though the rock has previously been used to construct the flow slide barrier, it doesn't guarantee the rocks were up to the specified standard at the time. Rock characteristics will have to be determined by means of testing before obtaining rocks from this quarry.

Based on available information from previous quarry operations there is sufficient rock available in the quarry for use on the flow slide barrier. Several quotes indicate the combined price for purchase and transportation of rock to the Amity Point foreshore would be between $40-$55/tonne, where a body truck is able to carry between 10-14 tonnes of rock per load.

5.3.2 Mainland-based quarries

There are many well established quarries on the mainland in and around Brisbane. Most of those quarries have been operating for a long time and have appropriate quality management systems in place. Each load can be weighed and samples for the grading curve of the rock can be provided.

If rock is sourced from the mainland, trucks equipped with dog-trailers will need to be transported by barge to and from North Stradbroke Island. This will increase rock supply costs since barge fees and the inevitable waiting time of trucks during journeys will need to be incorporated in the price per tonne. A dedicated barge could be hired for $450/hr and can do two trips each day carrying a maximum of two trucks equipped with dog-trailers. The ferry fees are estimated to be around $350/truck and dog-trailer each way.

Based on quotations from two mainland-based quarries (Boral and Karreman), it is evident that the price for rock (including delivery to Amity Point township) would be around $85-$90/tonne. This cost per tonne of supplied rock is about twice that from an Island-based quarry.

5.4 Stockpile location

The SEMP discusses the need for a readily available rock source. If the rock source is from one of the Island-based quarries, the quarry itself can be used as a stockpile location. If the rock is imported from the mainland, a local stockpile location is required. Several options have been considered, such as leasing industrial areas,

stockpiling at Amity Point Recreation Reserve at 24-42 Claytons Road (Figure 5-3) or at an old landfill area near 46-80 Claytons Road (Figure 5-3) and the Island-based quarries. No suitable industrial areas of sufficient size could be identified as available for stockpiling of the rock.

An option could be to use a section of the Council-owned Amity Point Recreation Reserve, since other areas have implications with regard to native land title. The former landfill location has been identified to be transferred to the State as the location does not have a designated purpose yet. Leasing of land from QYAC to secure a stockpile location is another option. Other than the implications regarding native title, other environmental and cultural significance restrictions need to be addressed.

FIGURE 5-3 LOCALITY OF TWO STOCKPILE SITES, SOURCE QLD GLOBE

The area of Amity Point Recreation Reserve is rather large and is a recreational area for public use. A cricket ground, the Community Club and a mini golf course are located within the reserve. The former landfill area is largely overgrown, and this might be a more suitable location since it has lesser visual impacts.

It should be noted that both locations are within the coastal management district and partly within the erosion prone area, see Figure 5-4. A large area of the recreation reserve is within Category X vegetation management mapping (clearing is exempt on freehold, Indigenous and leasehold land). Furthermore, the entire area of the former landfill and part of the recreation reserve is within essential habitat area and Category A or B area that is a least concern regional ecosystem, see Figure 5-4. The former landfill has also been identified for cultural significance - which would need to be considered in the plans. Additional environmental requirements have to be met if Council decides to clear land at either of the two locations.

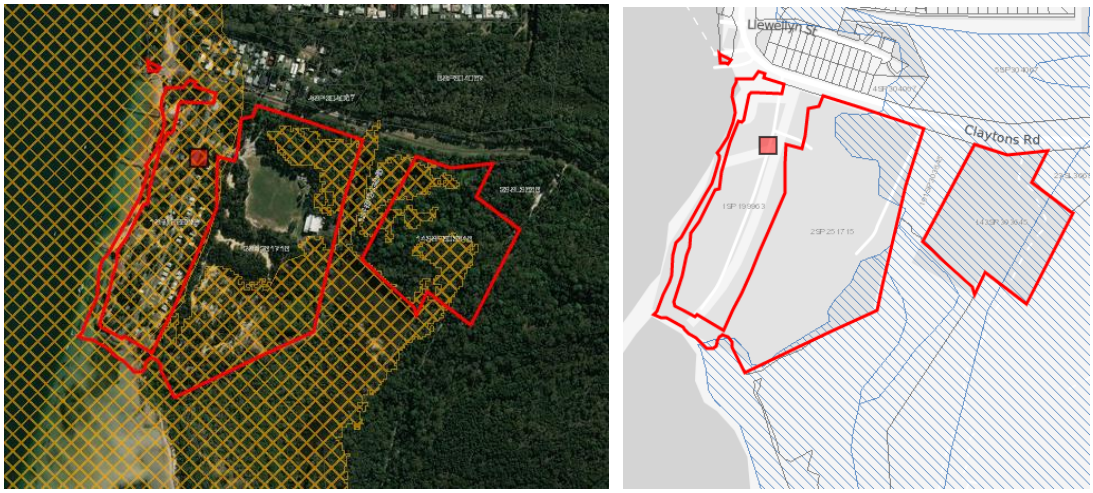


FIGURE 5-4 LEFT: EXTENDED EROSION PRONE AREA AND RIGHT: ESSENTIAL HABITAT AREA, SOURCE QLD GLOBE

Geotechnical investigations would give the necessary details regarding the stability of the ground and whether these locations need to be sheeted with base material. This is especially so if the landfill area is used as a stockpile location. Previous landfill should not be uncovered or mixed with any overburden. Nonetheless, the stockpiled material could be fenced for safety and to deter undesired trespassers. An area of about 0.4-0.6 hectares would need to be prepared to accommodate the rock stockpile, truck movements and appropriate buffer to fencing. Depending on the exact location, a road may need to be cleared as well.

Considering the nature and extent of further investigations into legal and environmental constraints of these stockpile locations in the vicinity of Amity Point, in conjunction with their high capital expenditure for establishment, it would be better to use existing local quarries as a stockpile location for rock supplied from the mainland.

However, while a local quarry would limit the need to setup a local stockpile, the rock would need to be double handled on the island. Firstly, from the barge landing point to the quarry, and then again from the quarry to the site of any flow slide event. This will further increase rock supply costs, that are already significant for rock supplied from the mainland.

5.5 Transport and Placement

As recommended in the SEMP, appropriate rock should be placed as soon as possible after the start of a flow slide event to limit the extent of its damage. The rock would be loaded directly onto trucks by an excavator and the delivered to the foreshore, where it would be dumped directly from each truck onto the flow slide event. Dumping of rock directly from a truck has been the most successful practice in the past, since the event happens very quickly and an immediate response is required to halt any actively developing flow slide. However, it is recommended to use appropriate construction methods when building any new seawalls, for example as recommended at the Southern Reach.

There are currently two contractors on the island that are able to undertake the transport and placement of rock and have done so in the past, these being Meithke Earthmoving and Mazzonis Plant Hire. The owners and managers of those firms understand the urgency of undertaking works in response to flow slide events and have generally been available at short notice to respond as needed in the past.

Transport of rock is undertaken by truck with a driver and is quoted to be $100/h on average. An excavator with an operator costs around $120/h.

5.6 Costing

Costing are presented in Table 5-2 and Table 5-3 for Island-based quarries and Table 5-4 for mainland-based quarries.

Transport from the two Island-based quarries to the foreshore of Amity Point takes around 30 minutes. However, including loading and unloading operations, a roundtrip will take about 1.25 to 1.5 hours. Typically transport and placement activities can operate 8 hours each day, with a truck capacity of approximately 12 tonnes. Consequently about 60-70 tonnes rock could be moved per day per truck. It would therefore take an operation using two trucks about 7-8 working days to move 1,000 tonnes, 14-17 working days to move 2,000 tonnes and about 21-25 working days to move 3,000 tonnes rock. The time for transport and placement of rock could decrease should more trucks be used, or if relief drivers and loading crew are able to work extended hours as an emergency response during a critical flow slide event.

Loading the rock from the quarry is relatively quick, and transport of the rock is the limiting factor. The total price for rock sourced from the Council-operated quarry, placement and transport will be about $63,000 - $187,000 for 1,000 to 3,000 tonnes, see Table 5-2. This is based on a price for the rock which includes transport.

TABLE 5-2 COSTING COUNCIL QUARRY

Works	Unit price	Total 1,000 tonne (min)	Total 3,000 tonne (max)
Rock sourcing + transport	$55/ tonne	$55,000	$165,000
Loading (1 excavator)	$120/h	$7,680	$22,080
Total		**$62,680**	**$187,080**

The Private quarry is located almost the same distance as the Council-operated quarry and it takes about 1.25 to 1.5 hrs round trip to supply rock from the quarry to the Amity Point foreshore. For costing purposes, it is assumed that the price for rock and transport is similar to previous rates used when the quarry was under Peter Meithke's operation. Assuming again that two trucks are available for transport and placement, the following costing has been prepared, see Table 5-3.

TABLE 5-3 COSTING PRIVATE ISLAND QUARRY

Works	Unit price	Total 1,000 tonne (min)	Total 3,000 tonne (max)
Rock sourcing + transport	$55/tonne	$55,000	$165,000
Loading (1 excavator)	$120/hour	$7,680	$22,080
Total - minimum		**$62,680**	**$187,080**

The cost from both quarries are very similar. However, because the Private quarry is currently not in a commercial position to sell the rock the cost estimate needs to be considered with caution. Therefore, it would be prudent to allow a 20% contingency to any costing associated with the Private quarry.

If rocks are sourced on the mainland and the rocks are stockpiled near the foreshore at a designated area, the price is as shown below in Table 5-4. It is assumed that a stockpile location near the Amity Point foreshore is available. The same methodology for transporting and placing rock as for the Island-based quarry is used in response to a flow slide event. However, the rock must be ready at the stockpile location and the costs for establishing a local stockpile increases the overall price. Again, it is envisaged using two trucks and one excavator, so that loading, transporting and dumping will take about 20 minutes round trip, this can take longer

when the flow slide barrier is not easily accessible and the truck has to manoeuvre to and at the site. When one truck is being loaded the other truck is dumping so it will be a continued process of loading and dumping. Based on 12 tonnes per truck it will take about 2 days to place 1,000 tonnes, 3-4 days to place 2,000 tonnes and about 5 days for 3,000 tonnes, based on an eight-hour workday. The costs for setting up a stockpile location are unknown at this stage. A contingency of 20% has been added to the cost estimate.

TABLE 5-4 COSTING LAND-BASED QUARRIES AND LOCAL STOCKPILE AT AMITY

Works	Unit price	Total 1,000 tonne (min)	Total 3,000 tonne (max)
Rock sourcing + transport to Amity	$90/ tonne	$90,000	$270,000
Stockpile setup		tbd	tbd
Stockpile lease (if required)		tbd	tbd
Transport (2 trucks)	$100/h	$3,200	$8,000
Loading (1 excavator)	$120/h	$1,920	$4,800
Contingency	20%	$19,024.0	$56,560.0
Total		**$114,144***	**$339,360***

*plus cost for stockpiling at Amity Point

The other option is to source rock from the mainland but use the quarry as a stockpile location. This will increase costs due to the increased transport to and from the quarry. The unit price per tonne of rock will be similar since the barge landing is at Dunwich and a similar distance will be driven towards Amity Point, or the Council quarry. Once a flow slide event occurs, the rock has to be transported to the flow slide location which will take 1.5 hours round trip and the same time constraint as sourcing rock from the Council or Private quarry. The costing is presented in Table 5-5.

TABLE 5-5 COSTING LAND-BASED QUARRIES AND STOCKPILE AT A QUARRY

Works	Unit price	Total 1,000 tonne (min)	Total 3,000 tonne (max)
Rock sourcing + transport to quarry	$90/ tonne	$90,000	$270,000
Transport from the quarry (2 trucks)	$100/h	$12,800	$36,800
Loading (1 excavator)	$120/h	$7,680	$22,080
Contingency	20%	$22,096.0	$65,776.0
Total		**$132,576**	**$394,656**

Stockpiling costs are uncertain at this stage, depending on the cost of setting up and possibly leasing a stockpile location at Amity Point. Based on the technical review, rock sourced from one of the quarries on North Stradbroke Island is preferred. Therefore, rock from the mainland can only be justified if there is no legal solution to using rock from either one of the two quarries on the island. Therefore, at this stage, there is no need to investigate those costs further. However, should the implementation phase reveal that the local rock cannot be legally obtained and rock would need to be brought in from the mainland this will need to be revisited.

The above considerations are only valid for emergency works. Should a large amount of rock be needed for other works without the need for a local stockpile location, such as the construction of the seawall in the Southern Reach, this option can be reconsidered.

It must be noted that all costing is based on using two trucks for transporting and placing rock at the site of each flow slide event. If more trucks are available, the response time will decrease and the costing will change slightly as well.

5.7 Summary and recommendations

In summary, rock can technically be sourced from either of the two Island quarries (not considering any legal restrictions) or from the mainland. The rock from the mainland is about double the price due to increased transport rates via barge.

Should the rock be sourced from the mainland, a local stockpile location on the Island will need to be established. The rock can either be stockpiled locally near Amity Point or at either of the quarries. This will further increase the costs when using rock from the mainland. Therefore, from a technical and costing viewpoint, using rock from the local quarries is preferred.

6 FINANCIAL ANALYSIS

6.1 Introduction

A financial analysis was undertaken by Molino Stewart. The scope of the financial analysis was to assess whether the shoreline recession control strategies proposed in the SEMP are economically worthwhile. This was achieved through a cost-benefit analysis (CBA). The CBA estimated the socio-economic benefits of the proposed erosion control strategies (i.e. in terms of the expected reduction of erosion damages) and compared these with the costs of implementation and maintenance. In line with the SEMP, the CBA was undertaken over a time span of 20 years and included the following tasks:

- Generation of an erosion worst credible scenario, estimating the probable location of the shoreline in 20 years' time if no protection strategies were put in place;
- Identification of the assets that would be lost *without* the proposed erosion control strategies in place (i.e. "Do Nothing" scenario). These include public and private items such as beaches, coastal infrastructure and amenities (i.e. boat ramp, coastal reserves), residential lots and buildings, coastal landscape and ecosystems;
- Identification of the assets that would be lost *with* the proposed erosion control strategies in place, and estimate of the reduction in damages that the strategies would provide (i.e. the strategies "benefits");
- Financial analysis to discount the strategies benefits and costs to their Present Value (PV);
- Calculation of a Benefit to Cost ratio for each strategy to assess if this would be economically worthwhile (i.e. Cost/Benefit Analysis).

