RESILIENT SYSTEMS: WHAT TO DO WHEN ENGINEERING IS NOT ENOUGH?

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ABSTRACT

The 2023 Auckland Anniversary weekend floods were a visible reminder of what can happen when our stormwater systems cannot cope with extreme rainfall and runoff. In the past, the solution has been to increase the capacity of our stormwater systems to accommodate increasing flows expected, but what do we do when additional capacity might not be the best long-term option? With increasing groundwater levels and development intensification, the ability of the environment to absorb rainfall is decreasing while rainfall intensity is increasing due to climate change. Therefore, the way we manage stormwater must change.

The Mount Maunganui (Mount North) catchment in the Bay of Plenty consists of 47 hectares of high value, high density residential and commercial area. It is presently drained to Pilot Bay via a gravity-driven piped network with no overland flow outlet, and therefore is prone to flooding. Existing risk will worsen due to increased rainfall intensities, sea level rise and associated rising groundwater (likely emergent by 2070) as the climate changes.

In 2023, Tauranga City Council (TCC) began a pilot adaptation planning process in Mount North – with stormwater engineering, planning, climate adaptation, and communications and engagement specialists – to develop a 100 year strategy to respond to multi-driver flooding (sea level rise, storm surge, groundwater and rainfall). The pilot applies latest adaptation planning methods aligned with soon to be released Ministry of the Environment guidance and places engagement at the centre through use of a focus group.

This paper will outline the pilot process adopted by TCC and will identify lessons learned that could be applied in similar catchments and by similar organisations across Aotearoa by directly working with communities to develop long-term (100 years) visions for stormwater management to reduce vulnerability, increase adaptive capacity, and reduce exposure to flooding.

KEYWORDS

Adaptation strategies, resilient systems, risk management, community engagement

1 INTRODUCTION

Stormwater management in coastal catchments with rising groundwater will become increasingly difficult in the future due to climate change. Conditions of tomorrow are not the climate conditions of the past, and as a result, managing these hazards to an acceptable level by increasing capacity is becoming increasingly expensive and difficult. This paper presents the pilot process adopted by TCC in the Mount North catchment and identifies lessons learned that could be applied in similar catchments across Aotearoa.

Adaptation pathways, as discussed below, provides an approach which allows for flexibility over time and can reduce the risk of maladaptation by considering potential futures, identifying signals that indicate when the need for a change is approaching, and making a plan to respond. This approach allows for uncertainty – not only as it relates to climate change but also future legislation, funding, community values, technology and other factors – and responds with short term actions to reduce risk without locking in a specific pathway.

2 CATCHMENT HISTORY

2.1 CATCHMENT OVERVIEW

The stormwater catchment for this project ("Mount North") includes 47 hectares of commercial and high-density residential land draining to the southeast into Pilot Bay. The catchment extends from Banks and Salisbury Avenues in the south to Adams Avenue in the North as depicted in Figure 1. It does not include the dunes or portions of the neighborhood closer to the Pacific coast as this area drains to the northwest. As of 2019, the Mount North catchment includes $2.2 billion in property and assets, and population (Beca, 2020) and value has continued to grow.

Figure 1: Mount North Stormwater Catchment

Because of its low-lying nature, the catchment is susceptible to flooding as the basin has no natural outlet. Climate change is likely to exacerbate this flooding due to rising sea levels resulting in more frequent overtopping of the shorelines, increased backflow in the stormwater network, and less capacity in the soil profile to absorb rainfall as groundwater rises. Further, as rainfall intensity increases due to climate change, flooding will become more frequent (even if sea levels were to remain constant).

2.2 FLOODING IN MOUNT NORTH

This low-lying, basin shaped urban catchment is susceptible to flooding with documented events as identified below. The level of detail provided (e.g. rainfall intensity, tidal phase, flood depth) herein is based upon the data available.

- April 1948 when there was a large anti-cyclone impacting the region with the largest rain event in 30 years resulting in a washout 3m wide and 1.2m deep along Beach Road with a similar washout along Commons Avenue and widespread flooding of low lying open space. During this event, Tauranga recorded 228mm in 24 hours, with 212mm of that occurring during a 6hr period, estimated with a return period of 150 years (NIWA, 2018).
- May-June 1962 when water was 0.6m deep in the streets of Mount Maunganui during three days of heavy rain, with 297mm in 24hrs measured (NIWA, 2018)
- April 2000 when 166mm of rain in 12hrs (with the peak not coincident with high tide) was recorded resulting in 150-200mm of flooding in homes and businesses, as well as the fire station, in Mount Maunganui (NIWA, 2018).
- April 2004 when several homes in the catchment were flooded after 60-100mm over a12hr period (from MetService predictions) (NZ Herald, 2004).
- May 2005 when the same event that caused debris flows in Matata dropped 217mm of rain in 12hrs with 133mm of that rain in 3hrs in Mount Maunganui resulting in flooding and evacuations (unclear the extent of damage in this catchment) (NIWA, 2018).
- April 2013 along The Mall and widespread surface flooding in the catchment (Weather Watch, 2023). Many businesses and homes in the Mount North catchment were flooded after approximately 75mm of rain in 3hrs (Otago Daily Times, 2013). This rain event occurred after months of dry weather allowing litter and debris to accumulate and reduce the functionality of drainage. Some shops had up to 500mm of water inside (Stuff, 2013).
- May 2013 flooding on Commons Avenue (Crawford, 2014).
- November 2014 flooding on Commons Avenue after modifications to the Council drainage system following the May 2013 flood (Crawford, 2014).
- November 2019 when The Mall running parallel to Pilot Bay flooded up to 600mm in some locations (Houghton, 2019).
- April 2024 when Commons Avenue flooded due to sand build-up in the outfalls (Liddle Crawford, 2024).

