MACKAY REGION FLOOD AND STORMWATER STRATEGY

Executive Summary

The Mackay Flood and Stormwater Management Strategy project was completed as a partnership between Mackay Regional Council (Council) and AECOM. The project brought together several concepts across a range of disciplines with the aim of actively managing flood and stormwater risks in the Mackay Region to minimise the consequences to life, assets, community wellbeing, the environment and the economy.

Over the last decade the local government area has experienced historically high growth followed by a period of population stabilisation linked to the resource boom and subsequent downturn. Rapid growth resulted in a massive increase in stormwater assets for Council to manage, and an associated increase in potential liability associated with the operation, maintenance, renewal and replacement of this infrastructure. A contraction of growth across the region contributed to a contraction in available funds to service these liabilities. Furthermore, 40% of the urban population within the LGA is identified as within a flood and coastal hazard zone. Community surveys also indicated that Council did not have the capacity to meet expectations related to flood and stormwater management.

The challenge for Council was to balance growth planning with responsible asset management required to mitigate the risk and impact of flooding against a backdrop of existing flood risks, economic constraint and an ageing asset portfolio. Initiating the Flood and Stormwater Strategy was Council’s response to this challenge.

The project was completed in three phases. Phase 1, data compilation and condition assessments provided Council with an improved understanding of existing natural hazards and potential liabilities. This was achieved by reviewing Council operations, assessing asset conditions and completing a flood damage and flood risk assessment. Phase 1 identified the most significant flood and stormwater management challenges for the strategy to address.

Phase 2, strategy development, involved understanding community priorities, identifying clear strategic objectives and developing a tool to assess projects. Key stakeholders representing a cross section of interest groups were consulted to understand priorities for stormwater management. These priorities informed the development of a Multi Criteria Assessment (MCA) that provided a justifiable, transparent and repeatable method for ranking projects. The MCA was applied to potential structural, non-structural and developer driven projects were identified from existing capital works programs, flood studies, strategic planning programs and development approvals. The process resulted in a ranked list of projects and indicative ten-year capital works program.

Implementation of the strategy formed phase 3 of the project. Council formally adopted the strategy in late 2017, with several projects identified during the strategy either already delivered or underway. A Floodplain Management Plan for the Pioneer River floodplain has commenced to address flood risk from the Pioneer River, which from a flood damage perspective is the most significant hazard across the region. The development of the plan has been completed in parallel with the collection of terrestrial LiDAR data, development of local area specific flood damage curves and ongoing monitoring and maintenance of existing assets. Each of these projects are aimed at facilitating better decision making within council.

Phase 1 condition assessments also identified several defects with existing assets. High risk defects have successfully been addressed before they were identified from a complete failure. Furthermore, targeted ongoing monitoring stormwater assets has been implemented to continue to identify potential issues and facilitate pro-active maintenance.
Mackay - a brief introduction

Mackay is located on the east coast of Queensland, approximately 1,000km north of Brisbane and 1,000km south of Cairns. The Mackay Regional Council (MRC) local government area (LGA) encompasses 7,300km², including 320km of coastline. The region supports a population of approximately 124,000 across numerous beach and inland communities, with the majority of those located in the City of Mackay.

Figure 1 - The Mackay Regional Council local government area boundary.

Mackay was first established in the 1860’s and like many towns in Australia, first settled on the banks of a major water way before spreading out over the floodplain. That waterway was the Pioneer River and with a catchment area of 1,560 km² it is the largest in the LGA. There are also numerous other significant rivers and coastal streams across the area. Today, the majority of the urban land is low-lying, having an average elevation of less than 10 metres AHD with parts of Mackay at or near the Highest Astronomical Tide (HAT) level of 3.64 m AHD.

Rainfall patterns in the region are heavily summer dominant, and while the statistic of 65% of rain falls over the approximate four-month wet season is often quoted, this is generated on a long-term average. Looking at individual years, patterns are generally much more concentrated, with on average over 70% of rain falling during the wet season, and over 30% concentrated to a single month for any given year.
The combination of a population on the coastal floodplain in a cyclone zone with high annual rainfall results in a high flood and inundation risk from one, or a combination of flooding mechanisms including:

- river and creek flooding from excess runoff exceeding the capacity of defined overland flow paths
- urban catchment flooding during localised rainfall events where ponding occurs
- coastal inundation from sea water inundation due to high tides, storm surge and wave action.