Because the SEMP did not recommend any protection measures for the Northern Reach other than a monitoring plan, this section of the study area was excluded from the scope of the financial analysis. The aim of the monitoring campaign proposed in the SEMP will be to provide reliable and timely consistent information to Council regarding the erosion rate of Amity Beach and the adjoining properties. To date it is not possible to predict if and when coastal protection measures will become necessary, their costs or what type of benefits these will provide. It is recommended that a financial analysis of these measures is undertaken when this information becomes available.

6.2 Methods

6.2.1 Generation of Erosion Scenarios

6.2.1.1 "Do Nothing" Scenario

In order to generate a credible erosion scenario projected 20 years into the future, if no erosion protection strategies were implemented, the following assumptions were made:

- For all the sandy sections of shoreline (i.e. in the Southern Reach), the Erosion Prone Area (EPA) as calculated by the Queensland Government (https://www.qld.gov.au/environment/coasts-waterways/plans/hazards/erosion-prone-areas) was used as the worst-case erosion scenario for year 2100. In Amity Point, this equates to a linear distance landward from the current shoreline of 145m. For the 20-year planning horizon, it was assumed that this would correspond to an erosion buffer of 90m[1].

[1] The Erosion Prone Area for the Southern Reach has been re-calculated for the shorter planning horizon of 20 years using the Coastal Hazard Technical Guide, Determining coastal hazard areas, DEHP, 2013, Equation 1. The long term erosion rate has been adopted from the SEMP with 2m/year, a short term erosion rate of 17m has been applied as an average size of a flow slide event in this specific area, erosion due to sea level rise is 5m and a dune scarp component of 3.

This approach may be considered conservative as the Southern Reach is currently protected by a seawall, however the SEMP emphasized that its structural integrity is uncertain. As such, in the absence of reliable information on the capability of the Southern Reach seawall to provide long term protection, a conservative approach based on the EPA was adopted. It was also assumed that erosion would progress at a constant rate over the next 20 years, resulting in an erosion rate of 4.5m per year.

- In the Central Reach, if the current flow slide barrier (FSB) was not maintained (i.e. "Do Nothing" scenario), this will stop serving its purpose of preventing future flow slides penetrating into the private properties. Under such a scenario, it would be appropriate to assume that foreshore erosion would maintain its historical trend, which from 1970 to 2015 was on average 1.8m/year along the entire length of the Central Reach. This would result in a total linear recession of 36m over the 20-year planning horizon.

The shoreline recession buffer in the "Do Nothing" scenario is shown in Figure 6-1.

6.2.1.2 Erosion protection strategies in place

Even if the SEMP erosion protection measures were put in place, it would be unrealistic to assume that shoreline erosion would cease completely. In this case, a 10m total linear recession in 20 years was assumed for the Central and Southern Reaches to allow for some slumping of the structure in line with the Coastal Hazard Technical Guide – determining coastal hazard areas, DEHP, 2013. The shoreline recession buffer with the SEMP control measures in place is shown in Figure 6-2.

FIGURE 6-1 SHORELINE RECESSION BUFFER WITHOUT COASTAL PROTECTION MEASURES ("DO NOTHING" SCENARIO) IN 20 YEARS

FIGURE 6-2 SHORELINE RECESSION BUFFER WITH THE SEMP COASTAL PROTECTION MEASURES IN PLACE IN 20 YEARS.

6.2.2 Assets exposed to erosion

6.2.2.1 "Do Nothing" scenario

Under the scenario in which no erosion protection strategies are implemented, the following assets would be affected within the 20-year time horizon:

- 34 residential lots and 26 buildings. These were all located in the Central Reach except one, which is in Amity Point Camping Ground (Southern Reach);
- Boat ramp;
- Amity Point's Camping Ground Beach (100% loss);
- Old Schoolhouse Park, Cabarita Park, Amity Point Picnic Park, part of Amity Point Recreation Reserve;
- About 250m of local roads; and
- Local utilities distribution network servicing the affected properties.

6.2.2.2 Erosion protection strategies in place

If the SEMP recommended erosion protection strategies were implemented, the following items will be exposed to erosion damages in the next 20 years:

- 20 residential lots and 3 buildings, all located in the Central Reach;
- Boat ramp;
- Part of the Old Schoolhouse Park and Cabarita Park;
- About 30m of local roads; and
- Local utilities distribution network servicing the affected properties.

6.2.3 Erosion Damages Assessment

Erosion damages were quantified in monetary terms and converted to their Present Value (PV) to discount future costs to present day values to account for the time value of money. Damages were assessed under the "Do Nothing" option and if the SEMP erosion control measures were put in place. The following damages were assessed:

- Damages to properties, infrastructure and public assets;
- Damages caused by the loss of the beach along the Southern Reach; and
- Social and intangible damages, affecting the local environment, cultural values and community identity.

6.2.3.1 Built Environment

Figure 6-3 summarises the possible types of damages to the built environment from natural hazards (DIPNR, 2015, modified). The two main categories are tangible and intangible damages. Tangible damages are those that can be more readily evaluated in monetary terms. Intangible damages relate to the social cost of natural hazards and are more difficult to quantify.

Tangible and intangible damages are further divided into direct and indirect damages. Direct damages relate to the loss (or loss in value) of an object or a piece of property caused by erosion. Indirect damages relate to consequences of direct damages such as additional accommodation or relocation costs. The following subsections explain how each damage type was assessed for buildings and infrastructure.

The analysis was undertaken using a dataset in GIS format containing only cadastre lots across the area. Building footprints and infrastructure were not provided. The dataset also did not contain information on individual buildings, such as use or number of storeys. This information, when available, was collected from real estate datasets. Where no data was available, buildings were assumed to be single storey and residential, because this is the most common building type in the study area.

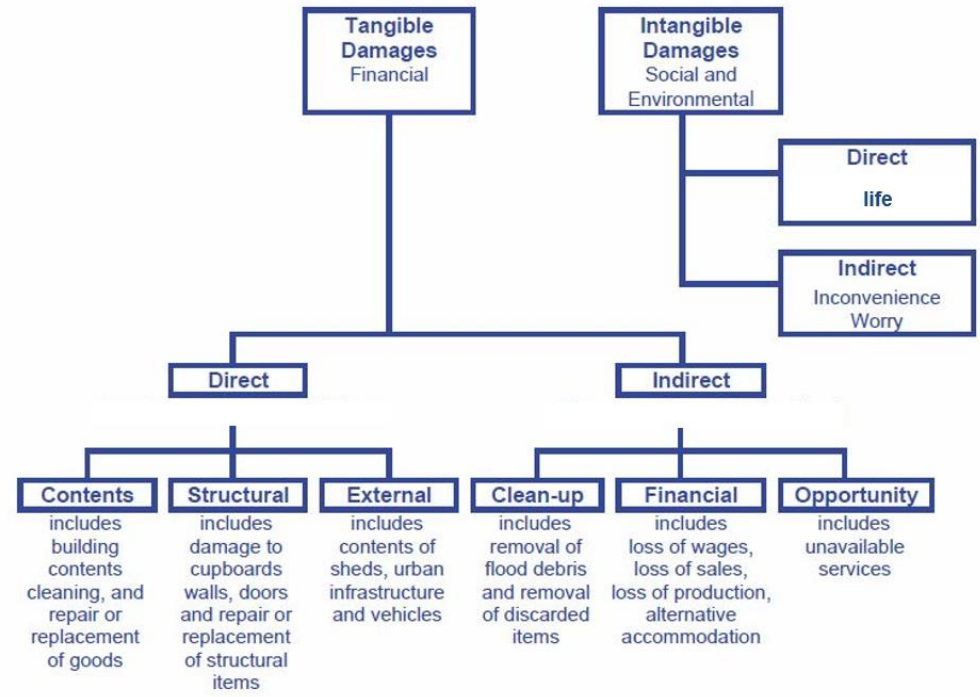


FIGURE 6-3 TYPES OF DAMAGES TO THE BUILT ENVIRONMENT (DIPNR, 2005, MODIF.)

a) Properties

Direct Damages

Direct damages were assessed based on the expected loss of value of the building structure and the land. Building contents was not considered as it was assumed that there would be sufficient time and notice to move the contents elsewhere before the building is undermined. It is acknowledged that buildings located within 10m from the shore, or from the flow slide barrier if this is installed, could become affected by erosion on a shorter term (e.g. overnight), however these are a small number compared to the total number of buildings within the erosion buffer. As such, a contents loss for these buildings would not affect the outcomes of the present financial analysis.

The value of the building structure for each of the above mentioned building types was obtained from average 2018 construction costs per square metre for Australian buildings estimated for tax depreciation purposes (https://www.bmtqs.com.au/construction-cost-table). The average area of each building type was obtained from 2017 aerial imagery and multiplied by the number of storeys. The overall building replacement costs were obtained by augmenting construction costs by a factor of 1.2, to account for demolition and clean up (Geoscience Australia, 2012) Table 6-1.

TABLE 6-1 REPLACEMENT COSTS FOR RESIDENTIAL BUILDINGS IN THE STUDY AREA

Dwelling type	Construction cost (per m^2)	Total Replacement cost per m^2 (incl. demolition)
Single Storey	$1,849	$2,218
Double Storey	$1,849	$2,459

Finally, the unimproved value of the land for each lot was obtained from the Queensland Department of Natural Resources, Mines and Energy via the online web GIS platform "Queensland Globe" (https://qldglobe.information.qld.gov.au/).

Indirect Damages

For the residential sector, indirect damages caused by natural hazards usually include clean-up costs and the costs of alternative accommodation while the house is being repaired and cleaned up. In case of buildings undermined by erosion, these costs were considered irrelevant as clean-up would be unnecessary and in most instances the building occupants would have sufficient notice to organise a permanent alternate accommodation. As such, a household relocation cost of $2,000 was used as the only residential indirect damage.

b) Building Damage Model

Direct damages to properties affected by erosion were assumed to be equal to the total building replacement value, plus the value of the portion of eroded land. It is acknowledged that in some instances, depending on the specific characteristics of the affected lots and the exact location of building within the lot, the overall lot value may be lost more quickly, as even the non-eroded land may depreciate because it is too small to be habitable. This effect was however assumed to be small and partially balanced by a likely increase in value of the next row of buildings, which would become waterfront. It was also assumed that the damage from erosion would be permanent and that in most instances this would result in the building owner not being able or willing to rebuild at the same location.

While the damage to the land was assumed to occur consistently across the 20 year time horizon (i.e. same amount of damage each year), damage to buildings was assumed to occur at a specific point in time, obtained by dividing the distance of the building from the shoreline by the erosion rate.

6.2.3.2 Infrastructure

Consistent with most floodplain risk management studies in Australia, this study quantified overall damages to infrastructure, public assets and local environmental features as a proportion (i.e. 15%) of the total building and land damages.

6.2.3.3 Beach width loss

The loss of beach width caused by shoreline recession is associated with a range of socio-economic impacts, including:

- Degraded landscape and views;
- Loss of amenity for recreational and social activities;
- Loss of access to the water for swimming/water based activities;
- Loss of protection against storm bite and inundation; and
- Loss of the beach and dune ecosystem.

The literature on valuation of coastal environment assets provides several examples of attempts to estimate the economic value of a beach, through an analysis of the services it provides to the community.

Travel Cost Methods (TCM) have been used to estimate the recreational value provided to beach goers. The theory behind the TCM is that beach users will only yield the expenses of a trip to the beach if these are smaller than the utility they gain from the trip (SCCG, 2013). These expenses include travel costs, onsite costs, and time. Information regarding the number of trips taken at different travel costs is then used to create a demand function for a specific beach (Pendleton et al., 2007).

The TCM is a popular method in environmental valuation, as it relies upon observations of real behaviour. The main limitation it has however is that it only estimates the value obtained from accessing and using the beach. As such, it does not account for other values such as improved views/landscape, or environmental and ecological values of a beach (SCCG, 2013).

Another popular method to estimate beach value is based on Hedonic Pricing Methods (HPM). These are usually applied to estimate the contribution to property value made by different environmental attributes. In the case of properties located on or in proximity to a beach, these may include distance from the beach and a measure of beach quality (e.g. beach width). In HPM, real estate sales records are correlated to these attributes to obtain an estimate of the market's Willingness to Pay (WTP) for the privilege of living near a beach of a given width.

This study investigated the suitability of TCM and HPM to estimate the value of the beach along the Southern Reach of the study area. Amity Point Beach, in the Northern Reach, was excluded from the financial analysis for the reasons described in Section 6.1.

When assessing the applicability of the TCM, it was noted that the Southern Reach beach is mostly used by members of the local community and by tourists. Tourists may include people owning a holiday property in Amity Point, and people staying at the camping ground or renting any of the local cottages/vacation homes. The cost that these people would have to pay to travel from their accommodation to the beach was considered negligible due to the very short distance. The cost for tourists to travel from their homes to their accommodation in Amity Point is more significant, but this is already reflected in the market value of such properties (i.e. the property value includes a measure of the owner WTP to have access to accommodation near the beach), which was considered in the damages assessment exercise.

Generating an ad-hoc HPM-based model to estimate the value of properties in Amity Point as a function of their distance from the beach and the beach width was not possible because of the relatively small number of properties and limited information on real estate sales and beach width fluctuations. As such, a suitable ratio between property value and beach width was obtained from a study undertaken by Gopalakrishnan et al. (2011) in a comparable environmental coastal context (i.e. the property market in coastal town on the barrier islands of North Carolina, US), also affected by high beach erosion rates.

Gopalakrishnan et al. (2011) used four different models and estimated that, depending on the model used, a 1% increase in beach width could generate an increase in the value of beachfront properties of up to 0.5%. However, of the four models used, the only one that produced results consistent with previous, well referenced work (e.g. Pompe and Reinhart, 1995) estimated a +0.08% beach-front property value increase as a result of a +1% increase in beach width. As such, this figure was considered the most appropriate for the context of Amity Point.

Gopalakrishnan et al. (2011) also noted that the effect of beach width on property value decreases exponentially with the distance from the beach and becomes negligible at a distance of 100 m. In Amity Point, it was assumed that the only property whose value would be affected by beach width fluctuations is the Amity Point Camping Ground, currently valued $2,750,000 (Queensland Globe, 2019).