While it appears that the frequency increases from the 2000s, it is likely that this is largely due to availability of online records of flood events.

Following the May 2005 event, a report by John Palmer commissioned by TCC indicated that $52M in funding ($10M in the industrial and residential areas of Mount Maunganui) was required to upgrade Tauranga's stormwater systems, and recommendations were made to incorporate climate change projections for rainfall associated 3.8 C of warming by 2080 compared to a 1990 baseline, increasing required pipe capacity by 30-40% (Rowan, 2005).

STORMWATER LEVEL OF SERVICE

Through the 2015-2025 Long Term Plan, Tauranga City Council reviewed the target level of service provided by their stormwater system. Traditional levels of service are surface water should not enter buildings in a 2% annual exceedance probability (AEP) or 50 year annual return interval (ARI) event where nominally a 10 year ARI event can be accommodated by the stormwater network and overland flow paths or stormwater storage would provide further capacity to provide the 50 year ARI level of protection. However, in a 2018 assessment by Tonkin + Taylor, Ltd., it was found that stormwater infrastructure in Tauranga was able to service a 2 or 5 year ARI event including both the stormwater network and secondary stormwater interventions. As a result, TCC transitioned to a level of service aligned with a safety-to-persons approach based upon a depth and velocity calculation. There is a requirement for new development that new stormwater systems servicing brownfields should prevent flooding to buildings during a 50 year event.

In the Mount North catchment, there are no areas where the safety-to-persons threshold is breached. Due to the high-density urban nature of the catchment, providing additional capacity via storage or overland flow paths is challenging without significant land use changes. Therefore, it is difficult to provide infrastructure to accommodate extreme rainfall. Stormwater is presently managed by soakage to ground and a gravity-based pipe network collecting water when it flows via hard surfaces into the road corridor which discharges to Pilot Bay. Functionality is reduced due to sea levels limiting the hydraulic gradient.

A flood modelling assessment by Awa Environmental in 2020 identified hundreds of residential and commercial buildings at risk in a 1% AEP event present day with this risk increasing significantly in the future as sea levels and groundwater levels rise while rainfall intensity is increasing. It is not only extreme, low frequency events that pose a risk to the catchment; more than 300 buildings are exposed in a 10% AEP present day event. The reality of the present day challenges, coupled with the increasing challenges of the future make stormwater management in this catchment particularly tricky.

Figure 2: Changing flood risk over time, modelling of flood risk by Awa Environmental (Mount Maunganui North Options Modelling, 2020)

SUB-CATCHMENT	FLOOD TYPE	RESIDENTIAL	COMMERCIAL
Adams	Flood Risk	59	0
	Might be at Risk	6	0
Commons / Grace	Flood Risk	141	0
	Might be at Risk	5	1
CBD	Flood Risk	68	66
	Might be at Risk	10	3
Salisbury	Flood Risk	14	33
	Might be at Risk	4	5

SUB-CATCHMENT	FLOOD TYPE	RESIDENTIAL	COMMERCIAL
Adams	Flood Risk	62	0
	Might be at Risk	3	0
Commons / Grace	Flood Risk	147	0
	Might be at Risk	11	1
CBD	Flood Risk	71	66
	Might be at Risk	10	5
Salisbury	Flood Risk	16	34
	Might be at Risk	2	8

SUB-CATCHMENT	FLOOD TYPE	RESIDENTIAL	COMMERCIAL
Adams	Flood Risk	64	0
	Might be at Risk	3	0
Commons / Grace	Flood Risk	179	1
	Might be at Risk	1	0
CBD	Flood Risk	91	75
	Might be at Risk	5	0
Salisbury	Flood Risk	34	61
	Might be at Risk	1	3

2.3 INITIAL EVALUATION OF ENGINEERED APPROACHES

In 2017 Beca prepared a report which summarized the effectiveness of traditional flood risk management strategies for the Mount North catchment including a primary system, secondary system and non-infrastructure improvements (e.g. regulations for redevelopment of properties such as floor level requirements but not including retreat) considering rising sea levels (1m of sea level rise by 2100), rising groundwater and rainfall (Beca Ltd., 2017). The options assessment concluded that the only viable engineering response would be a large and costly pump station, but that would reduce in efficacy over time reducing benefits provided as climate change continues. A series actions were undertaken to alleviate flood risk in the short term and prepare for future strategies. These included both structural and non-structural actions. TCC purchased a property within one of the areas with highest flood risk which provides a potential location for stormwater infrastructure in the future. Additionally, as part of a wider stormwater management strategy, two large pipes were constructed from Salisbury Avenue to an outlet at the Port near Nikau Crescent while other works within the Port were occurring to provide future discharge capacity across adjacent catchments if required in the future.