Of the 53,000 properties in the LGA, approximately 12,000 (or over 20%) are covered by the known coastal hazard areas. Furthermore, approximately 20,000 (or 40%) are within a flood hazard area. Long term and multi-generational residents understand the flood risk from either experiencing or learning from historical events.

Figure 2 Flood and coastal hazard mapping over the Mackay urban area for the 2100 1% AEP event.
The storm surge of 1918 remains widely regarded as the most significant natural disaster in the region's history, claiming 22 lives and causing hundreds of injuries whilst destroying approximately 75% of the building stock in Mackay (Wright, B. 2008). The event was caused by the coincidence of heavy rainfall, 1397 mm in 3.5 days, with an intense tropical cyclone crossing the coast. The system produced a storm tide level of approximately 5.4 m AHD (1.76m above HAT). The ‘Foulden Flood’ during 1958 is regarded as the largest documented catchment flood in the Region and is most well-known for removing the entire settlement of Foulden. Two lives were lost to drowning and one person was declared missing, while 136 people were rescued from Foulden and Cremorne (Wright, B. 2008). Significantly, the Pioneer River has not broken its banks at Mackay City since the construction of a levee system in the 1960’s in response to the 1958 flood. More recently, in 2008, an intense rainfall event (unofficially 736 mm in less than 6 hours) directly over the Mackay urban area and local catchments damaged more than 4,000 houses. While the intensity of the 2008 event was not comparable to anything experienced in the region before, the pattern of flooding, rapid rise followed by rapid recession of flood waters on the falling tide is generally typical of the urban catchment flooding experienced across the region.

![Figure 3 Historical flood map showing inundation extents of the 1918 storm surge and Pioneer River flood, 1946 Pioneer River flood and 1958 flood event.](image)

While a similar flooding history could be plotted for large parts of North Queensland, due to Mackay’s favourable soil, topography and reliable rainfall, the region has historically supported a strong sugar industry with even small-scale cane farms remaining financially...
sustainable. This led to comparatively high property values and highly fragmented land ownership across the region. The result, smaller, fragmented developments according to ownership boundaries compared to large master planned developments in neighbouring regional centres like Townsville. Furthermore, the region experienced historic high population growth between 2002 and 2013 corresponding to the resources boom with development in the region reacting accordingly. During that period of high growth, the length of stormwater infrastructure doubled compared to what had been in place for the previous (prior to 2002) 40 plus years.

At present, the population has stabilised due to a decline in migration to the region which has an impact on revenue generation for Council. The challenge for Council is to balance growth planning with responsible asset management required to mitigate the risk and impact of flooding. This needs to be achieved against a backdrop of existing flood risks, economic constraint and an ageing asset portfolio. This requires a long-term vision to make more informed decisions on planning policy and infrastructure investment. This was the foundation for the development of the Flood and Stormwater Management Strategy.

**Strategy Development**

The overarching goal of stormwater management within council has always been;

“to actively manage Flood and stormwater risks in the Mackay Region to minimise the consequences to life, assets, community wellbeing, the environment and the economy.”

Council as an organisation understood that a strategic approach to achieving this goal was required. However, the scope, specific objectives and existing internal tools and processes available to achieve those objectives were not clearly understood. Council engaged AECOM as a strategic and technical consultant to assist Council to identify and achieve these objectives.

An internal technical working group was established to ensure organisational commitment and promote ownership for the implementation of the strategy. The project team, including key technical working group members and consultant identified a three-phase approach to deliver the strategy summarised in Figure 1
Phase 1 – Condition Assessment and Data Compilation

Mapping a pathway from ‘where Council are’ to ‘where Council want to be’ required an understanding of potential existing risks and liabilities. Phase 1, data compilation and condition assessment ensured the project team has the necessary information to develop a functional strategy.

Asset Management Review

The data compilation process began with a review of Council’s asset management database. Historically, the database was set up for financial reporting purposes and does not link an asset to a specific location. While asset age is captured, no details of asset condition or data reliability (i.e. surveyed/as constructed etc) was recorded. A parallel GIS database is being developed, a comparison between the two databases identified a 10% discrepancy between the two. As no condition data, very little location data and the no reliability data, Council had a limited understanding of future asset maintenance commitments. A condition assessment review of the underground network, levee system and open channel network was therefore completed.