6.2.3.4 Social and intangible impacts

The most important social impact of natural hazards is the possible loss of lives, however this does not generally apply to coastal erosion, as building occupants are able to leave the premises well before they experience any significant structural instability. Other than risk to life, additional social and intangible impacts of severe coastal erosion may include implications on:

- Community identity and cohesion;
- Landscape and environmental degradation;
- People's overall well-being; and
- Loss of items of sentimental value.

These impacts are difficult to quantify. Attempts have been made in some floodplain risk management studies to include intangible damages estimates as a proportion of total residential and commercial tangible damages (usually 20-25%). Consistently with this approach, this study estimated social/intangible damage to be 25% of total tangible property damages.

6.3 Cost-Benefit Analysis

6.3.1 Southern Reach

6.3.1.1 Costs of proposed erosion controls

For the Southern Reach, the SEMP proposed the following erosion control measures:

- Construction of approximately 165m of seawalls to be buried at the rear of the northern and southern beach compartments. This consists of approximately 55m along the northern compartment and 110m on the Southern compartment;
- Placement of approximately 5,000 m^3 of sand (of appropriate grading and size) within the existing three beach compartments. This consists of approximately 800 m^3 along the northern compartment, approximately 1,700 m^3 on the Central compartment, and approximately 2,500 m^3 on the Southern compartment;
- Undertaking a structural audit of the existing rock-armoured seawall to the south of the three beach compartments to confirm its future effectiveness as a foreshore defence structure;
- Monitoring the performance of the beach nourishment by annual surveys of the foreshore profile;
- Undertake future beach renourishment campaigns to reinstate beach widths should sand losses result from severe storms and/or future climate change. It is estimated that on average there will be a re-nourishment every 4 years with 1,200 m^3 of sand; and
- For the purposes of developing cost estimates, it is assumed that local sources of sand for beach nourishment and armour rocks for seawall construction are available on North Stradbroke Island;

Table 6-2 summarises the cost estimates for the above listed works:

TABLE 6-2 CAPITAL AND MAINTENANCE COST OF THE SEMP EROSION CONTROL MEASURES IN THE SOUTHERN REACH

Activity	Capital Cost	Annual Cost
Design and Approvals		
Site survey	$5,000	
Sand sourcing study	$15,000	
Structural audit of existing seawall	$7,500	
Design of seawalls & beach nourishment	$30,000	
Obtain appropriate approvals	$17,500	
Construction Works		
Construct approx. 165m of buried rock seawall	$112,500	
Procure and place 5,000m^3 of sand	$87,500	
Allowance for annual renourishment		$5,000
Project Monitoring		
Annual survey of beach		$5,000
Totals	**$275,000**	**$10,000**

Table 6-3 shows the above costs spread across the 20-year time horizon, and calculates their Present Value using a discount rate of 7%, consistent with the guidance provided by Building Queensland and Infrastructure Australia.

TABLE 6-3 PRESENT VALUE OF THE COSTS ASSOCIATED WITH THE EROSION CONTROL MEASURES IN THE SOUTHERN REACH

Year	Costs	Present Value (7% discount rate)
1	$275,000	$275,000
2	$10,000	$9,346
3	$10,000	$8,734
4	$10,000	$8,163
5	$10,000	$7,629
6	$10,000	$7,130
7	$10,000	$6,663
8	$10,000	$6,227
9	$10,000	$5,820
10	$10,000	$5,439
11	$10,000	$5,083
12	$10,000	$4,751
13	$10,000	$4,440
14	$10,000	$4,150
15	$10,000	$3,878

Year	Costs	Present Value (7% discount rate)
16	$10,000	$3,624
17	$10,000	$3,387
18	$10,000	$3,166
19	$10,000	$2,959
20	$10,000	$2,765
	Total Present Value	**$378,356**

6.3.1.2 Benefits of proposed erosion controls

The economic benefits of the proposed erosion controls were assessed as the associated reduction in erosion damages, plus the increase in value of beach-front properties (i.e. the camping ground) driven by the availability of a wider beach (post-nourishment). The reduction in damages was estimated by subtracting the damages with the erosion controls in place from the damages in the "Do Nothing" scenario.

a) Damages in the "Do Nothing" scenario

If no coastal protection measures were implemented, the beach and about 60% of the camping ground would be lost over the selected time horizon of 20 years. The current land value of the camping ground is $2,750,000 (Queensland Globe, 2019).

According to the erosion scenario used in this analysis, the beach would entirely erode before the camping ground is affected. Namely, in the worst-case scenario of an erosion rate of 90m in 20 years (i.e. 4.5m per year), the beach would erode within the first three years. As discussed in Section 2.3.3, a complete loss of the beach would result in a decrease of the value of the camping ground of about 8%, corresponding to $220,000. This loss would be experienced in the first three years (i.e. a loss of approximately $73,333 per year).

The remaining value of the camping ground after the beach has disappeared would be $2,530,000. Sixty per cent of such value, corresponding to $1,518,000, would be lost over the following 17 years, at a pace of about $89,294 per year.

It is acknowledged that this is a simplification of the erosion process as in an unaltered natural system the erosion of the camping ground would nourish the beach, which would continue to exist to some extent. However, it was deemed more likely that the existing seawall will prevent any erosion of the camping ground land before the beach is completely eroded.

Finally, as discussed in Section 6.2.3.2 and 6.2.3.4, an allowance of +15% and +25% of the total tangible damages to property was included to account for damages to infrastructure/public assets and intangible damages respectively.

Table 6-4 summarises the above mentioned damages over the time horizon of 20 years, and calculates their present value.

TABLE 6-4 PRESENT VALUE OF THE DAMAGES IN THE SOUTHERN REACH IN THE "DO NOTHING" SCENARIO.

Year	Tangible Damages	Infrastructure Damage (15%)	Intangible Damages (25%)	Total	Present Value
1	$73,333	$11,000	$18,333	$102,667	$102,667
2	$73,333	$11,000	$18,333	$102,667	$95,950
3	$73,333	$11,000	$18,333	$102,667	$89,673
4	$89,294	$13,394	$22,324	$125,012	$102,047
5	$89,294	$13,394	$22,324	$125,012	$95,371
6	$89,294	$13,394	$22,324	$125,012	$89,132
7	$89,294	$13,394	$22,324	$125,012	$83,301
8	$89,294	$13,394	$22,324	$125,012	$77,851
9	$89,294	$13,394	$22,324	$125,012	$72,758
10	$89,294	$13,394	$22,324	$125,012	$67,998
11	$89,294	$13,394	$22,324	$125,012	$63,550
12	$89,294	$13,394	$22,324	$125,012	$59,392
13	$89,294	$13,394	$22,324	$125,012	$55,507
14	$89,294	$13,394	$22,324	$125,012	$51,875
15	$89,294	$13,394	$22,324	$125,012	$48,482
16	$89,294	$13,394	$22,324	$125,012	$45,310
17	$89,294	$13,394	$22,324	$125,012	$42,346
18	$89,294	$13,394	$22,324	$125,012	$39,576
19	$89,294	$13,394	$22,324	$125,012	$36,986
20	$89,294	$13,394	$22,324	$125,012	$34,567
	Total Present Value				**$1,354,337**

b) Damages with SEMP erosion controls in place

The recommended beach nourishment and associated protection would bring the width of the beach in the Southern Reach from about 15m (today) to about 40m. Periodic re-nourishments would then be undertaken on average every 4 years (this may vary depending on erosion rates). Each of these would use about 1,200 m^3 of sand in an attempt to reduce the beach erosion rate. It was assumed that these measures would result in a total beach loss of about 10m over 20 years, corresponding to a rate of 0.5m/year.

An initial beach width of 40m, under the scenario in which the coastal protection measures proposed in the SEMP are implemented, was then used to estimate the increase in property value of the camping ground in year 1. Increasing the current beach width (i.e. about 15m) to 40m would represent a width variation of +266%. The corresponding increase in beach-front property value, according to Gopalakrishnan et al. (2011), would be +21.3%. This would correspond to an increase of the camping ground lot value from a total of $2,750,000 to a total of $3,335,500, for a benefit of $585,750 in year 1 (i.e. when the nourishment is undertaken).

The beach would then erode at an average rate of 0.5m/year, generating a corresponding decrease of the camping ground lot value in the following 20 years calculated as the percentage of beach loss times 0.08%. This corresponds to an average yearly loss of $3,336.

Table 6-5 summarises the above-mentioned damages over the time horizon of 20 years and calculates their present value.

TABLE 6-5 PRESENT VALUE OF THE DAMAGES IN THE SOUTHERN REACH WITH THE SEMP EROSION CONTROL IN PLACE

Year	Damages	Present Value
1	-$582,414	-$582,414
2	$3,336	$3,118
3	$3,336	$2,914
4	$3,336	$2,723
5	$3,336	$2,545
6	$3,336	$2,378
7	$3,336	$2,223
8	$3,336	$2,077
9	$3,336	$1,941
10	$3,336	$1,814
11	$3,336	$1,696
12	$3,336	$1,585
13	$3,336	$1,481
14	$3,336	$1,384
15	$3,336	$1,294
16	$3,336	$1,209
17	$3,336	$1,130
18	$3,336	$1,056
19	$3,336	$987
20	$3,336	$922
	Total Present Value	**-$547,937**

6.3.1.3 Benefit to cost ratio

The Benefit to Cost Ratio (BCR) of the proposed erosion control measures in the Southern Reach would be 5.0. This means that the proposed controls would yield a significant economic profit.

Present Value of Damages (Do Nothing)	$1,354,337
Present Value of Damages with Erosion Control in Place	$-547,937
Net Present Value of Benefits	$1,902,275
Net Present Value of Costs	$378,356
Benefits to Costs Ratio (BCR)	5.0

6.3.2 Central Reach

6.3.2.1 Costs of proposed flow slide controls

The SEMP proposed the following controls in the Central Reach to mitigate flow slides:

"to support and enhance the effectiveness of the current erosion management practice of repairing damage to the existing flow slide barrier whenever necessary following flow slide events - by placing additional rock armouring."

The costs associated with the above strategy vary depending on the source of the rocks (i.e. from the islands vs. from the mainland). The SEMP implementation plan estimated the cost of rock supply from the mainland to be significantly higher than using a source on the island. Because sourcing rocks from the mainland would not bring any advantages over using a source from the mainland, the latter option was disregarded.

As discussed in the SEMP Implementation Plan Report, rocks can be sourced from two quarries within the island: (1) a Council quarry, or (2) a Private quarry. Both quarries would be able to supply the necessary quantity of rocks, which was estimated to on average 1,000 tonnes per year. The cost of the rocks (i.e. $55 per tonne), loading (i.e. $120 per hour) and stockpiling would be the same regardless of the quarry. The only difference in terms of costs and benefits would be that the Council quarry already has a sales permit, which will need to be renewed in 2020, while the Private quarry needs a new sales permit before any supply can begin. For simplicity, it was assumed that the cost of a permit renewal and a new permit would be of the same order of magnitude, and that both costs would have to absorbed in year 1. Table 6-6 summarises the costs of the flow slide controls as described in the SEMP.

TABLE 6-6 CAPITAL AND MAINTENANCE COSTS OF THE SEMP MEASURES TO CONTROL FLOW SLIDES IN THE CENTRAL REACH

Activity	Capital cost	Annual cost
Quarry Sales Permit	NA	NA
Annual bathymetric survey of Rainbow Channel		$17,500
Annual structural audit of flow slide barrier		$7,500
Rock sourcing + transport (1,000 tonne per year @ $55 per tonne)		$55,000
Loading (1 excavator @ $120/hour		$7,680
Total	**NA**	**$87,680**

Table 6-7 shows the above costs spread over the 20-year time horizon, and calculates their Present Value using a discount rate of 7%.

TABLE 6-7 PRESENT VALUE OF THE COSTS OF IMPLEMENTATION AND MAINTENANCE OF THE SEMP EROSION CONTROL MEASURES IN THE CENTRAL REACH

Year	Costs	Present Value (7% discount rate)
1	$87,680	$87,680
2	$87,680	$81,944
3	$87,680	$76,583
4	$87,680	$71,573
5	$87,680	$66,891
6	$87,680	$62,515
7	$87,680	$58,425
8	$87,680	$54,603
9	$87,680	$51,031
10	$87,680	$47,692
11	$87,680	$44,572
12	$87,680	$41,656
13	$87,680	$38,931
14	$87,680	$36,384
15	$87,680	$34,004
16	$87,680	$31,779
17	$87,680	$29,700
18	$87,680	$27,757
19	$87,680	$25,941
20	$87,680	$24,244

Year	Costs	Present Value (7% discount rate)
	Total Present Value:	**$993,905**

6.3.2.2 Benefits of the proposed flow slides controls

The economic benefits of the proposed flow slides controls were assessed as the associated reduction in damages from flow slides over the selected 20-year time horizon. The reduction in damages was estimated by subtracting the damages with the controls in place from the damages in the "Do Nothing" scenario.

a) Damages in the "Do Nothing" scenario

If no flow slides controls were implemented in the Central Reach it was assumed that the shoreline would recede by 36m over 20 years, corresponding to a recession rate of 1.8m per year. This would affect coastal properties in two ways:

- By progressively reducing the area of the affected lots (loss of land); and
- By undermining the foundations of any buildings within 36m from the shoreline (loss of buildings).

In addition to the above, any infrastructure and public assets within the erosion zone would be entirely lost and there would be intangible social impacts. These additional types of damage were estimated as a proportion of direct damages to properties as described in Section 2.3.2 and 2.3.4.

Table 6-8 and Table 6-9 summarise the damages to buildings and land respectively (including the proportional allowance for infrastructure and intangible damages) over the 20 year time horizon, in the "Do Nothing" scenario. The Present Value is also calculated, using a discount rate of 7%. It is noted that in years with a zero loss no buildings will be affected, although erosion will continue at the same rate.