BUSINESS CASE

As it was clear that significant investment into flood management was likely to be required, an Indicative Business Case (IBC) was initiated to consider strategic objectives, and to understand the lead time associated with planning, design and construction of flood risk management actions to inform a programme of works to deliver a flood risk management solution. Investment objectives were related to improved livability via reduced impacts from surface flooding, alignment with local plans, and efficient, appropriate investment into stormwater management. While the focus was significant reduction in flooding in the short term, internal TCC stakeholders emphasized the importance of packages of options that would deliver benefits extending into the long (50-100 years) term.

There were four sub-catchments evaluated in the IBC with various interventions included in the long list, broadly related to regulatory controls, pumped solutions, bunding, stormwater storage and raising ground levels. These options were evaluated based upon who would deliver the options (TCC, private or combination), when the option could be implemented (immediate, when funded, or in response to climate change), and how it could be funded. Cost estimates included both capital costs, present day operational costs and operational costs in the future that reflect the additional pumping frequency required due to climate change.

The IBC process indicated that a traditional approach to managing stormwater (e.g. piped primary network with secondary overland flows) would not be sufficient to manage risk alone in the long term. The preferred short to medium term solution from the IBC process included a combination of approaches with land raising over time in one of the sub-catchments, increased capacity in the gravity pipe network, and pump stations to increase discharge capacity. This solution had significant short term tradeoffs during implementation and would require a coordinated effort to be effective. Therefore, a dynamic adaptive planning pathways (DAPP) approach was recommended.

3 PILOT PROJECT

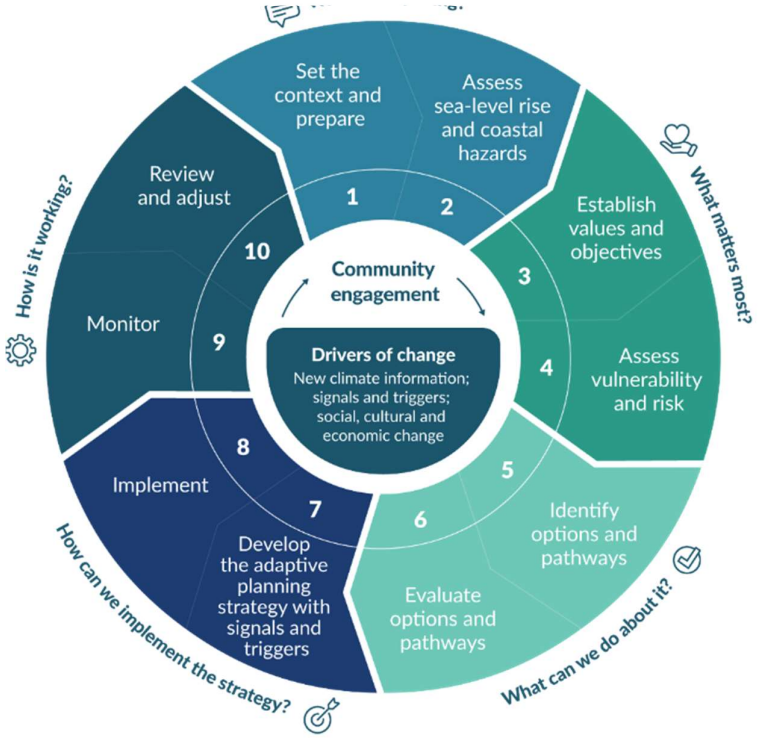
Coastal communities are often value laden, contested spaces where visitors, residents, tangata whenua, and business owners can at times have conflicting values. In this environment, it is critical to have a well-considered, tailored communications and engagement approach to set up the project for success. The findings of the business case indicated that from a technical perspective, the preferred option for managing flood risk in the mount includes a mixture of short-term improvements to the piped network including large pump stations, followed by increasing levels of some public infrastructure with private infrastructure also being elevated over time as development continues. However, it is noted that community engagement had not formed part of the long-term considerations to date (i.e. technical assessments only) and there was also a long term strategic plan exercise being undertaken by Council in the catchment that presented an opportunity to confirm community values, objectives and preferred approaches. Because of this, a DAPP approach with communities at the heart was recommended by the Beca team. This is consistent with the Tauranga Climate Action and Investment Plan which includes raising awareness of climate change (action 28) and progressing a DAPP pilot (action 29) (Tauranga City Council, 2023).

Because DAPP was a new approach for Tauranga City Council and because of the sensitivity of hazard management, a "DAPP Lite" project was proposed to take a focus group along the journey of developing adaptation pathways for the Mount in order to test this process before a community-scale rollout. The objective was to evaluate the delivery of information and workshop approaches with the goal to identify what worked well, what could be improved, and what additional technical information may be required ahead of the wider rollout of the DAPP project in the Mount which will include a more comprehensive community engagement process.

While not solely coastal hazards, the pilot process follows broadly the first seven steps of the Ministry for the Environment Coastal Hazards and Climate Change Guidance (Ministry for the Environment, 2024). There are presently limited examples of a DAPP development and implementation process in an urban pluvial flood risk management context; however, due to the compounding challenges (particularly for coastal urban stormwater catchments), this will likely become a more frequently adopted approach over time.

Figure 3: Adaptation Plan Development Process from the MfE Coastal Hazards and Climate Change Guidance

(Ministry for the Environment, 2024)



The indicative business case provides the context and technical supporting information, and there was a variety of hazards information available. Further, the Mount Spatial Plan engagement process was ongoing and therefore provided information regarding how communities live, interact with, and value the Mount area and the local experience of flooding hazards and perceptions of climate change.