Condition assessments

Council manages approximately 630km of underground stormwater infrastructure and a condition assessment was completed on a 5% representative cross section. It was acknowledged that any projection across the entire network based on a small sample involved a low level of confidence, however 5% met the balance between strategy development timelines and meaningful projections. The condition profile of stormwater assets, based on the representative cross section is shown in Figure 5. Condition is measured according to the Condition Assessment and Asset Performance Guidelines (IPWEA, 2015), using a 1 – 5 grading system with ‘1’ very good, through to ‘5’ very poor.

Figure 5 Asset condition profile

The Pioneer River levee system includes approximately 11km of constructed walls and associated infrastructure. Levee infrastructure was inspected with 420 defects logged and ranked on a scale from ‘acceptable’ through to ‘imminent threat’ according to the International Levee Handbook (CIRIA, 2013). Defects were assigned a recommended timeframe to rectify according to their ranking as summarised below;
Mackay Regional Council: Flood and Stormwater Management Strategy

- Imminent Threat - Issues to be addressed immediately (within 3-6 months or before flood season) of which 6 were identified;
- Unacceptable - Issues to be addressed as soon as practical (within 5 years) of which 25 were identified.
- Acceptable – Issues to be the subject of ongoing monitoring and maintenance of which made up the balance of the defects.

In addition to physical defects, several documentation and operational issues were also identified.

The open channel network consists of a combination of concrete lined channels and earth channels with a total length of 77km. Council staff undertake an annual inspection prior to the wet season and assign a serviceability and structural ranking using a 1 to 5 scale according to the Stormwater Systems - Reticulated Services Assessment Manual (DoD, 2013) with ‘1’ as new through to ‘5’ very poor. Approximately 800 m of bank protection rectification was identified as required across 15 locations.

The assessments of councils existing stormwater infrastructure provided a snapshot of the overall condition of the assets and a foundation for estimating funding allocations for repairs and replacements required to maintain agreed levels of service.

**Flood Hazard Assessment**

Developing a strategy to mitigate the risk and impact of flooding requires a detailed understanding of the risks to be mitigated. To this end, a high-level flood damage assessment (FDA) and a flood risk assessment were completed.

**Flood Damage Assessment**

An FDA was completed to compare tangible damages arising from different flooding mechanisms. Direct and indirect flood damages were estimated through the application of stage-damage curves to peak flood depths. Flood mapping and depth information for the 1% AEP design flood event was collated from several previously completed flood studies.

Appropriate potential flood damage curves were adopted based on a literature review of available damage curves for both residential (property and structural) and commercial property types. Appropriate factors were applied to convert the damage curves to current dollars and to calculate actual damages from potential damage curves based on available response times of the flooding mechanism being assessed. Indirect damages were calculated as a ratio of direct damages.

Details of the properties that the curves were being applied to were derived through a combination of an automated process applied to LiDAR data and manual checking. Manual checking identified several potential issues with the automated LiDAR process and it was acknowledged that the results of the FDA should remain indicative only. A summary of the high-level flood damage assessment is shown in Figure 6 which demonstrates that from a flood damage perspective, the Pioneer River presents the greatest potential financial impact to the region.
Figure 6 Summary of high level flood damage assessments.

Flood Risk Assessment

Unlike flood damages which estimate the economic impact of flooding, flood hazard identification focusses on risk to life and property associated with the likelihood of flooding, flow depth and velocity. Existing flood studies were reviewed against flood risk factors and flood hazards were summarized by locations. High risk areas were highlighted and data gaps were identified for areas where no flood hazard information was available for reference to future works.