TABLE 6-8 PRESENT VALUE OF THE DAMAGES TO BUILDINGS IN THE CENTRAL REACH IN THE "DO NOTHING" SCENARIO

Year	Tangible Damages	Number of affected buildings	Infrastructure Damage (15%)	Intangible Damages (25%)	Total	Present Value
1	$0	0	$0	$0	$0	$0
2	$0	0	$0	$0	$0	$0
3	$0	0	$0	$0	$0	$0
4	$0	0	$0	$0	$0	$0
5	$1,066,365	3	$159,955	$266,591	$1,492,910	$1,138,934
6	$224,967	1	$33,745	$56,242	$314,954	$224,558
7	$1,379,393	3	$206,909	$344,848	$1,931,150	$1,286,807
8	$1,101,840	2	$165,276	$275,460	$1,542,576	$960,639
9	$519,557	1	$77,934	$129,889	$727,380	$423,342
10	$609,619	1	$91,443	$152,405	$853,466	$464,229
11	$1,180,611	3	$177,092	$295,153	$1,652,855	$840,228
12	$1,563,977	1	$234,597	$390,994	$2,189,568	$1,040,248
13	$0	0	$0	$0	$0	$0
14	$1,015,972	2	$152,396	$253,993	$1,422,361	$590,229

Year	Tangible Damages	Number of affected buildings	Infrastructure Damage (15%)	Intangible Damages (25%)	Total	Present Value
15	$774,057	2	$116,109	$193,514	$1,083,679	$420,270
16	$1,498,051	2	$224,708	$374,513	$2,097,272	$760,148
17	$772,966	1	$115,945	$193,242	$1,082,153	$366,563
18	$260,024	1	$39,004	$65,006	$364,034	$115,244
19	$1,241,051	3	$186,158	$310,263	$1,737,471	$514,055
20	$0	0	$0	$0	$0	$0
	Total Present Value					**$9,145,492**

TABLE 6-9 PRESENT VALUES OF THE LOSS OF LAND IN THE CENTRAL REACH IN THE "DO NOTHING"SCENARIO

Year	Tangible Damages	Infrastructure Damage (15%)	Intangible Damages (25%)	Total	Present Value
1	$410,685	$61,603	$102,671	$574,958	$574,958
2	$410,685	$61,603	$102,671	$574,958	$537,344
3	$410,685	$61,603	$102,671	$574,958	$502,190
4	$410,685	$61,603	$102,671	$574,958	$469,337
5	$410,685	$61,603	$102,671	$574,958	$438,632
6	$410,685	$61,603	$102,671	$574,958	$409,937
7	$410,685	$61,603	$102,671	$574,958	$383,118
8	$410,685	$61,603	$102,671	$574,958	$358,055
9	$410,685	$61,603	$102,671	$574,958	$334,630
10	$410,685	$61,603	$102,671	$574,958	$312,739
11	$410,685	$61,603	$102,671	$574,958	$292,279
12	$410,685	$61,603	$102,671	$574,958	$273,158
13	$410,685	$61,603	$102,671	$574,958	$255,288
14	$410,685	$61,603	$102,671	$574,958	$238,587
15	$410,685	$61,603	$102,671	$574,958	$222,978
16	$410,685	$61,603	$102,671	$574,958	$208,391
17	$410,685	$61,603	$102,671	$574,958	$194,758
18	$410,685	$61,603	$102,671	$574,958	$182,017
19	$410,685	$61,603	$102,671	$574,958	$170,109
20	$410,685	$61,603	$102,671	$574,958	$158,980
	Total Present Value				**$6,517,495**

The total Present Value of damages in the Central Reach in the "Do Nothing" scenario is $15,662,987.

b) Damages with SEMP flow slides controls in place

It was assumed that with the SEMP flow slides control in place the shoreline recession would be contained to 10m in 20 years, corresponding to a recession rate of 0.5m per year. In this scenario the amount of land and the number of buildings lost would reduce significantly. Table 6-10 and Table 6-11 summarise the damages to buildings and land respectively (including the proportional allowance for infrastructure and intangible damages) over the 20 year time horizon, with the SEMP flow slides control options in place. The Present Value is also calculated, using a discount rate of 7%.

TABLE 6-10 PRESENT VALUE OF THE DAMAGES TO BUILDINGS IN THE CENTRAL REACH WITH THE SEMP FLOW SLIDES CONTROL MEASURES IN PLACE

Year	Tangible Damages	Number of affected buildings	Infrastructure Damage (15%)	Intangible Damages (25%)	Total	Present Value
1	$0	0	$0	$0	$0	$0
2	$0	0	$0	$0	$0	$0
3	$0	0	$0	$0	$0	$0
4	$0	0	$0	$0	$0	$0
5	$0	0	$0	$0	$0	$0
6	$0	0	$0	$0	$0	$0
7	$0	0	$0	$0	$0	$0
8	$0	0	$0	$0	$0	$0
9	$0	0	$0	$0	$0	$0
10	$0	0	$0	$0	$0	$0
11	$0	0	$0	$0	$0	$0
12	$0	0	$0	$0	$0	$0
13	$0	0	$0	$0	$0	$0
14	$0	0	$0	$0	$0	$0
15	$0	0	$0	$0	$0	$0
16	$225,566	1	$33,835	$56,392	$315,793	$114,458
17	$0	0	$0	$0	$0	$0
18	$840,798	2	$126,120	$210,200	$1,177,118	$372,645
19	$0	0	$0	$0	$0	$0
20	$0	0	$0	$0	$0	$0
	Total Present Value					**$487,103**

TABLE 6-11 PRESENT VALUE OF THE LOSS OF LAND IN THE CENTRAL REACH WITH THE SEMP FLOW SLIDES CONTROL MEASURES IN PLACE.

Year	Tangible Damages	Infrastructure Damage (15%)	Intangible Damage (25%)	Total	Present Value
1	$52,546	$7,882	$13,137	$73,565	$73,565
2	$52,546	$7,882	$13,137	$73,565	$68,752
3	$52,546	$7,882	$13,137	$73,565	$64,255
4	$52,546	$7,882	$13,137	$73,565	$60,051
5	$52,546	$7,882	$13,137	$73,565	$56,122
6	$52,546	$7,882	$13,137	$73,565	$52,451
7	$52,546	$7,882	$13,137	$73,565	$49,019
8	$52,546	$7,882	$13,137	$73,565	$45,813
9	$52,546	$7,882	$13,137	$73,565	$42,816
10	$52,546	$7,882	$13,137	$73,565	$40,014
11	$52,546	$7,882	$13,137	$73,565	$37,397
12	$52,546	$7,882	$13,137	$73,565	$34,950
13	$52,546	$7,882	$13,137	$73,565	$32,664
14	$52,546	$7,882	$13,137	$73,565	$30,527
15	$52,546	$7,882	$13,137	$73,565	$28,530
16	$52,546	$7,882	$13,137	$73,565	$26,663
17	$52,546	$7,882	$13,137	$73,565	$24,919
18	$52,546	$7,882	$13,137	$73,565	$23,289
19	$52,546	$7,882	$13,137	$73,565	$21,765
20	$52,546	$7,882	$13,137	$73,565	$20,341
	Total Present Value				**$833,903**

The total Present Value of damages in the Central Reach, with the SEMP flow slides control options in place, is $1,321,006.

6.3.2.3 Benefit to cost ratio

The Benefit to Cost Ratio (BCR) of the proposed flow slides control measures in the Central Reach is 14.4. This means that the proposed controls would be economically worthwhile.

Present Value of Damages (Do Nothing)	$15,662,987
Present Value of Damages with Erosion Control in Place	$1,321,006
Net Present Value of Benefits	$14,341,981
Net Present Value of Costs	$993,905
Benefits to Costs Ratio (BCR)	14.4

6.4 Conclusions

The financial analysis showed that the coastal protection measures proposed in the Amity Point SEMP for the Central and Southern Reach yield significant socio-economic net profits, having a benefit to cost ratio of 14.4 and 5.0 respectively.

For the Central Reach, there is no significant difference, from a financial perspective, between sourcing the rocks from the Council quarry or the Private quarry, assuming that the Private quarry would charge the same amount for the rocks. The most practical option should be pursued.

The unusually high benefit to cost ratios are consistent with the analysis' assumptions about erosion rates, namely:

- An erosion rate of 4.5m per year was used in the Southern Reach for the "Do Noting" scenario. Such rate, in the selected time horizon of 20 years, would produce a shoreline recession of 90m, which is consistent the EPA buffer zone for Amity Point for year 2100. The recession rate was reduced to 0.5m per year with the SEMP erosion control measures in place.
- In the Central Reach, a recession rate of 1.8m per year was used for the "Do Nothing" scenario. This is consistent with historical recession rates for this section of the coast and would produce a total recession of 36m over 20 years. The recession rate was reduced to 0.5m per year with the SEMP erosion control measures in place.

Additional assumptions/limitations include:

- Use of a 7% discount rate to calculate the Present Value (PV) of future costs and benefits, in line with the guidance provided by Queensland Treasury and Infrastructure Australia;
- The value of building contents was not considered as it was assumed that in most instances the building occupants would be able to move the contents elsewhere before the building is affected;
- The cost of double accommodation while buildings are repaired was not considered as it was assumed that in most instances, if no erosion control measures are in place, buildings that are undermined by erosion would not be repaired, and there would be sufficient time for the occupants to find a permanent accommodation elsewhere before having to leave the building;
- The loss of land value was assumed to be proportionate to the area of eroded land. A loss in value of the non eroded land was not considered as this was deemed negligible and partly balanced by fluctuations in land value across the area driven by coastal recession; and
- The costs of erosion control in the Central Reach did not include items such as covenant, local law and easement costs.
- While the financial analysis identified a net cost benefit to the proposed approach, there is no differentiation of costs and benefits between landowners and Council. It is recognized that the financial benefits are predominantly private and the costs should be therefore borne by private. However, as highlighted throughout the SEMP, collective management is key for the success of the SEMP recommendations and Councils involvement is therefore warranted.

7 MANAGEMENT OPTION IMPLEMENTATION SCENARIOS

This section of the report brings together all previous chapters, namely the technical and legal review, emergency rock supply and financial analysis. All implementation options are presented, and their advantages and disadvantages outlined. Extensive stakeholder consultation has been performed with Council, State and the residents to ensure that the implementation plan provides a sensible way forward and that it does not pose an unreasonable level of obligation, responsibility or liability on any party involved.

7.1 Stakeholder consultation

Appendix A outlines the details of the community engagement activities undertaken during development of this Implementation Plan. In particular, two workshops were held with both the Northern Reach and Central Reach communities. The first workshop was held on 15 Oct 2019 to discuss the status of the Implementation Plan and the second on 27 Nov to present the Draft Implementation Plan. Council is directly engaging with QYAC with regard to the Implementation Plan for the Southern Reach. The feedback gained during the workshops has been incorporated in the development of all options.

In addition to this, all relevant State agencies were consulted during development of the SEMP Implementation Plan, namely:

- Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP)
- Department of Agriculture and Fisheries (DAF)
- Queensland Parks and Wildlife Service (QPWS)
- Department of Natural Resources, Mines and Energy (DNRME)
- Department of Environment and Science (DES)

All State agencies should be presented with the Draft Implementation Plan before it is finalised. A pre-lodgement meeting should be scheduled to progress with the development application for the flow slide barrier.

Stakeholder consultation formed an important part in the development of the implementation plan and a brief summary of the stakeholder preferences on the individual issues has been incorporated into the following chapters.

7.2 Southern Reach

The SEMP recommendation for the Southern Reach is a combination of a structural audit of the existing seawalls, construction of additional sections of seawall and beach nourishment.

The technical review confirmed that this strategy is appropriate for the location and is also consistent with the previous BMT WBM (2013) SEMP. The recommendation from the review is to include a contingency for the possible need to reinstate a part or all of the groyne, should it become affected by subsidence due to a flow slide event.

The entire Southern Reach is held in one single land tenure. Any foreshore protection works will benefit the campground which is managed by QYAC. The majority of the proposed works are likely to be located on State land with some being located within the boundaries of the land parcel.

The legal review highlighted that there are no major legal obstacles that prevent the works from being implemented.

Based on this assessment, the works proposed at the Southern Reach can be implemented. Implementation of the works will need to be organised by the body that benefits from the works. Ongoing consultation is needed between Council and QYAC on the implementation of the recommended works. It is noted that the

recommended works will principally protect the campgrounds, but there is also a community interest in the works where they facilitate public access to the foreshore and where there is Council land and assets.

QYAC also flagged ground water issues as a potential key contributor to the flow slide events. Flow slide events are not yet fully understood and there is more research required to understand them in more detail and to determine what actually causes them. The SEMP was able to recommend the maintenance of the existing flow slide barrier, because it has been shown that it is effective in halting erosion, regardless of the exact cause. However, to increase our understanding of flow slide events, Council has requested that UQ led research considers whether the impact of ground water conditions on flow slide events warrant further investigation. Council is to assist with and support the research into ground water impacts on flow slide events.

7.3 Central Reach

The Amity Point foreshore property owners have been active in protecting their property by dumping rocks on the foreshore whenever a flow slide event occurred. Historically, once a flow slide occurs, the property owners have a mutual agreement which allows for immediate action. Access via neighbouring properties would be provided, acting on behalf of absent residents was agreed and payment for the works would be arranged after rocks were placed. The SEMP recommends legally streamlining these informal agreements in order to guarantee the future effectiveness of the flow slide barrier.

Construction of the flow slide barrier to its current extent and standard has taken many years. Several different materials have been used during those years, depending what was available at the time. The layout of the structure has not been designed, assessed or signed off by an appropriate chartered professional engineer. Currently, there is no Development Application granted for the flow slide barrier. One of the great strengths of the SEMP is that the plan recognises the value of the existing flow slide barrier in the mitigation of the erosion threat. However, a legal framework must be defined to obtain its formal recognition. Furthermore, there is a need to legally define the duties and obligations of all concerned stakeholders in order to ensure the flow slide barrier continues to be functional in the future.

~~7.3.1~~ Ownership and Responsibilities

The flow slide barrier runs continuously along the foreshore of the Central Reach. Consequently, the land parcels on which the flow slide barrier is located are of varied tenures. The tenure of these properties ranges from freehold, reserve (Council), road reserve (Council) and State land. It is important to define where the flow slide barrier is situated relative to land parcel boundaries to enhance clarity of the duties and obligations to maintain the flow slide barrier's functionality.

The maintenance responsibility for the flow slide barrier generally lies with the owner of the land parcel on which the structure is located. However, the majority of the flow slide barrier is located on unallocated state land fronting the private or Council parcels. For unapproved structures (the flow slide barrier is currently still an unapproved structure) the land holder or person who constructed the works without a development permit may be required to remove the works. Once the flow slide barrier is approved (the approval process is set out in this Implementation Plan) the right to construct, use and maintain the works in a safe condition lies with the holder of the development approval for the works. As this is a legislative obligation though, it extends to any subsequent purchasers of the land.