With the available background information, the TCC and Beca team designed a pilot engaging a focus group to test the engagement processes, collateral, messaging and ideas. The pilot process enabled the team to test an approach and learn lessons on what is the most suitable method for wider adaptation planning exercises with the Tauranga community. To test engagement without a full consultation process, a focus group of community representatives was assembled (as further described below). There were some good learnings along the way, and the focus group provided valuable insights that will be taken forward to inform planning of the next phase working with wider communities. Herein, we present the series of internal (TCC/Beca) activities and external (with focus group) workshops following the first three questions on the 'MfE Wheel':

- What is happening?
- What matters most?
- What can we do about it?

3.1 WHAT IS HAPPENING?

3.1.1 INTERNAL PROCESS

Within the 'what is happening' phase, the first step is to set a clear scope and prepare to undertake the work. For this project, scoping included clearly defining which hazards will be considered and which are beyond the scope of the pilot. As this was a project led by the stormwater team within TCC, coastal erosion was not considered as part of this work, nor was tsunami. The hazards included in scope are directly related to flood risk in the Mount North catchment, namely rainfall and sea level rise. The hazards below will result in an increase in flood risk over time.

- As the sea level rises, this both reduces the hydraulic gradient for outfalls but also increases groundwater levels in the Mount therefore reducing the capacity for soakage.
- As the climate changes, rainfall is expected to become more intense.
- Groundwater may become emergent in parts of the catchment as early as 2070. Rates of sea level rise are likely to become greater than rates of vertical land movement and therefore will result in reduced hydraulic gradients. These effects will result in no discharge capacity in two of the five outfalls that service the catchment (Beca, 2020).

Following the confirmation of hazards within the scope of this work, the team prepared a plain English summary of hazards to be used in engagement and worked with an illustrator to develop Figure 4 below to be used as a communication tool throughout the project.

Figure 4: Mount North Hazards

The second part of understanding what is happening in the catchment requires an understanding of how flood risk is presently being managed. This is critical as implementation of projects with clear precedents or using techniques already being used in an area is easier than introducing unfamiliar ways of managing risk (Robichaux, Kench, & Owen, 2019). Within the catchment, flood risk is managed via:

- TCC gravity driven stormwater systems
- TCC regulations requiring finished floor levels of new builds above coastal inundation levels
- TCC Plan Change 27 which prohibits new developments from increasing flood risk (or stormwater discharge) to adjacent properties
- Individual property level interventions including bunded driveways, flood gates, block walls to re-direct flow, and pumps to dewater ponding stormwater or seawater that emerges through drains during king tides.

This mixture of physical and planned interventions from local government indicates that while changes in regulations can be contentious, the communities will be broadly familiar with multiple measures of reducing risk. The individual property level interventions demonstrate that where risk to property owners is intolerable, they are proactively incorporating measures to protect their individual properties.

The third and final component of the pilot in this phase was selecting a focus group. The focus group included residents, ratepayers, iwi, environmental trusts, and representatives from the business and tourism sectors. The focus group was identified via a stakeholder mapping exercise, contacted and provided with a briefing sheet to explain the project and their role. Individuals were not selected but rather nominated by their respective groups.

The Takawaenga Maori unit within TCC recommended engaging directly with the hapū within the project area – Ngati Kuku and Ngai Tukairangi who nominated kaitiaki to sit with the focus group. Prior to the rollout of full community engagement, more dedicated contact with hapū and iwi will occur.

To meaningfully test the process and seek feedback, surveys were prepared and passed out at each workshop with questions related to understanding and enjoyment of the workshop, how they were feeling, and suggestions for moving forward.

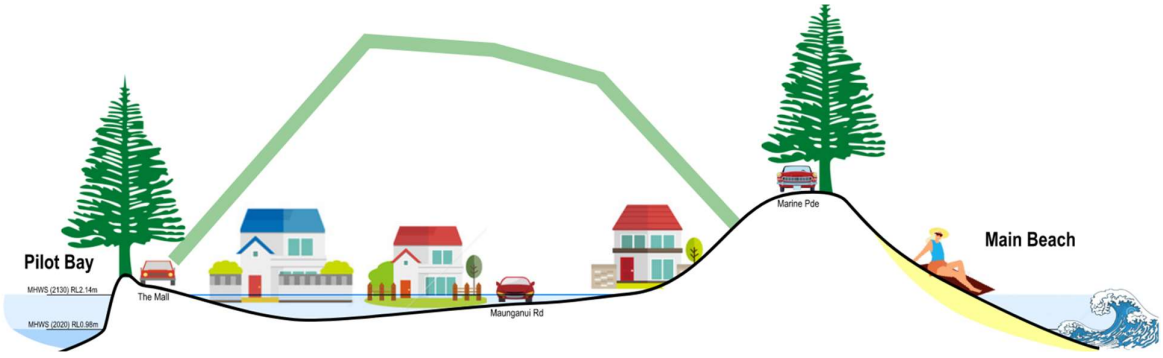
3.1.2 EXTERNAL PROCESS

The workshop focusing on 'what is happening' was held for the purpose of onboarding the focus group and establishing a foundational understanding of hazards impacting the area, their extents, their severity and how they will change over time. During this discussion, it was clear that in general, most of the group was extremely well informed – in fact, more than one was challenging and asking about mapping of compound hazards (noting that the modelling by Awa simulated proxies for increased sea level and elevated groundwater). However, not all of the group was fully aware of the hazards affecting the Mount so the information provided needed to be relevant for various levels of knowledge.