Literature Review

Given the diversity of stormwater management projects, a multi criteria assessment (MCA) tool was required to assess potential projects. A literature review was completed to identify several important principles to be incorporate into the MCA process with central guidance provided by The Green Book (HM Treasury, 2018) and Multi-criteria Analysis: A Manual (DCLG, 2009). Key principles identified included:

- Setting objectives and targets so that it is clear what the process is trying to deliver
- Capturing a broad range of projects and options to be assessed
- Setting consistent and logical assessment criteria Use definable metrics rather than a rating scale where possible
- Providing transparency
- Ensure that multiple benefits and constraints of a project are properly captured and costs, including maintenance, are realistic
- Limiting criteria that are important to stakeholders and the community and apportioning weightings that reflect their importance
- Test the sensitivity of the outcomes to the weightings applied
- An MCA ranks projects and opportunities but does not explicitly prove a project should be undertaken
Developing a strategy – not a paperweight

At the completion of phase 1, Council understood existing liabilities, natural hazards, potential flood damages and data and process gaps which facilitated strategy development. The project team outlined where Council would like to be and compared it to existing arrangements. A summary of the comparison is provided in Figure 7, the central theme was replacing generally re-active actions with planned actions.

![Figure 7 Comparison of old management practices with post-strategy targets.](image)

**Strategy Objectives**

To transition to a pro-active approach, the project team developed several key objectives for the strategy.

- Manage flood and stormwater infrastructure in an integrated way, ensuring the sustainable use of physical resources.
- Ensure flood and stormwater management considerations are integrated into Council’s decision making and future projects are prioritised based on defined criteria using a transparent process.
- Ensure flood and stormwater asset renewals are proactively managed at reducing risk, using current condition data and agreed levels of service.
- Understanding and meeting the demands of growth through demand management and infrastructure investment.
- Continuous improvement in asset management practices.
- Cost effective collection, storage, analysis and sharing of data throughout the organisation, external stakeholders and the community.
- Educating and raising the awareness in the community about flood / stormwater management and potential flood risk.
- Build capacity and capability within Council and the community to develop an understanding of flood risk, risk management and response and recovery that will reduce the social, economic and environmental impacts of flood events.
The strategy objectives clearly defined what Council need to achieve through the strategy.

**Understanding Community Priorities**

Community attitude surveys completed prior to the development of the strategy outlined community expectations for stormwater management. Knowing Council’s potential liabilities and the regions natural hazards, it was clear that Council did not have the capacity to meet these expectations. Effective use of Council resources requires an understanding of how the community prioritises these expectations.

Stakeholder engagement workshops were led and facilitated by the consultant attended by a representative cross section of the community including developers, environment groups, community groups and emergency management organisations. Stakeholders were asked to give a weighting to their priorities for stormwater management, the outcomes of the survey are summarised in Figure 8.

![Figure 8](image)

Figure 8 Comparison of stakeholder weightings to those applied to the MCA Blue depicts weightings used in the MCA and red indicated stakeholder preferences.

The weightings developed during stakeholder engagement were amended slightly to reflect Council legislative responsibilities. Final weightings are shown in Figure 8.

**Using community priorities to drive strategic direction**

Council stormwater management projects can be categorised into three groups; structural, non-structural and development driven. As each of the projects are fundamentally different, three separate MCA tools were developed which applied key principles identified during the literature review.

**Structural Projects**

Structural projects are those most associated with Councils role as stormwater managers and traditionally include asset renewals and replacements and construction of flood mitigation infrastructure. Structural projects also include property buybacks and raising or flood proofing of private property. Key criteria and indicators used to assess a projects contribution to the criteria is detailed in Table 1.
Table 1: MCA criteria and indicators for application to structural projects.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Indicators</th>
<th>Criteria Weighting</th>
<th>Sub-Criteria Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood Benefit</td>
<td><strong>FB1</strong> Reduction in impacted properties for existing area</td>
<td>20%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td><strong>FB2</strong> Protection of business centres and key industry (including agriculture)</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>Public Safety</td>
<td><strong>PS1</strong> Removal of Public Safety Risk</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>PS2</strong> Improved immunity Emergency Evacuation Routes</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>PS3</strong> Protection of public safety infrastructure</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>PS4</strong> Risk of failure (risk to people, evacuation etc)</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Environment and Cultural Heritage</td>
<td><strong>EC1</strong> Environmental regulatory approval risk</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>EC2</strong> Climate change</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>EC3</strong> Cultural heritage regulatory approval risk</td>
<td>8%</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td><strong>EC4</strong> Environmental impact / benefit</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td><strong>SOC1</strong> Impact on open space</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>SOC2</strong> Effect on amenity value</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>SOC3</strong> Disruption to the community</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>SOC4</strong> Benefit to community facilities</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>Reputation</td>
<td><strong>RE1</strong> Support for project</td>
<td>8%</td>
<td>100%</td>
</tr>
<tr>
<td>Feasibility/Implementation</td>
<td><strong>FI1</strong> Combined with another project</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>FI2</strong> Sequencing</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>FI3</strong> Internal delivery</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>FI4</strong> Risk in the successful delivery of the project</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>FI5</strong> Project staging (needs further investigations, concept, business case etc)</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td><strong>CO1</strong> Construction Cost</td>
<td>20%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Non-structural Projects