Generally, because the State has no assets at risk and does not fund the protection of private property, the State does not have any direct interest in protecting the land and therefore of maintaining the flow slide barrier. There is no common benefit for the State to protect the land. However, the State does acknowledge the positive impacts of the flow slide barrier if it is maintained properly. Therefore, the State indicated that it would allow Council and private property owners to use and maintain the flow slide barrier where it is located on State land. Formal confirmation would be obtained as part of the approval process, which is detailed in the following chapter.

Council is responsible for all public spaces, such as road reserves and parks. The flow slide barrier on two parks (Old School House Park and Cabarita Park) were recently maintained during the months of September and October 2019.

Specific examples (red outline) are explained below for information only (legend: State land, Freehold, Reserve (Council) and Road parcel (Council); Source: Qld Globe)

1. Responsibility is with the private property owner:

Example A

The flow slide barrier is located within the property boundary of the private land parcel.

Example B

The flow slide barrier is located on Unallocated State land (non-shaded area) fronting the private land parcel. If the private property owner was granted a development permit to construct tidal works on State tidal land the private property owner is granted a right to use and occupy the State land for constructing, maintaining and using the structure and is required to maintain it in a safe condition.

Example C

Similar to Example B, the flow slide barrier is located on state land (tidal non-shaded area and grey shaded lot) fronting the private parcel. This case should be treated the same way than Example B, but will need to be considered in more detail with all relevant state agencies (DNRME and DES) in a pre-lodgement meeting.

It must be noted however, that the adjoining freehold lot has no entitlements to use any part of the state lot for any private use (other than maintenance of the flow slide barrier with all relevant approvals in place). If the adjoining owner wishes to use the state lot for any other private purposes, they would need to make an application to purchase the areas under the Land Act 1994, and pay current market value for the land.

Example D

The flow slide barrier is located on Unallocated State tidal land, Reserve and private property fronting the private land parcel.

In its current state, as Council is not the owner of the works not have the works been approved, Council has responsibility to remove unlawful works or make arrangements with the owner of the lot that receives the benefit to seek approvals. There is no public access to this part of the reserve and there are no public assets in the area of the reserve fronting the private property and therefore there is no common benefit for Council to protect the land and Council should seek to have responsibility for the barrier taken-up by the owner of the lot which benefits from the structure. It is advised for Council to revoke the part of the reserve fronting the private properties[2]. The land can either be handed back to the state and classified as unallocated state land or can be purchased by the freehold owner at market value. Both options would enable the freehold owner to maintain the part of the flow slide barrier protecting their private property (with all relevant approvals in place) as per Example A or B.

2. <u>Responsibility is with Council:</u>

Example A

The flow slide barrier is located within the property boundary of the Council parcel (Road Reserve).

Example B and C

The flow slide barrier is located on State tidal land abutting the Council parcel. Generally, the State will be liable to maintain, however, if Council was granted a development permit to construct tidal works on State tidal land Council is required to keep it in a safe condition.

[2] This might not be required, should the local law be preferred over the covenant. The local law could define waterfront land in a similar way to how it is defined in the Gold Coast Local Law No. 17 - Maintenance of Works in Waterway Areas

Alternatively, another option for maintenance responsibilities of the flow slide barrier is that Council could take responsibility, regardless of the tenure of the land. Maintenance would then be implemented by Council. However, in order for Council to fund the maintenance activities of the whole flow slide barrier, a levy may need to be implemented. A levy is an additional fee on top of the normal rates, that would fund the works on the flow slide barrier. Council may also be taking on liability if the flow slide barrier fails and properties are damaged.

TABLE 7-1 PRO AND CONS OWNERSHIP AND RESPONSIBILITIES

Responsibilities	Advantages	Disadvantages
Responsibility depending on tenure	Close to current (informal) arrangements. Each owner to take care of their property.	Property owners who don't want/ can't pay for maintenance. Additional legal regulations will have to be set into place. New property owners might not be aware of the obligations when purchasing the property.
Council to take responsibility	Easier to obtain rocks from Council quarry. Continuous maintenance of the flow slide barrier assured. Equal spread of costs.	Levy to be placed on property owners. Loss of control for the property owner. Additional management costs would occur. Increased liability for Council.

Council, State agencies and affected landowners were all consulted through this projects' Community Engagement process regarding their preferences. Council and affected landowners were in favour of keeping the maintenance of the flow slide barrier as close to historical arrangements as possible, where the maintenance was organised and performed by the individual property owner. Most State departments are in favour of Council taking control of maintenance - for quality control and efficiency reasons. Quality control can however also be realized by implementing other controls such as training and instructing all contractors that can perform the works on the flow slide barrier and RPEQ and/or Council sign off on constructed works.

7.3.2 Development Application

In order to be able to legally maintain the flow slide barrier it needs firstly to gain a development approval (DA) under the Planning Act 2016. Because it is an existing structure, a development application (DA) will need to be prepared retrospectively.

A permit under the Marine Parks Act will also be required. The works are (partially) located within the Conservation Park Zone of the Moreton Bay Marine Park with HAT (Highest Astronomical Tide) being the boundary of the marine park, with freehold property excluded.

Prior to the DA, owner's consent will be required from the State (DNRME) for properties where the flow slide barrier is located outside of the private property - to address the issue of the flow slide barrier being located on State land. Once owners' consent is granted the DA can be prepared and submitted to SARA (State Assessment and Referral Agency) for referral to relevant State agencies. As part of the approval process, the State can put conditions on the approval of the flow slide barrier, such as implementing a covenant on the property as outlined in more detail in the Section 7.3.3.

There are different ways in which the DA can be prepared and submitted:

1. Council to apply for development approval for the entire structure.

This option avoids the need for the private property owners to navigate through the approval process. However, the DA would span a combination of private, State and Council land - which will make it a difficult DA process. Also, conditions on the DA will be difficult to tie to individual property owners. As highlighted in Section 7.3.1, both Council and residents prefer to maintain the individual management of the flow slide barrier and this would be very difficult to implement with one overarching DA from Council. It also raises the issue as to why Council would take on the liability for a structure that is intended to protect private property.

2. Private property owners and Council to apply for DAs individually for each of their sections of the flow slide barrier.

   This option will ensure that each DA is tailored to the individual lot and the existing land tenures (for scenarios where the flow slide barrier located either on State land or within private lot). Conditions can be imposed on individual property owners. Each individual will be responsible for their section of the flow slide barrier and have the obligation to manage their own risk and to maintain the structure. This arrangement is also the preferred strategy of most State agencies.

   The downside of this option is that it can be difficult for private landowners to navigate through the approval process. This can be overcome by Council guiding applicants through this process. Another complication is with the State-issued Marine Park permit. Unlike other permits, a Marine Park permit applies to the applicant rather than the land parcel for the parts of the barrier in tidal water forming the Moreton Bay Marine Park. This means, should the owner of a property change, then the relevant Marine Park permit would need to be transferred to the new landowner.

3. Another option is for Council to obtain a variation (preliminary) approval for the entire structure. This would seek in-principle approval of the structure, to then be followed by individual property owners submitting a DA for their length of the structure (including detailed engineering drawings).

   This option will make it easier for individual owners to undertake the approval process, but also provides all the benefits of individual DA's as outlined above. The issue of the Marine Park Permit applying to an individual should be addressed in a pre-lodgement meeting.

   A streamlined process like this, lodging all DA's at the same time will provide significant efficiencies for the applicants and the assessment agencies.

The advantages and disadvantages of each option are outlined in Table 7-2.

TABLE 7-2 PRO AND CONS DA APPLICATION STRATEGY

Option	Advantages	Disadvantages
Council to get DA for entire structure	Streamlined process. No obligation for private property owners. No transfer of Marine Park permit required.	Varying land tenures. Conditions to be put on entire structure rather than on individual parcels where conditions might apply. Responsibility is with Council.
Property owners to obtain a DA for their length of the flow slide barrier	Conditions are tied to the individual land parcel. Responsibility is with the individual.	Can be a difficult process to go through by each individual. Preparation, lodgement and assessment of several individual DA's would be required. Transfer of Marine Park permits required in the event of changed ownership.

Option	Advantages	Disadvantages
Council to obtain preliminary approval, then property owners to obtain individual approval	Streamlined process. Conditions are tied to the individual land parcel. Responsibility is with the individual.	Transfer of Marine Park permits required in the event of changed ownership.

Most State departments and Council are either in favour or impartial to individual DA's - with the exception of the Queensland Parks and Wildlife Service (QPWS) which administers the Moreton Bay Marine Park. QPWS prefers one consolidated DA from Council for the entire structure for the reasons outlined above.

7.3.3 Maintenance

Once the flow slide barrier is an approved structure and legally binding maintenance obligations are imposed, maintenance obligations for the flow slide barrier are assigned. The SEMP highlighted that the flow slide barrier will need to be maintained as a continuous structure. Any weak areas (e.g. insufficient rock) will increase the risk of a flow slide event occurring in this area. Protection of the Amity Point foreshore can only be guaranteed if the barrier is maintained properly and topped up after each flow slide event, or following any subsidence or erosion of rock. Most residents have lived in the area for a long time and understand this obligation to maintain an effective flow slide barrier. Should there be an instance where a foreshore landowner does not fulfil the maintenance obligations, Council can compel the owner to undertake maintenance and repairs.

At the moment, maintenance is performed by every individual foreshore property owner on an as-required basis. Many existing foreshore property owners have witnessed flow slide events in the past and understand the implications of the threat to their property and the importance of acting quickly in response to a flow slide event. However, future foreshore landowners may not be aware of this unique threat and the (currently informal) maintenance obligations that come with it. Should any future owner then decide on a wait-and-see approach, it could create a structurally weak section of the flow slide barrier. This could then potentially expose neighbouring properties to an increased risk of a flow slide event adversely affecting their land. Therefore, it is important to formalise and enforce maintenance obligations. These can be achieved by adopting one of the following methods:

1. *Statutory Covenant*

   A statutory covenant is defined under the *Land Title Act 1994* (Qld) and is registered on land title. A covenant is a written agreement between a State/local government and a landholder regarding use of the lot, preservation of a native animal, plant or natural or physical feature of the lot that is of cultural or scientific significance, or restricting future transfer of the land. A covenant is registered on a land title and binds future owners, thereby creating a mechanism to ensure that landholders comply with the obligation. At Amity Point, a covenant may be used where the flow slide barrier is located on privately owned land. However, it would not be applicable where the structure is located on State land. Under that scenario, the Coastal Protection and Management Act 1995 would apply, binding landowners to maintenance obligations through the development application process).

   The covenant obliges property owners to maintain the flow slide barrier, which could fall within 'use of the lot'. This is not clear however, and legal advice from a qualified solicitor should be sought. The advantage of this option is that the obligations of landowners automatically transfer to any new owner once the lot is sold, and the maintenance obligations are evident at the time of sale - due to being registered on the land title.

   Private landholders will need to consent to the covenant to be placed on their title. Generally, during the community consultation, this was seen as beneficial as it enables the landholder to actively impact on

conditions within the agreement (unlike the local law as discussed below). Should applying statutory covenants be the preferred means of formalising maintenance obligations but some residents not agree with this option, a covenant could be imposed on landholdings as a condition in the DA process. It is the responsibility of the landowner to implement the covenant.

2. *Local Law*

   Implementation of a local planning law for the Amity Point locale could be considered. Maintenance obligations could be applied to both State and freehold land, where Council has the authority to oblige landowners to maintain the flow slide barrier. The local law applies to properties where the work/structure is located on (or which receives the benefit of) the prescribed work. If the landowner breaches the local law, Council can enforce compliance. The exact details of the local law would be drafted by Council.

   A local law is not registered on land titles and any new landowner might not be properly informed regarding maintenance obligations prior to the purchase of foreshore land. This could be overcome by implementing procedures into the local law that require disclosure of the local law in the sales contract.

   A local law has been established at the Gold Coast for the construction of a seawall. A step-by-step plan has been set out for any development on beachfront properties, whereby the local law ensures that the development meets the seawall location, construction and maintenance requirements. The Gold Coast City Council's local law contains a clear definition of waterfront land and a disclosure obligation that is intended to alert prospective buyers of relevant lots to the operation of the local law. However, Council can only compel a person to build a seawall when they undertake a major renovation (material change of use) on the property. In the case of the Amity Point foreshore, the flow slide barrier is mostly already built, but is deemed to be unlawful since it requires a DA. The local law could be enforced during the DA process.

   The local law can define the specifics of what is stipulated as waterfront land. This can remove the need for Council to revoke parts of the Old Schoolhouse Park Reserve as outlined in Section 7.3.1

3. *Development Permit*

   As part of the DA process, conditions can be placed on the development. Conditions can oblige property owners to maintain the flow slide barrier. A development approval applies to premises and binds future owners (*Planning Act 2016* (Qld) s 73). However, similar to the local law, this is not registered on the land title and there is no mechanism in place to inform future property owners of those obligations.

4. *Council to have maintenance obligations*

   Alternatively, Council could be responsible for maintenance of the entire flow slide barrier. For this to be financially viable for Council, it would likely require a levy to be put in place to enable Council to fund the work.

The maintenance obligations include regular monitoring of the flow slide barrier, accompanied by periodic 'topping up' of the structure with rocks when required and undertaking emergency works during or following a retrogressive flow slide event. The last two obligations relate to each specific land parcel. Whereas the first obligation relating to monitoring of the entire structure should be funded by all affected stakeholders. It is recommended that Council undertake monitoring of the flow slide barrier (to ensure appropriate quality control and monitoring methodology) regardless of which strategy is adopted with regard to ongoing maintenance obligations and any emergency works to the flow slide barrier. This is the monitoring process advocated for both the Northern and Southern Reaches, with the SEMP recommendation for a three-year monitoring program along the Northern Reach to be implemented and paid for by Council. Advantages and disadvantages are described in Table 7-3.

TABLE 7-3 PRO AND CONS FOR MAINTENANCE OPTIONS

Option	Advantage	Disadvantage
Covenant	Will be registered on land title.	Will come with a cost for the property owner (approx. $200). Clarification should be sought from a qualified solicitor to determine if the flow slide barrier falls within the definitions of a covenant.
Local Law	All property owners (existing and future) will be bound to this law. Council to bear cost for implementation of the local law.	Is not registered on land titles, but the law can include provisions for the local law to be disclosed in property sales documentation.
Maintenance conditions within development application	Indication of maintenance upon approval application.	Not registered on land title, future purchasers may not have knowledge of obligations.
Council to take ownership	Make use of the Council quarry without many legal difficulties. Quality control is maintained.	Levy means that specific residents will have to contribute to maintaining the flow slide barrier, where it might not be directly benefitting their property.