Simplified graphics such as Figure 4 and Figure 5 were used alongside more technical figures such as graphs showing sea level rise under various climate scenarios and maps of hazard extents. While the team tested simplified versions of the hazard maps, we opted not to use these in the workshop in favour of maps similar to what would be readily found online within TCC's GIS portal, Mapi, so that the focus group could readily find similar information at home or show their friends, families and others within the stakeholder group that they were representing.

The focus group asked questions related to why the Mount is first for adaptation planning, how this work sits alongside the Spatial Planning and Plan Change 33 (potential up-zoning) programmes, how the current stormwater system functions and to what degree were they exposed to hazards. Ultimately feedback was that the information provided was at the right level of complexity, though an explanation was required alongside the figures (e.g. pamphlets or posters would not provide the same value).

Figure 5: Simplified cross section of the Mount North catchment



3.2 WHAT MATTERS MOST?

3.2.1 INTERNAL PROCESS

The 'what matters most' phase is traditionally focused on the risk assessment following definitions of values and objectives. Because the IBC and associated modelling investigated risk to buildings and because land use and demographics in the Mount are generally well understood, the focus of this phase was on establishing values and objectives.

In parallel with the start of this work, there was ongoing engagement on the Mount Spatial Plan which identified a range of values or 'things that matter most' to people who live, work, or visit the Mount. From the Spatial Plan, the engagement identified elements of value and aspirations for the future of the Mount. This data was assessed by the project team to identify the values below that were presented to the focus group as a starting point for a brainstorm about 'what matters most'.

- **Cultural** – the community is passionate about celebrating and enriching Māori culture, and they want to preserve and enhance natural and historical landscapes. They have expressed the importance of preserving our landmarks such as Mauao, Moturiki Island, the beach, the dunes and Mount Drury (Hopukiore).

- **Social** – the community are concerned about safety and crime reduction; they want to see more health and wellbeing support. They believe access to outdoor activities and facilities should be maintained and improved to benefit the community and would like wheelchair and age friendly areas considered so that everyone can thrive together. The community also identified some concerns about rising sea levels, flooding and coastal erosion impacting the Mount and would like to see increased post-disaster response awareness.

- **Economic** – people want to improve and enhance Mount Main Street and Central Parade through improving the pedestrian experience and encouraging markets, live music and family-friendly activities, incorporating considerations climate risks into future development. They feel as though traffic and parking is an issue and want to encourage small businesses and innovation.

- **Environment** – the community identifies strongly with the natural landscape; people are into the outdoors and like to enjoy parks, the beach, reserves and walking tracks. People want to see more planting and biodiversity and want to improve community facilities and spaces and creating more green spaces for recreational activities, gatherings and events.

3.2.2 EXTERNAL PROCESS

In the interest of time, the 'what is happening' and 'what matters most' components were run in a single session. While this was to reduce the number of touch points for the pilot, it provided a useful, hopeful starting point for the project. The workshop started with introductions including name, which group the individual was representing, their relationship to the Mount (live, work, visit), and what they valued about the Mount area. This icebreaker served to set the context and establish that everyone in attendance was here because they care about their communities.

Following the discussion of hazards, the summarized spatial plan data was presented, alongside Figure 6 below to initiate the discussions on what people value about the Mount. Attendees value the village feel of the Mount, how it always seems as though you're on

vacation when you're at the Mount, proximity and access to nature, cultural heritage of tangata whenua, ability to gather kaimoana, weekly markets and other events, and the value of the local homes and businesses. They discussed the importance of these places, spaces and things of value and how if you were to lose any of these, the Mount would not feel like the same community. There was little discussion of specific buildings or built environment features but rather more focus on the environment and communities. While the themes of this discussion were similar to the Spatial Plan engagement results, the conversation centred more on "what makes the Mount special" rather than how they wanted it to change in the future. This discussion provided a good understanding of "what matters most" to guide discussions in later stages of the pilot.