Non-structural measures to manage stormwater risks generally involve a lower capital spend but require a greater period to realise their full benefit. Traditional non-structural projects include land use planning and emergency management and more recently community awareness programs. Key measures used to assess non-structural projects contribution to the criteria are detailed in Table 2

Table 2 MCA criteria applied to non-structural projects.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Measure</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Regrets</td>
<td>Is this an action that should generally be completed as part of good practice? Does the action provide future flood resilience and preparedness?</td>
<td>Yes - Meets the 'No Regrets' Criteria No - Does not meet the 'No Regrets' criteria</td>
</tr>
<tr>
<td>Meet Gaps</td>
<td>Does the action address a need to fill gap/s in current floodplain management?</td>
<td>Yes - Meets the 'Meet Gaps' Criteria No - Does not meet the 'Meet Gaps' criteria</td>
</tr>
<tr>
<td>Performance</td>
<td>How well is the action likely to perform, in relation to its intended benefit?</td>
<td>Low - Not effective Medium - Short term fix or partially effective High - Effective long-term solution</td>
</tr>
<tr>
<td>Practicality</td>
<td>How difficult is the implementation likely to be?</td>
<td>Low - Difficult to implement Medium - Moderate effort to implement High - Straightforward to implement</td>
</tr>
<tr>
<td>Community Acceptance</td>
<td>How likely is the project to be accepted by the community and be politically palatable?</td>
<td>Low - Not likely to be acceptable Medium - Likely to be acceptable to some but not others High - Likely to be acceptable</td>
</tr>
<tr>
<td>Costs / Resources</td>
<td>Where does the estimated cost sit within the scoring bands?</td>
<td>Low - Expensive (&gt; $2M) Medium - Moderately expensive ($500,000 to $2M) High - Manageable costs (&lt; $500,000)</td>
</tr>
<tr>
<td>Alignment to Current Industry Standards</td>
<td>Does the action assist in Council alignment to current industry standards, such as Flood Commission of Enquiry, regulatory standards etc?</td>
<td>Yes - Meets the 'Industry Standard' Criteria No - Does not meet the 'Industry Standard' criteria</td>
</tr>
<tr>
<td>Improved Community Resilience</td>
<td>Does the project improve community resilience, community education or flood preparedness?</td>
<td>Yes - Meets the 'Community Resilience' Criteria No - Does not meet the 'Community Resilience' criteria</td>
</tr>
</tbody>
</table>

Development driven projects

Development driven projects represent the trunk stormwater drainage infrastructure required to provide a future level of service as and when the stormwater catchment reporting to the individual structure is either partially or fully developed. Developer driven projects are predominantly influenced by the rate and distribution of development around Mackay. The MCA for development driven projects included;

- Timing – whether the proposed required infrastructure was within a priority area identified through other planning processes
- Alternative other solution – is council funding required or is there an alternative available
- Future flood benefit – whether the proposed infrastructure would provide a benefit to existing areas
- Indicative cost
**Prioritised project list**

The project working group was consulted to finalise the MCA frameworks. An extensive list of Council projects was collated from existing capital works programs, flood studies and business cases. With input from the working group, the projects were assessed against the appropriate MCA framework. This process provided a ranked list of projects according to their capacity to meet Council and community priorities. It is important to note that the list was intended to provide only an indicative ranking of generally higher value projects, with large benefit at a comparatively low cost, compared to higher cost, or lower benefit projects.

The ranked list was combined with assumed funding rates to develop a ten year forward work program, with high value projects given priority for completion. The indicative program did not lock projects in to a particular financial year but did identify high priority works early in the program. Critically, this allowed for projects to be brought forward where external funding was made available, or, delay projects where they could be incorporated into other planned major works, including road upgrades.