The residents that participated in the consultation process are generally in favour of the covenant as it enables the owner to comment on any conditions that are put in place as part of the covenant because it is an agreed arrangement from both parties. A local law in comparison could change over time with limited opportunity for the individual to shape the changes. Being registered on the title was also seen as a great advantage as it enables all future owners to be aware of the maintenance obligations and should ensure a continuously strong flow slide barrier. Council is also generally in favour of the covenant over the local law.

7.3.4 Access to the flow slide barrier for maintenance/repair purposes

If emergency or maintenance works need to occur to sections of the flow slide barrier, the foreshore should be readily accessible for the appropriate machinery. The legal review undertaken for this project advised for the implementation of a series of easement under the terms of the Land Title Act 1994 (Qld). Access paths can potentially (subject to legal advice) be defined as “public utility easements”, which would allow Council to register easements over private properties.

An easement is described as a right attached to land, which gives another party the right to use a pre-defined section of the land for a specific purpose - even though they are not the landowner. It is registered on land titles. To register an easement, a survey plan is needed depicting the physical extent of the easement. Parties may also negotiate specific terms (e.g. that grass/garden beds if destroyed by machinery accessing a flow slide location during an emergency response to an event) must be reinstated. Property owners must not obstruct any easement. If the property owners wish to build on an easement, they would need to negotiate with Council to obtain formal approval. An easement is not designed to allow unauthorised persons to traverse the property, or to declare a portion of the property as Council land. It will be defined as the right to use the land for a specific purpose, such as for emergency or maintenance works on the flow slide barrier.

Some sections of the flow slide barrier can currently be accessed from public roads through private properties. However, the flow slide barrier along the frontages of some properties will have to be accessed by heavy vehicles traversing through neighbouring properties. In the past, private property owners had informal agreements in place whereby access was approved, and any damages caused were rectified to the cost of the landowner undertaking the works to their section of the flow slide barrier. This has relied on the goodwill of the neighbouring residents. Nevertheless, formal agreement is required to ensure that all future property owners provide access for maintenance and emergency works, and these make-good requirements are formalised.

A 3.5-metre-wide easement is proposed to allow for access of trucks and excavators. This width does not provide a turning area and trucks will need to be backed up when delivering rocks to the flow slide barrier. This will need to be incorporated on appropriate cadastral plans. The easement should be located directly behind the flow slide barrier for ease of construction and to limit the size of easements required, however, this area is prone to erosion. Should part of the easement erode in the future alternative access would need to be determined. **Error! Reference source not found.** and **Error! Reference source not found.** provide an indicative overview of where easements might be required. A detailed assessment and negotiations will need to be undertaken with the affected group of residents in between the road ends.

The need for easements is understood by all owners that participated in the consultation process and they are generally in agreement with establishing easements to enable access.

FIGURE 7-1 INDICATIVE ACCESS ROUTES AND EASEMENTS – NORTH

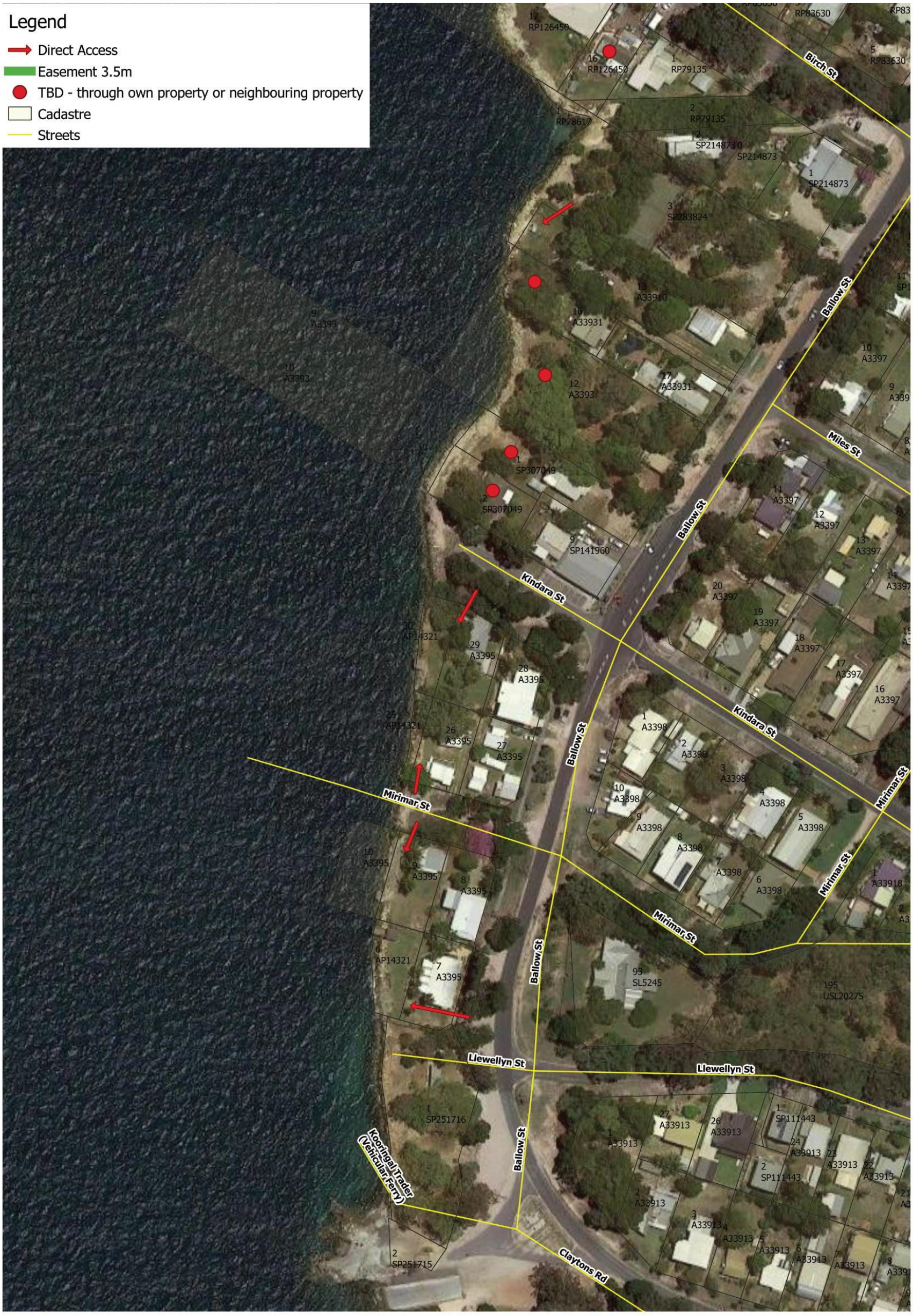


FIGURE 7-2 INDICATIVE ACCESS ROUTES AND EASEMENTS - SOUTH

7.3.5 Rock Sourcing

Maintenance and emergency work on the flow slide barrier will require a rock source. Previously, rocks have been sourced from two local island-based quarries. To date, rock used for construction of the flow slide barrier has been appropriate and of good quality.

7.3.5.1 Council quarry

Previously, the Council quarry has provided rock for repairs and enhancement of the flow slide barrier. To operate the quarry, a third party is engaged to load the rock and transport it to the Amity Point foreshore. Council has a sales permit valid until 2020. This permit (in principal) allows Council to sell rock from this quarry. As the sales permit is only valid till next year, Council will need to seek an extension of this permit. During this process it should be clarified and determined in writing within the sales permit document that the renewed sales permit allows Council to sell the rock to third parties. For the implementation plan to work Island based rock supply is required. Therefore, Council will need to be pro-active in managing the quarry, ensuring sufficient and qualitative rock supply and establishing a stockpile in the quarry. Blasting needs will need to be identified well in advance to ensure the rock supply. Council will also need to ensure that all the right permits are in place on an ongoing basis.

Regardless of the sales permit arrangements, Council is permitted to use rock for its own purposes (such as for maintenance of the flow slide barrier on Council land). This means should Council have maintenance obligations of the entire flow slide barrier (see chapter 7.3.3), the rock can be supplied in accordance with the sales permit. However, a financial mechanism may need be put in place to recoup any costs (e.g. levy).

Council has established an internal procedure to enable the provision of rock to foreshore property owners during and following a flow slide emergency. A strong recommendation of the SEMP is for rock reserves in the flow slide barrier to be proactively managed. This means supplying rock to at-risk sections of the structure identified by the monitoring (bathymetric survey). Council's procedure should be expanded to also allow for rock supply to those at-risk sections.

The emergency rock supply procedure enables residents to use rock from the Council quarry for protecting foreshore properties at Amity Point if a rock slump or movement is detected. The procedure is currently drafted as follows:

1. After a slump or movement is detected, the Owner must contact Redland City Council. A Council officer will arrange a time to inspect the property to determine the extent of the emergency before the rock will be made available to the Owner.
2. If rock is made available for emergency work, the work must be done in accordance with Safety Management Plan that forms part of the Amity Point Shoreline Erosion Management Plan (**SEMP**) (appendix G). A copy of the SEMP is available for download at https://yoursay.redland.qld.gov.au/18927/documents/108068. Additionally, owners are advised they are responsible for the relevant State Agency notifications, including where it is proposed to enter the Moreton Bay Marine Park.
3. Rock will only be supplied to Owners whose land immediately adjoins the foreshore at Amity Point.
4. Owners are responsible for organising all works, including all costs incurred for the purchasing, sorting, loading, transportation and placement of rock.
5. It is the Owner's responsibility to ascertain quantities of rock required.
6. The Owner is responsible for ensuring that all necessary insurances, approvals and or permits are obtained prior to commencement of work. Owners should be aware that work may require other approvals, including from Council.

7. Works using Council-supplied rock must be carried out by an approved contractor nominated by Council.
8. Any persons accessing Redlands City Council Fisherman quarry must have Sibelco cross lease induction and site induction for Fisherman Quarry prior to works starting.
9. Applications to access this rock must be made by using form CSOM 002 NSI and signing the Indemnity form these can be obtain at (TBA) the cost of rock for 2019-20 has been set at $15.00 per cubic metre gst inclusive.
10. The supply of rock is subject to change and availability.

7.3.5.2 Private Island quarry

It is understood that most of the rock provided to the flow slide barrier originated from this Private quarry. While there is appropriate rock of sufficient quality available in this quarry, Council will need to liaise with State agencies to assess if this rock is available as a rock source into the future.

7.3.5.3 Mainland-based

As discussed in the preceding Section 5.3, a local rock source should be the first preference when undertaking works on the flow slide barrier - since it provides the most timely and cost effective source. However, a mainland-based quarry source has also been investigated.

There are no adverse legal implications to this option. However, it is not favoured because of its high cost, adverse environmental impacts (long transport routes cause high carbon dioxide emissions) and adverse social impacts (haulage of heavily laden construction vehicles on major roads through and residential streets). Sourcing rock from the mainland will also mean that a local stockpile location will need to be made available. This is unfavourable in light of the rock available on the island.

7.3.6 Stockpile Location

Should rock be sourced from the Island, there is no need to have a local stockpile located at Amity Point. The relevant quarry will suffice as a stockpile location. A stockpile location is however required should mainland-based rock be used. Legal and environmental implications make it difficult to find a suitable location at Amity Point. Most of the State-owned land parcels around Amity Point are on the list of non-exclusive native title areas. There are also time implications as the establishment of a new local stockpile location requires long timeframes for planning and establishment. Therefore, even if mainland rock is sourced, one of the island-based quarries should be the preferred emergency stockpile location.

As highlighted under the rock sourcing chapter, exploring all island-based options should be the first priority. Further investigation into local stockpile locations should only be pursued if it has been determined that both island-based rock quarries are unable to supply rock to the flow slide barrier and cannot stockpile rock from the mainland. In that case, alternative materials such as concrete blocks can also be explored.

7.3.7 Transport and Placement

The two local companies on Stradbroke Island that can currently transport and place armour rock are Meithke Earthmoving and Mazzoni Plant Hire. Each of those contractors understand the importance for repair works to the flow slide barrier to be undertaken as quickly as possible following the commencement of a flow slide and in the past have generally been available at short notice to respond to such events. QYAC has also expressed an interest to be involved in the rock supply. However, until more details are known as to QYAC's plans and commercial arrangements, it is assumed that only those two companies will available in the short-term.

Mazzoni Plant Hire is currently an approved and inducted contractor to transport and place rock from the Council quarry. However, it is recommended that Council establish standing agreements with both contractors

to improve the likelihood of having a contractor available at all times as well as enabling a healthy competition to ensure affordable prices to the residents. At times of a big flow slide event it might even be required to have both contractors operating at the same time.

In the past, most rock was sourced from the Private quarry which was operated by Meithke Earthmoving. That contractor also provided transport and placement of rock. Common procedure in the past whenever a flow slide caused damage to the flow slide barrier was for affected landowners to call Meithke Earthmoving to arrange the purchase, transport and placement of rock. Since recent native title determinations, and Meithke Earthmoving no longer operating the Private quarry, there are now more parties involved in the recommended transport and placement procedure. While Council is overseeing the Council quarry, a contractor is doing the transport and placement of the rock. This highlights the need for an emergency response plan to ensure that all stakeholders and rock supply contractors understand their obligations and required actions, to have contact arrangements and backup plans on hand in case of a flow slide emergency. The emergency response plan is included in Chapter 9.

7.3.8 Monitoring

The Amity Point SEMP recommendations include an annual bathymetric survey of Rainbow Channel and an annual structural audit of the flow slide barrier.

There are theoretically two options for undertaking the survey and audit, either as a whole by Council or on an individual basis. However, the practicalities of undertaking the monitoring works as a whole far outweigh the individual monitoring due to economies of scale and consistency in quality and timing of the works. It is therefore recommended to undertake all monitoring works for the whole structure.

All other implementation strategies discussed above support the individual ownership and maintenance and there is no support for a levy from the local residents. Therefore, it was investigated if Council could bear the cost for monitoring of the whole flow slide barrier. The annual cost of monitoring are estimated to $25,000. This is not considered too onerous for Council to fund the monitoring in the central reach. This would also provide the same level of service that is provided to the northern reach where an ongoing 3-year monitoring program is to be funded by Council.