Figure 6: Mount communities

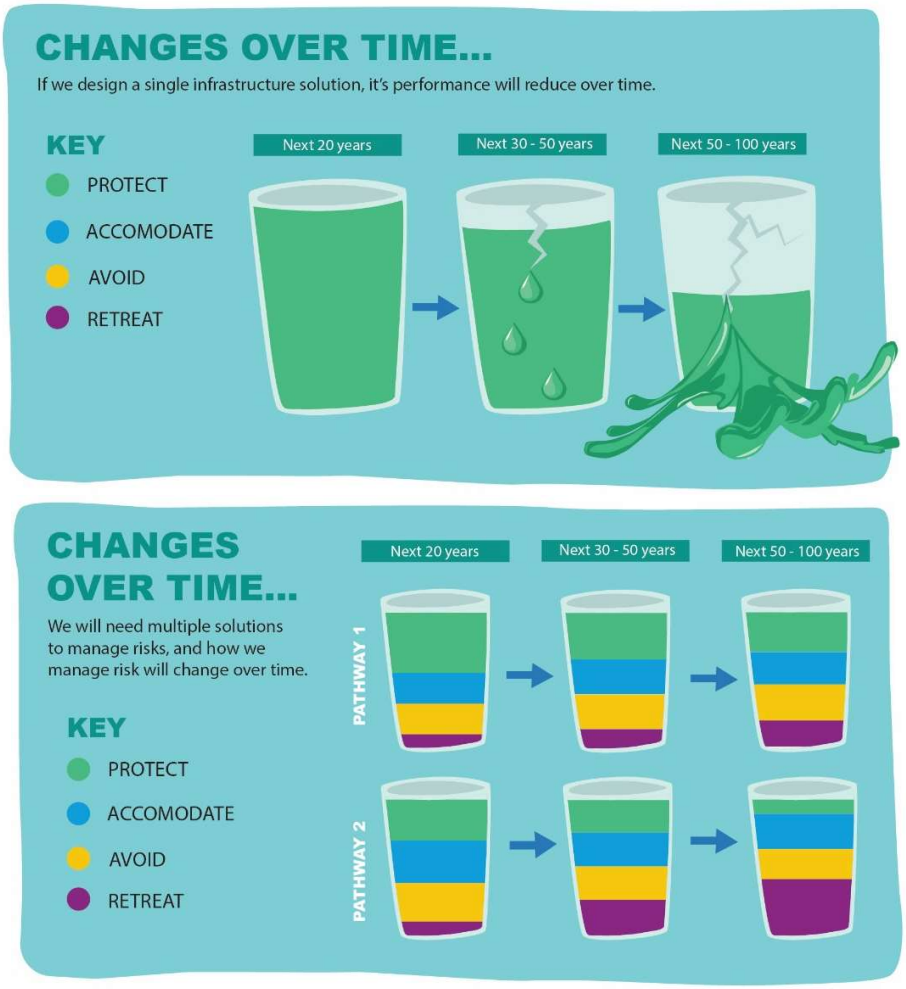
3.3 WHAT CAN WE DO ABOUT IT?

The "what can we do about it" stage was spread over three workshops with the focus group – brainstorming options, evaluating the long list of options, and shortlisting options to build pathways. This allowed for collaborative identification of options to build on the technical work that had been completed to date (through the options assessment and the IBC) and then for the focus group to see how their ideas are translated into options and then built into pathways. The internal and external process is described below.

3.3.1 INTERNAL PROCESS

To prepare for the brainstorming or design ideation workshop, the team knew that questions would likely trend to "so what do we already know?" and therefore reviewed the IBC and previous work in detail to be prepared to answer questions related to options previously identified considered. However, other than providing examples in the context of clarifying mitigation versus adaptation and the PARA (protect, accommodate, retreat, avoid) framework, the team wanted the focus group to feel empowered to suggest any and all options they could think of to build ownership of potential solutions. After testing options internally to depict the reduction in efficacy of a pumped solution over time and the benefits of a mixture of solutions over time, where proportions may also change over time, Figure 7 was developed. This allowed for members of the focus group to begin thinking about not just one option but a series of options with some options operating in parallel. This transitioned from an either/or mindset to a both/and to begin thinking about integrated flood risk management.

Figure 7: Reduction in efficacy of a pumped system versus a pathways approach to change risk management approaches over time