Many of the non-structural projects ranked highly and will be completed in the initial few years of the program. This has the benefit of achieving rapid results in addressing flood resilience while also establishing systems, processes and information to efficiently and effectively target future infrastructure projects.

**Implementing the strategy**

The final Flood and Stormwater Management Strategy document was formally adopted by Council in late 2017. However, the strategy is not just a stagnant document, and the prioritised project list was designed to be applied to all potential future stormwater projects and remain a dynamic project list to be reviewed with budget cycles.

The development of the strategy has already resulted in both structural and non-structural projects being implemented.

**Non-structural projects completed**

Non-structural projects identified as the highest priority were generally those that filled data gaps or addressed operational issues identified during phase 1 works.

The flood damage assessment identified that the automated process for determining building footprints and floor levels was not reliable and that accurately defining these parameters is critical to understanding the actual flood risk of the region. Council completed a comprehensive pick-up of floor levels using terrestrial LiDAR and undertook a manual digitisation of building footprints. This process was accompanied by the development of flood damage curves specific to the region. Council now has the dataset to accurately quantify flood damages across the region which can be applied to both existing and proposed flood studies. This information will facilitate a better understanding of actual benefits for proposed structural mitigation options and will also be used to more accurately inform the community of their flood risk.

Phase 1 reporting also noted a low level of confidence in the projection of sampled underground network condition assessments across the entire region. The collection of this data, targeting highest risk infrastructure was considered critical for effectively and efficiently implementing a renewal and replacement program. Council has implemented an ongoing inspection program of 5% of the network annually. This understanding of forward work has enabled the purchase of equipment and staff training to complete the work in house.
Improved monitoring and maintenance was also identified as critical for the levee network. A direct outcome of the initial works package has been the development of a Pioneer River Levee Operation and Maintenance Manual. The manual informs Council personnel of the correct operational procedures, required maintenance and appropriate management to ensure the continued viability and safety of the PRLS and associated infrastructure.

Non-structural projects will contribute to the identification of potential structural projects. The MCA framework for structural projects will allow these projects to be prioritised against existing potential projects already identified to inform whether newly identified works should be brought forward.

**Structural projects**

Riverine flooding from the Pioneer River presents the greatest potential financial impact to the region from a flood damage perspective. The condition assessment of the levee system identified six imminent threat defects which were addressed as a matter of priority. The issues identified as ‘unacceptable’ are being worked through based on their potential risk to the levee system integrity.

Like the levee system, issues were identified in the underground and open channel network. A program of renewals and replacements based on assets that present the greatest risk should they fail has been implemented. From the completion of the first condition assessments, renewals and replacement works have been completed on over 500 meters of high risk underground infrastructure before they presented as an issue at ground level.

The strategy not only identifies additional projects, but also ensures investment is directed at the highest value projects. An unexpected outcome of the strategy has been the delay of projects scheduled in the capital works program prior to the MCA development until additional information can be gathered to assess the merits of the project.

**Lessons learnt**

The development of the Strategy has been a highly successful project for Council as evidenced by the number of projects implemented in the twelve months following the adoption of the strategy. However, as with all projects, several lessons were learnt that should be considered by other local governments considering undertaking a similar project.

The main lesson involved data management. Very large amounts of data were collected to develop the strategy and will continue to be collected, which is a very resource intensive exercise. Careful consideration needs to be given to what this data will be used for which in turn will inform required accuracy and how it is stored and managed.

Data storage and management is not generally at the forefront of considerations for stormwater management. However, ensuring appropriate systems and resources are in place to manage this data is critical to optimal use of the data.
Mackay Regional Council: Flood and Stormwater Management Strategy

References

Construction Industry Research and Information Association (CIRIA), 2013, International Levee Handbook, United Kingdom

Department for Communities and Local Government (DCLG), 2009, Multi-criteria Analysis: A manual, London

Department of Defence (DoD), 2013, Base Engineering and Assessment Program – Stormwater Systems – Reticulated Services Assessment Manuals. Australia

Institute of Public Works Engineers of Australasia (IPWEA), 2015, Condition Assessment and Asset Performance Guidelines - Practice Note 5, Australia