7.3.9 Cost sharing

Cost sharing arrangements will vary depending on the preferred implementation strategy and are outlined in more detail in chapter 8.2.

7.4 Northern Reach

The SEMP recommendation for the Northern Reach is for continuous monitoring of the shoreline and undertaking a detailed coastal process assessment to better understand the erosion processes.

The technical review undertaken for this Implementation Plan confirmed that this strategy is appropriate for the location. The legal review highlighted that there are no legal obstacles that prevent the recommendations from being implemented. Based on this assessment, the works proposed at the Northern Reach can be implemented by Council.

In the meantime, should they wish to do so residents can construct coastal protection works within their property boundary provided the relevant approvals are obtained. They can also perform minor works such as restricted beach re-profiling or beach nourishment with relevant approvals in place.

8 IMPLEMENTATION PLAN

This chapter provides an outline of the recommended implementation plan. While the previous chapter presents and outlines all options, this chapter describes the recommended way forward.

8.1 Southern Reach

The recommendations for the Southern Reach are:

- Structural audit of the existing groynes and seawalls.
- Construction of additional seawalls.
- Beach nourishment within the beach pockets.

The financial analysis showed that there is a positive benefit to cost ratio to implement the works. This means that there is a benefit in following the recommendations from the SEMP despite the initial costs for the works. There are no technical or legal hindrances in implementing the works. It is therefore recommended to implement the Amity Point SEMP recommendations.

In general construction and maintenance of erosion control works is the responsibility of those parties that will benefit from the works. Landowners have a responsibility to manage that erosion impacting land they own and manage, while Council has an interest in managing erosion impacts on their assets and on public facilities.

8.2 Central Reach

The recommendation was given to support and enhance the effectiveness of the current erosion management practice. This means, repairing damage to the existing flow slide barrier and reinstating the foreshore whenever necessary (following a flow slide event) by placing additional rock armouring.

The recommendation has been split up in several steps, which are listed below:

a. Adopting the flow slide barrier as the necessary coastal protection work.

b. Recognition of the flow slide barrier and seeking formal approval as substantially completed tidal works.

c. Monitoring the flow slide barrier regularly to identify weak spots and to inform structural reinforcement and repair needs.

d. Formalise a maintenance regime to preserve the integrity and function of the flow slide barrier.

The Amity Point SEMP was endorsed by Redland City Council in 2019. This means that the flow slide barrier has been adopted as the necessary coastal protection work. In addition, the technical review contained in this report confirms this approach and the financial analysis found that there is a significant financial benefit to implement the recommendations (maintain the flow slide barrier) from the SEMP, compared to the “Do Nothing” option.

Steps b. to d. are discussed in more detail within this implementation plan.

Based on the technical and legal review of the SEMP recommendations, the emergency rock supply source and the financial analysis discussed in the previous chapters 4-6 a number of management options have been assessed and discussed in detail in Chapter 7. As such, the below outlined implementation plan is based on the technical viability and effectiveness, the fair and equitable allocation of costs and benefits and also the preferences of landowners, Council and State Government Departments. Extensive stakeholder consultation has been undertaken and informed the SEMP Implementation Plan throughout all the different stages.

In order to implement the SEMP recommendation in the central reach the following options and actions are recommended:

Ownership and responsibilities

The flow slide barrier is crossing various land tenures, Council, State and freehold. Generally speaking, two options have been considered in terms of ownership and responsibilities, Council to own and maintain the structure or the individual. Should Council be the owner of the flow slide barrier and be responsible for maintenance a cost recovery scheme (e.g. a levy or body corporate) would need to be established. Stakeholder consultation identified a clear preference from both, Council and freehold landowners, for individual ownership and responsibilities. This is also in line with how the flow slide barrier was managed in the past. Therefore, it is recommended to maintain the individual ownership of the flow slide barrier.

Development Application

Formal approval of the flow slide barrier is required to ensure continuous maintenance. A number of different pathways have been investigated. The recommended approach is for Council to obtain a variation approval for the whole flow slide barrier to seek in-principle approval of the structure, followed by the individual property owner to obtain a formal development approval for their section of the structure. This is the recommended approach to maintain a relatively simple process for the individual, to streamline the approval process and to maintain the individual ownership and responsibilities identified above.

In order to proceed with this recommended pathway owners consent by DNRME will be required first. A Marine Park permit will also be required.

Actions:

1. Request Owners Consent from DNRME.

2. Council to prepare an application to seek a preliminary/variation approval for in-principal support for the whole flow slide barrier and advice on Marine Park permits.

3. Council to seek pre-lodgement advice from SARA.

4. Council to provide detail of the variation approval and pre-lodgement advice to assist landowners as they prepare site specific development applications and Marine Park Permits.

5. Individual landowners to prepare and submit a development application for the section of the flow slide barrier protecting their property following approval of a variation/preliminary approval (or as otherwise required by legislation).

Maintenance

To ensure ongoing maintenance of the flow slide barrier from current and future land holders a mechanism has to be put in place that legally binds the individual owner to perform maintenance. It is expected that the flow slide barrier is moving and adjusting to any flow slide events happening in the area. Any weaknesses in the flow slide barrier will expose that location to increased movement and erosion of the abutting land. Ongoing maintenance is therefore of very high priority.

A covenant has been identified as the most suitable mechanism to implement maintenance obligations on current and future landowners. This has also been confirmed during stakeholder engagement activities (November workshop), however, it should be noted that not all affected residents participated in the consultation process. A covenant is a voluntary agreement and signature from both parties, the covenantor (owner of freehold land) and the covenantee (State or local government) is required. Should a covenant not be able to be implemented with all relevant parties a local law would need to be established. In addition to the covenant or local law maintenance obligations can be put on the individual landowner by means of DA conditions.

Actions:

1. Council to consult with all affected properties to establish covenants for ongoing maintenance of the flow slide barrier. It is the responsibility of the landowner to action the covenant.

2. Individual landowners to continue maintaining the section of the flow slide barrier protecting their land as provided for in their development approvals or the emergency management procedure.

Access

Access to the flow slide barrier for maintenance activities can be limited and access via neighbouring properties is required in some cases. Access should be established via easements. Indicative maps have been prepared to identify where easements might be required. This is based on past practices and existing arrangements between neighbours. Some affected properties require detailed clarification to ensure that either sufficient access is available via the property itself or via an easement across a neighbouring property.

Actions:

1. Council to consult with all affected properties to determine the exact location of easements. It is the responsibility of the landowner to implement the easements.

2. Landowners to assist with the formalization of access to the flow slide barrier for maintenance activities by the granting of easements as necessary.

Rock sourcing

The rock supply study found that there are no technical issues with the sourcing of suitable rock from the island. However the appropriate permits will need to be renewed to ensure the ongoing availability of rock from island-based quarries. It is important for the implementation of the SEMP that there is continuous and affordable supply of rock. The best option for this at the present time is Councils quarry.

Council has established an emergency rock supply procedure to enable the provision of rock from the Council quarry for emergency repairs to the flow slide barrier.

No local stockpile location at Amity Point is recommended, instead, sufficient rock will need to be stockpiled in Councils quarry to be readily available for emergency works as well as pro-active maintenance works.

Actions:

1. Council to take all reasonable steps to ensure to the best of its ability that the relevant sales permits and access arrangements are in place to facilitate the continued supply of rock from Councils quarry.

Emergency Works Procedure

An interim emergency works procedure is required to ensure timely and smooth action in a flow slide event before all recommended strategies are implemented. An emergency works procedure has been drafted in chapter 9.

Actions:

1. Council to establish and communicate emergency works procedure with all affected freehold landowners.

2. Council to take reasonable steps to provide access to rock from Councils Quarry for landowners to undertake emergency repairs. (Noting that there might be circumstances where Council cannot guarantee rock supply due to statutory and technical complexities to the operation of the quarry.)

3. Landowners to follow emergency works procedure including any necessary notifications and approvals.

Transport and Placement

Two companies are capable, available and have experience in transporting and placing rock on the flow slide barrier. Currently only one company is inducted in the quarry which is required to be able to take rock from the Council quarry. It is recommended that both companies are inducted so that both can access rock from the quarry and perform the transport and placement of it. Should additional resources become available in the future they should also be inducted.

Actions: 1. Council to make available inductions and standing agreements with all available transport and placement contractors on the island.

Monitoring

An annual bathymetric survey of Rainbow Channel and an annual structural audit of the flow slide barrier is recommended in the Amity Point SEMP. Due to the nature of this work and benefit of scales it is recommended that the monitoring to be undertaken for the whole flow slide barrier at once and to be organised and funded by Council. This report contains a similar recommendation for the northern reach (Chapter 8.3) and therefore provides consistent services to both reaches. The outcomes of the structural audit will need to be shared with all affected property owners and should contain clear instructions should pro-active maintenance be required.

Actions: 1. Council to undertake annual bathymetric survey and structural audit.

2. Share findings with all affected freehold landowners.

Cost sharing arrangements

The majority of the stakeholders prefer to maintain the management of the flow slide barrier as similar as possible to past arrangements. This means, no centralised management but individual ownership and responsibilities. Landowners want to maintain control over their part of the structure as well as control and manage their own expenses. In line with this any works will need to be funded by the individual landowner, including but not limited to the costs involved to prepare and gain approvals, covenants and easements, as well as performing and paying for maintenance, including the rock supply and transport and placement.

Council is expected to bear the costs for their land parcels (e.g. road ends and parks), establish arrangements to enable them to sell rock to third parties as well as organising and funding the monitoring for the whole flow slide barrier.

8.3 Northern Reach

The SEMP recommended strategy for the Northern Reach is:

- 3-year Monitoring Survey Program
- Coastal process assessment to determine necessity for erosion mitigation strategy
- Following conclusions of the assessment continuation of the Monitoring Survey Program

It is recommended that Council start implementing those works as there are no technical or legal issues identified in pursuing this strategy.

Council has been in ongoing dialogue with University of Queensland to conduct additional research at Amity Point and they will continue to do so.

In the interim, property owners are able to investigate possibilities for erosion mitigation options. For example, beach nourishment and beach re-profiling can be undertaken with the relevant approvals in place. Residents can also consider building their own coastal protection works within their lot provided that they are granted the

necessary approvals for such works. A communal approach regarding the design and construction of such a structure would be highly recommended to reduce costs and increase effectiveness.

Actions:

1. Start the 3-year Monitoring Survey Plan this financial year.
2. Undertake coastal process assessment after conclusion of the 3-year monitoring program
3. Continue dialog with UQ
4. Council to support residents in the approval process should they choose to pursue their own protection works.

9 RECOMMENDATIONS FOR IMPLEMENTATION OF EMERGENCY WORKS PROCEDURE

The below outlined Emergency Works Procedure is an interim plan to provide rock to residents in an emergency. It is required to ensure timely and smooth action in a flow slide event and to provide clarity to all affected residents.

The procedure describes the steps the affected residents must follow once a flow slide event has been detected. It is the aim to ensure all residents (temporary and permanent) understand what they must do and who to contact. It must be highlighted that properties are not always occupied by the owner, but by permanent (long term lease) or temporary (holiday rentals) tenants. Therefore, it is recommended to prepare fridge magnets (Figure 9-1), handouts and to place this procedure on Council's webpage to ensure that everyone is aware of the flow slide events and what to do when one is encountered. It should also be considered to place signs along the flow slide barrier in the vicinity of holiday rentals. It is important that the registered operator, inducted contractor and affected property occupant and owner act in a timely manner.

Contact details, phone numbers and email addresses should be obtained from all affected properties so that arrangements can be made in a timely and efficient manner, especially when access via other properties is required.

FIGURE 9-1 EXAMPLE FRIDGE MAGNET

TABLE 9-1 PROVISIONAL EMERGENCY WORKS PROCEDURE

Step	Action	Responsibility	Comments
1	A flow slide event is observed and movement is detected in the flow slide barrier.	Resident	-
2	Landowner (or authorised representative) is to assess and determine if a threat to the flow slide barrier requires emergency works under the Safety Management Plan for the Amity Point Flow Slide Barrier (Appendix G of the Amity Point SEMP).	Landowner (or authorised representative)	This will enable Council to release rock in a timely manner. Council should review this arrangement if it becomes clear that works are being done in situations that are not emergencies. Landowners to consider, and seek advice on whether they authorize another party to act on their behalf when they are not present or contactable and emergency works are required to the flow slide barrier on or adjoining their property.
3	Landowner (or authorised representative) contacts Council on Ph 3829 8999 to request that rock is made available for emergency works to the flow slide barrier. Landowner (or authorised representative) to: - Confirm that threat is consistent with a situation identified as requiring emergency works that the Amity Point Safety Management Plan. - Confirm that works will be carried out according to the concept design for a flow slide barrier contained in the Amity Point Safety Management Plan. - Confirms that they understand the legislative requirements for notification and approvals for emergency work under S166 of the Planning Act.	Landowner (or authorised representative)	-
4	Council to establish an internal procedure to direct calls in regards to a rock wall emergency at Amity Point to one specific team that is trained to deal with those instances and with on-call officers to be able to respond 24/7: - Council to notify Council quarry (and inducted contractor(s)) of emergency works requirements	Council	Lines of communications will need to be established. Owner, quarry operator and contractor will need to be contactable 24/7.

Step	Action	Responsibility	Comments
5	Landowner (or authorised representative) to organise works (quantity, sorting, loading, transport and placement of rock) by a contractor authorised to access Council's quarry.	Landowner (or authorised representative)	Quality Assurance to be implemented, documentation of event required (date, time, rock quantities etc.).
6	Landowner (or authorised representative) and contractor to undertake works in accordance with the specifications of the Amity Point Safety Management Plan.	Landowner (or authorised representative)	-
After the flow slide event:			
7	Make good of all impacted sites (turfing, fencing etc.), including areas that were used for access.	Landowner (or authorised representative)	-
8	Payment for the works to all relevant parties (e.g. contractor for transport and placement, Council for the rock - rates as per fees and charges schedule).	Landowner (or authorised representative)	-
9	Notify Council and any relevant State agencies and seek approval for the works as required under the Planning Act.	Landowner (or authorised representative)	Letter or email to Council to state the details of the event (extent, rock quantities etc.).