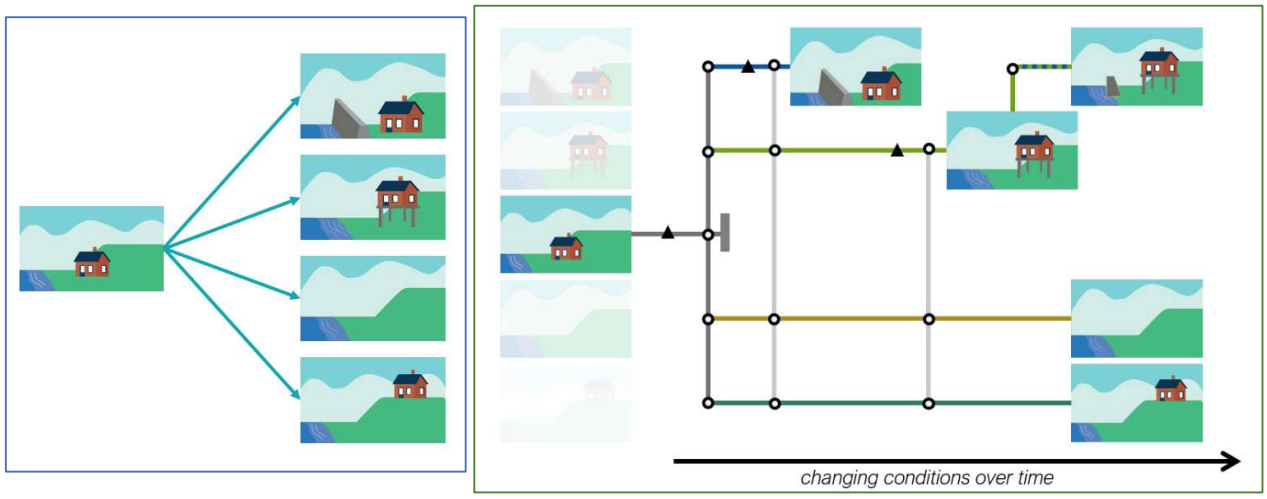


Following the brainstorming workshop, the team reviewed the list, combined some options, and added options where some were missing. This resulting list of 14 was then grouped in accordance with the PARA framework, and information sheets were developed with a visualization of the option (see Figure 8 for an example), a plain English description, some commentary related to how the option would affect the identified elements of value in the Mount, and some information about "what we know" using technical information previously developed (e.g. when costs were available, costs were included) and "what we don't know" clearly identifying where there were gaps in technical evaluations and there was uncertainty about potential performance of options. Other than the "what we do/don't know" sections, the information sheets were deliberately developed to be generic in nature so that TCC can use them beyond the Mount North area as required and just updating the site specific information. The visualizations, like shown in Figure 8, were developed using a conceptual image of a typical urban coastal town including mixed-density of residential areas and a main street. The conceptual images allowed conversations to remain high level rather than focusing on the details of exactly where interventions might be located or specifics on how the options would look in the Mount.

Figure 8: Visualization for "restore historic waterways" option

The final workshop was predominately to identify a shortlist and begin to build an understanding of pathways as well as to understand thresholds where adaptation would be required. To convey this, a simplistic coastal DAPP was developed and described showing "the usual way" (blue box) versus an adaptive planning approach (green box) as shown in Figure 9.

Figure 9: "The usual way" (left) versus adaptive planning (right)



3.3.2 EXTERNAL PROCESS

To guide the brainstorming session in the second workshop, the Disney Method was selected to encourage first dreamer thinking, followed by realist thinking and finally critic thinking (MindTools, 2024). This required all focus group members to dream up 'blue skies' ideas which did not need to be realistic or feasible. The dreamer stage allowed for uninterrupted flows of ideas where no idea is a bad one and all options are on the table. Following the dreamer stage, the realist stage required all focus group members to begin

discussing how realistic or feasible options were, and they at times asked technical questions of the facilitators who were able to provide answers based upon technical work to date (where technical work was available). Because the entire group was shifting from the dreamer phase to the realist phase, it reduced the tendency to protect your ideas and defend them because everyone was now in this realist space. Finally, the critic phase examined how the options might sit in the Mount context, particularly to identify barriers to implementation and how the options may impact the previously identified values of the communities.

The third workshop was predominately to present the refined (via combining some options and adding missing options) list of options back to the focus group members to seek feedback. This was done intentionally to build consensus on what each option is or isn't and to begin discussions of how each option might perform. Information sheets were presented on each option for feedback. Following the overview of options, focus group members were asked to identify options which most and least exemplified what they valued about the Mount, as discussed from Workshop 1. This allowed for a discussion of tradeoffs of various options. This workshop closed with an overview of how this kaupapa sits within the context of te ao Māori led by a Beca Kaiwhakatere. This served to ground the work in the principle of kaitiakitanga to prepare for the decision-makers to do the right thing at the right time by making a plan of action.

The final workshop shortlisted options by the group pairing up and selecting eight of the fourteen options. Reference cards with the name, image, a one sentence description and some key outcomes related to the previously identified values (as in Figure 10) were used to provide a tactile way of shortlisting and discussing options. Each pair presented their shortlist to the focus group and explained why the options that were not included in the shortlist were eliminated. This provided valuable insights into the perceptions of options as well as the level of influence of the facilitators ("we eliminated it because you said it wouldn't work!).

Figure 10: Reference cards used for Workshop 4

Finally, the group attempted a pathways building exercise following an explanation of a pathways approach. While the exercise was complex, the group readily understood that options would be combined, sequenced and actioned when required through this approach.

Lessons learned included how the exercise could be streamlined and simplified while still providing value to both communities and TCC.

ALIGNMENT WITH ONGOING TCC WORK

Research indicates that the more that adaptation planning is intertwined with other plans, projects and processes, the more likely it is to be implemented (Robichaux, Kench, & Owen, 2019). As the Mount North Flooding Adaptation Plan proceeds, this work will become increasingly integrated with ongoing work and initiatives across Council including:

- Other resilience work
- Plan Changes 27 and 33 (as well as future plan changes)
- Mount to Arataki Spatial Plan
- Tauranga Climate Action and Investment Plan
- Stormwater projects in the adjacent catchment
- Stormwater Reactive Reserve Fund
- Urban Form and Transport Initiative (UFTI)
- Coastal projects bordering the project area.

The pilot provided an opportunity to begin to explore how a DAPP process and how DAPP implementation may eventually integrate into existing TCC organizational processes. During the pilot, there were proactive discussions with ongoing work programmes to understand overlaps and likely interdependencies. As a result, the pilot has facilitated a scoping phase for the wider rollout which clearly defines the linkages between work and allows for proactive awareness raising, issue identification and capacity building.

CONCLUSIONS AND RELEVANCE TO INDUSTRY

More than 65% of New Zealanders live within 5km of the coast (Ministry for the Environment, 2019), and much of this area is low lying, either natural coastal margins or reclaimed land. The challenges of managing stormwater in these low-lying coastal areas are well documented (Foster, 2016; Bell, Stephens, & Lawrence, 2018) as the freeboard of infrastructure compared to mean sea level is 18-24cm less than it was in the early 1900s. The stormwater network has a replacement value of around $8.6 billion (White & Storey, 2021), and in low-lying areas with gravity driven stormwater systems, the ability to discharge will reduce rapidly as sea level rises.