10 REFERENCES

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WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

APPENDIX A
COMMUNITY ENGAGEMENT PLAN

WATER TECHNOLOGY
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APPENDIX B
TECHNICAL REVIEW

Introduction

I have been asked to provide a "comprehensive review of the recommended management options'' provided by the Amity Point Shoreline Erosion Management Plan" (the SEMP), (Water Technology, 2019). The purpose of the review is "to understand the context of the recommendations made in the SEMP", and assess "whether the recommended management options apply an unreasonable obligation, level of responsibility, liability or risk to Council, QYAC, State Government or property owners."

A key consideration for the purposes of this review is that the SEMP is a relatively short to medium-term management plan with only a 20-year planning horizon. This provides an opportunity for monitoring and review of the effectiveness of the plan before committing to longer-term management strategies.

Background

There is significant tidal exchange through the channels between North Stradbroke Island and Moreton Island. A significant proportion of this exchange occurs through Rainbow Channel which flows along the western side of North Stradbroke Island. Analysis of historical hydrographic surveys, going back to 1892, has shown that Rainbow Channel has been slowly migrating eastwards toward the northern end of North Stradbroke Island. This has been the principle cause of the erosion issues that have persisted at Amity Point over many decades.

The SEMP has been developed to address the erosion issues at Amity Point. It has been developed for what have been called three "coastal precincts", extending from the southern end of the Amity Point Camping Ground to the northern tip of North Stradbroke Island, as shown in Figure 1. From south to north, these precincts have been defined as follows:

Southern Reach: the foreshore frontage of the camping ground and boat ramp:

Central Reach: along the rock-armoured foreshore north of the boat ramp: and

Northern Reach: the sandy foreshore of Amity Beach

The SEMP notes that the coastal processes in each of these precincts are not "compartmentalised", but that the separation into the three coastal reaches *"lends itself to the development of viable erosion management strategies that integrate over the entire Amity Point coastal reach".*

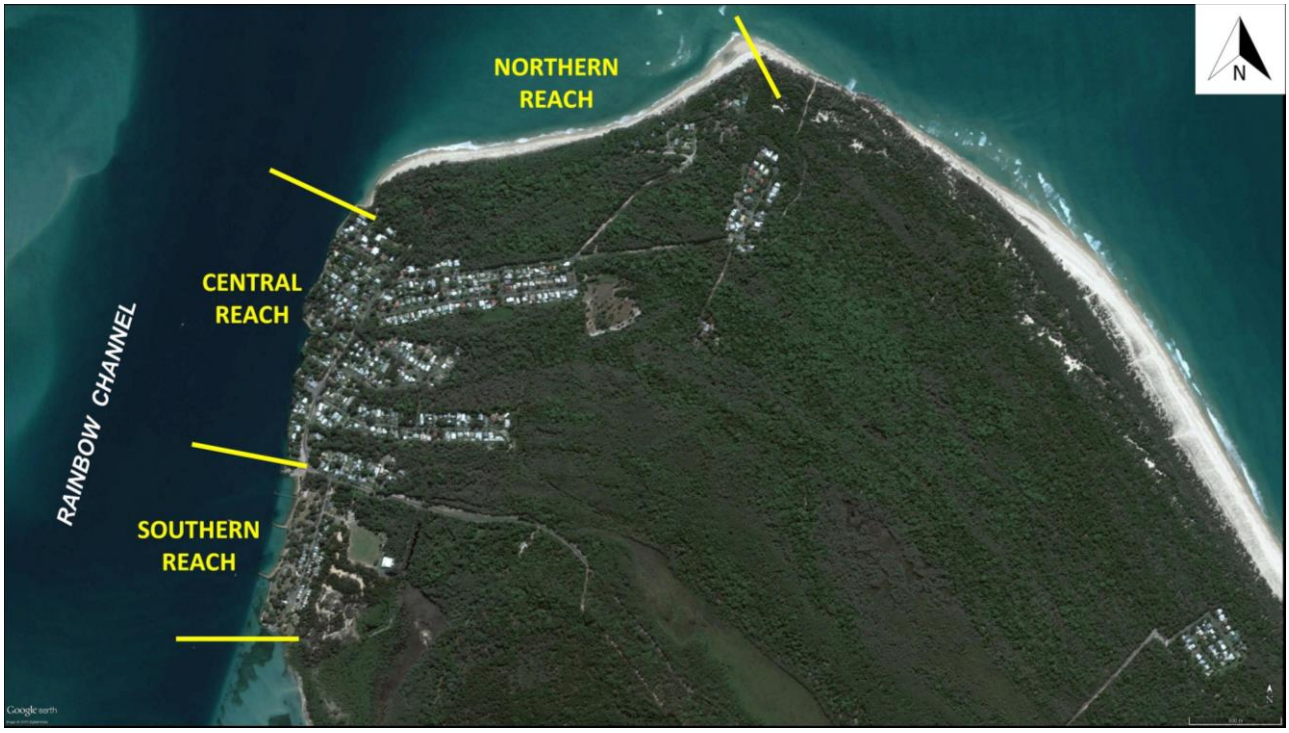

FIGURE B-1 COASTAL REACHES FOR THE AMITY POINT STUDY AREA (WATER TECHNOLOGY, 2019)

Previous Work

A Shoreline Erosion Study of the area had previously been carried out by BMT WBM (2013). This study investigated the local coastal processes and considered a range of social, environmental, cultural and economic values; and identified a range of erosion management options. The preferred erosion mitigation strategies for each of the precincts considered above were:

- Southern Reach: beach nourishment was the recommended management strategy for this precinct. This would *"provide added protection to the assets and minimise the need for other structural protection measures in the future"* and would *"retain natural processes and provide an improvement to the beach amenity"*.
- Central Reach: planned retreat was the recommended strategy for this precinct as it was considered to have the *"highest likelihood of success, lower cost and will leave the foreshore in a natural state"*.
- Northern Reach: The *"do nothing"* option supported by monitoring of the *"location of the shoreline"* was the recommended strategy for this precinct.

The SEMP notes that the planned retreat for the Central Reach (i.e., along the frontage of Amity Township) met with considerable opposition from the local community.

The SEMP

The purpose of the present SEMP is to set out *"an agreed framework and management strategy for responding to existing erosion problems and possible future erosion threats"* at Amity Point. It has been developed through consideration of *"the physical coastal processes"* occurring in the area *"in conjunction with the environmental, cultural, social and economic values of the shoreline"*.

I have reviewed the SEMP in detail and agree with the overall methodology used in its development.

Coastal Processes

The mechanisms driving the coastal processes in the area are well described in the "Physical Processes" section of report. In summary, the main factors are:

- Wave action, particularly along the more exposed eastern and northern coastline of North Stradbroke Island;
- Tidal exchange currents between North Stradbroke Island and Moreton Island; and
- The eastwards migration of Rainbow Channel.

There is a westward supply of sand to the Northern Reach from around Amity Point in the east. Historically, this westward supply of sand would have continued southwards along the Central and Southern Reaches.

The eastward migration of Rainbow Channel has, however, resulted in the eastern edge of the channel impinging directly on the coastline of the Central Reach. This has resulted in the once sandy foreshore of this reach becoming eroded. This in turn has resulted in a reduced supply of sand to the Southern Reach, causing subsequent erosion in this area as well.

Erosion of the shoreline along the Central Reach has been accompanied by what has been termed "retrogressive flow slides". These are sudden events where large sections of the coast have subsided into the channel.

Management of Retrogressive Flow Slides

In my opinion, the ability (or potential inability) to manage erosion caused by retrogressive flow slides is the key to the SEMP.

The current management practice is to dump rock to protect exposed coastline at the site of each flow slide, as and when they occur. Over time this has resulted in a continuous rock wall protecting the entire length of the coastline of the Central Reach. The SEMP contends that this rock wall acts as a flow slide barrier that either prevents the initiation of further flow slides occurring or inhibits the level of their destructiveness.

Flow Slide Barrier Concept Design

The SEMP then draws on "international research" to develop a "Concept Design" for a flow slide barrier. The concept design includes descriptions of the key requirements of a flow slide barrier in relation to rock size; barrier thickness; barrier slope or gradient; provision of toe protection; and provision of reserve "top-up" rocks to mitigate any damage that may be initiated by a flow slide. This section of the report could be enhanced by providing references to the actual research used in developing the Concept Design.

The Existing Rock Wall

The SEMP includes a detailed description of a structural audit of the existing rock wall along the Central Reach. From the results of the audit, it is noted that the existing structure is consistent with the Concept Design of a flow slide barrier and, as such, it is appropriate to consider the existing wall as being a flow slide barrier. Other findings include:

- There are many locations in deep water in front of the existing barrier where flow slides could be initiated;
- The foreshore opposite Old School House Park is the only location along the Central Reach where a flow slide might undermine and damage existing barrier; and
- The potential for damage to the barrier at Old School House Park could be mitigated by proactively placing additional rock to act as a top-up reserve consistent with the Concept Design.

Coastal Risks

The SEMP analyses the erosion risks along each of the coastal reaches. These have been summarised briefly below.

B-1-1 Southern Reach

With the reduced supply of sand from the north, rock groynes have historically been built along this section of coast in an attempt to control erosion. Of the approximately ten groyne that existed in the1970s, there are currently three remaining groynes. With the prevailing southwards littoral drift, there is build-up of sand immediately to the north of each groyne, and erosion to the south. A steady loss of sand from the beaches in this reach has resulted in at least one beach nourishment operation being carried out in recent years.

Shoreline modelling has shown that an extreme storm event could result in shoreline recession in the order of 20m along the sandy beach sections of coastline. Modelling has also shown, that in areas where the coastline is protected by seawalls, the seawalls could be at risk of undermining.

Analysis of aerial photography has shown that the nearshore region of this section of coastline can be at risk of retrogressive flow slides. With the low supply of sand form the north, depressions resulting from flow slides may remain evident for many years. The threat of flow slides is expected to increase in the future as Rainbow Channel continues to migrate eastwards.

Central Reach

The main threat to the Central Reach coastline is from retrogressive flow slides caused by the eastward migration of Rainbow Channel. The rock wall that has been progressively constructed in response to historical flow slides has now become an effective barrier to further flow slides in the area. The foreshore opposite the Old School House Park is the only area where the barrier is currently at risk of undermining by a flow slide.

Northern Reach

There is a westward supply of sand to this section of coastline from around the northern tip of North Stradbroke Island (i.e., the eastern end of the reach). The coastal processes in the area are, however, complicated by the periodic development and removal of a sand spit and associated offshore bars at the eastern end of the reach. As such, there is a need for a greater understanding of these local coastal processes.

The western end of this reach is also susceptible to the effects of retrogressive flow slides. This susceptibility could be expected to increase with further eastward migration of Rainbow Channel in the future. It is noted, however, that any depressions in the foreshore and nearshore bathymetry are infilled relatively quickly by the westward supply of sand along this section of coastline.

Recommended Erosion Management Strategies

The SEMP reviews the Guiding Principles for shoreline erosion management and describes the main non-structural and structural options available for managing erosion at Amity Point. An assessment is then carried out to determine the most appropriate management option for each of the coastal reaches under consideration.

Southern Reach

"*The recommended erosion mitigation strategy along the Southern Reach is to undertake beach nourishment within each of the three existing beach compartments; and to construct cut-off seawalls behind each beach where an appropriate structure does not already exist*"

This strategy includes beach monitoring (through annual beach surveys) and maintenance of the nourished beaches on an as needs basis. It also includes annual bathymetric surveys to monitor the rate at which Rainbow Channel is migrating eastward and thereby potentially increasing the risk of flow slides adversely affecting the foreshore.

A minor point missing from the strategy is that there is no contingency for the possible need to reinstate part or all of a groyne should it become affected by subsidence due to a flow slide.

The recommended strategy is consistent with the recommendations of the previous Shoreline Erosion Study carried out by BMT WBM (2013).

Central Reach

"The recommended erosion mitigation strategy for the Central Reach is to support and enhance the effectiveness of the current erosion management practice of repairing damage to the existing flow slide barrier whenever necessary following flow slide events - by placing additional rock armouring."

This strategy includes an annual structural audit of the flow slide barrier using information from an annual bathymetric survey of Rainbow Channel.

The recommended strategy is, however, at odds with the "planned retreat" approach that was the recommended in the previous Shoreline Erosion Study carried out by BMT WBM (2013). The main source of the discrepancy is that the earlier work of BMT WBM (2013) considered that a structural solution would require *"the design and construction of a full rock revetment at an estimated cost of $15M"* and that there would be *"the expectation that this will need to be extended in the future as Rainbow Channel continues to realign"*.

The great strength of the current SEMP is that it recognises the value of the existing rock wall for providing a barrier to further subsidence caused by flow slides. This provides a relatively low-cost option for maintaining the existing coastline, at least for the medium-term.

Northern Reach

"The recommended erosion mitigation strategy along the Northern Reach is to maintain the existing strategy of non-intervention, but to monitor future shoreline behaviour."

This strategy includes detailed twice-yearly beach surveys for the first three years. This is to be followed by a Coastal Processes Assessment to determine future monitoring requirements and the need (or otherwise) for the development of an erosion mitigation strategy.

The recommended is strategy is consistent with the *"do nothing at this time and monitor"* recommendation of the previous Shoreline Erosion Study carried out by BMT WBM (2013).

Conclusions

My main conclusions are as follows:

- For a 20-year planning horizon, the recommendations provided in the SEMP are appropriate and manageable and should not place unreasonable obligations on any involved stakeholders.
- A potential issue for the implementation of the strategy for the Southern Reach is the need for a suitable source of sand for beach nourishment and for a suitable source of rock for seawall construction.
- A great strength of the current SEMP is that it recognises the value of the existing rock wall as a "flow slide barrier" for providing a low-cost option for reducing the risk of further subsidence caused by flow slides along the Central Reach.

- The implementation of the recommended strategy for the Central Reach will, however, be dependent upon:
  - The development of an appropriate funding arrangement for future maintenance works;
  - The development of formal agreement between foreshore property owners to provide access that may become necessary for future repair work to the flow slide barrier; and
  - The availability of suitable rock for emergency repair works and the ability to carry out these works as soon as possible after a flow slide event.
- The inclusion of the Coastal Processes Assessment after the first three years of the implementation of the Northern Reach strategy will provide an opportunity to review the situation, based on the more detailed data provided by the monitoring program.

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