These challenges mean that for many low-lying communities with gravity stormwater networks, substantial changes to how flood risk is managed will need to occur in the coming years. Many councils are starting to move towards a longer term adaptive planning approach to these challenges. These adaptive approaches will require communities, Councils, government organizations, and technical advisors to work collaboratively, sharing knowledge and experience to drive change and reduce future risk. Collaboration begins with open exchanges of ideas, successes and challenges, as are documented herein and should continue in the future.

DAPP is an approach used to explore stormwater decision-making in complex environments. In the case of Mount North, this catchment has high economic, environmental, cultural and social value while also being faced with significant flood risk due to the low-lying coastal nature of this urban catchment. The Mount Pilot showed the benefits of initial planning to test communications, upskill teams and develop clear actions on how to integrate a DAPP process within Council ahead of a wider rollout.

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REFERENCES

Awa. (2020). *Mount Maunganui North Options Modelling.* Tauranga.

Beca. (2020). *Improving Stormwater Management for the Mount Maunganui North (High Density/CBD) Catchment: Indicative Business Case.* Tauranga.

Beca Ltd. (2017). *Mount North (High Density / CBD) Flood Risk Management - Engineering Options.* Tauranga.

Bell, R., Stephens, S., & Lawrence, J. (2018). EMERGENT CHALLENGES ADAPTING COASTAL STORMWATER AND DRAINAGE SYSTEMS . *New Zealand Stormwater Conference*.

Crawford, R. (2014, April 18). *Flooding in Commons Ave, Mount Maunganui, 7.30am, 18 April 2014*. Retrieved from Youtube: https://www.youtube.com/watch?v=LDbdEwixutA

Foster, L. (2016). RESILIENT STORMWATER FUTURES FOR COASTAL CITIES . *New Zealand Stormwater Conference*.

Houghton, C. (2019, November 14). *Severe Flooding in Mount Maunganui*. Retrieved from SunLive: https://www.sunlive.co.nz/news/226616-severe-flooding-mount-maunganui.html

Liddle Crawford, R. (2024, April 20). Commons Ave flooded at Mount Maunganui. *Sun Live*.

MindTools. (2024). *The Disney Creative Strategy*. Retrieved from MindTools: https://www.mindtools.com/abyeaeb/the-disney-creative-strategy

Ministry for the Environment. (2019, October 1). *What the marine environment means to New Zealanders*. Retrieved from Ministry for the Environment: https://environment.govt.nz/publications/our-marine-environment-2019/what-the-marine-environment-means-to-new-zealanders/

Ministry for the Environment. (2024). *Coastal hazards and climate change guidance.* Wellington: Ministry for the Environment.

NIWA. (2018). *April 1948 Bay of Plenty Flooding*. Retrieved from NZ Historic Weather Events: https://hwe.niwa.co.nz/event/April_1948_Bay_of_Plenty_Flooding

NIWA. (2018). *April 2000 Bay of Plenty Flooding* . Retrieved from NZ Historic Weather Events: https://hwe.niwa.co.nz/event/April_2000_Bay_of_Plenty_Flooding

NIWA. (2018). *May 2005 Bay of Plenty and Waikato Flooding*. Retrieved from NZ Historic Weather Events Catalogue: https://hwe.niwa.co.nz/event/May_2005_Bay_of_Plenty_and_Waikato_Flooding

NIWA. (2018). *May-June 1962 New Zealand Flooding* . Retrieved from NZ Historic Weather Events: https://hwe.niwa.co.nz/event/May-June_1962_New_Zealand_Flooding

NZ Herald. (2004, April 29). *Homes flooded in Mt Maunganui*. Retrieved from New Zealand Herald: https://www.nzherald.co.nz/nz/homes-flooded-in-mt-maunganui/CHEPRNKPLGGJMM3SLM4OEQB4TM/

Otago Daily Times. (2013, April 20). *Drenched Bay of Plenty braced for more rain*. Retrieved from ODT: https://www.odt.co.nz/news/national/drenched-bay-plenty-braced-more-rain

Robichaux, L., Kench, P., & Owen, S. (2019). How Might Engineers Minimize the Implementation Gap in Coastal Risk Management? *Coastal Management 2019*. doi:10.1680/cm.65147.619

Rowan, J. (2005, October 12). *Tauranga stormwater upgrade to cost $52m*. Retrieved from NZ Herald: https://www.nzherald.co.nz/nz/tauranga-stormwater-upgrade-to-cost-52m/D7F2J2ZAXBRTVT4ZVLFMAXZNQQ/

Stuff. (2013, April 20). *Torrential rain hammers Tauranga*. Retrieved from Stuff: https://www.stuff.co.nz/waikato-times/news/8576294/Torrential-rain-hammers-Tauranga

Tauranga City Council. (2023). *Tauranga Climate Action and Investment Plan.* Tauranga: TCC.

Weather Watch. (2023, April 21). *Deluge in Mt Maunganui*. Retrieved from Weather Watch: https://www.weatherwatch.co.nz/content/exclusive-flood-photos-9-deluge-in-mt-maunganui

White, I., & Storey, B. (2021). Climate Change & Stormwater and Wastewater Systems. *Motu Economic and Public Policy Research*.