South Dunedin Future Adaptation Workstream:
South Dunedin Future Programme Overview

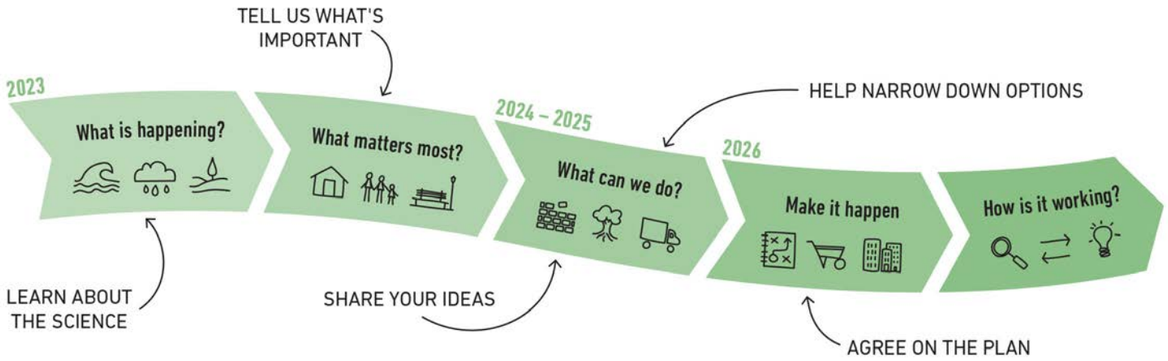
February 2025

South Dunedin Future

Adapting to our changing climate is a big challenge. South Dunedin Future (SDF) is a programme aimed at better understanding how the environment is changing, considering how that will affect us, and looking at what we can do about it.

Methodology Overview

The five stages of the SDF programme are summarised in the ribbon above, which captures the key questions relating to adaptation planning, as outlined in the Ministry for the Environment Coastal Hazards and Climate Change Guidance (2024). These are described below.



What is happening?

The initial stage of the SDF programme involved monitoring, investigation, and prediction work relating to a wide range of natural hazards affecting South Dunedin. The South Dunedin Risk Assessment summarises our current understanding of these hazards and outlines how they are expected to change over time, including in response to climate change.

What matters most?

The Risk Assessment also considers South Dunedin's exposure to these changing hazards, the vulnerability of things affected, and analyses the resulting risk – now and in the future. Understanding what is important and why allows an assessment of the consequences of risks to people, places, and assets in South Dunedin. This work considers many viewpoints and is informed by community engagement as well as a cultural values framework and assessment of risk from a mana whenua perspective. The Risk Assessment sets a risk baseline, providing a picture of what could happen to the things we value if appropriate action is not taken.

What can we do?

There are many things that can be done to adapt and reduce the level of risks affecting South Dunedin. Adaptation options are typically put into four categories – protect, accommodate, retreat, and avoid – each of which uses different ways to manage risk with each having a corresponding residual risk (the risk that remains with the option in place). This phase of the SDF programme seeks to determine the best mix of adaptation approaches for South Dunedin.

Drawing on best practice approaches from around the world, and ideas crowd-sourced from the community and stakeholders, a list of 16 generic approaches for helping South Dunedin adapt to flooding and future climate change was released in December 2023. These 16 approaches were consulted with the community in early 2024, with the feedback informing further analysis.

The 16 approaches have now been combined in different ways to form seven Potential Adaptation Futures for South Dunedin. They include a 'status quo' future - essentially the path we're currently on if we don't change anything - and six other futures representing a spectrum of responses, with a focus on infrastructure at one end and land use change at the other.

Visualisations of each of the seven potential futures are intended to show how South Dunedin could look in 75 years (end century) to inform further discussions with the community and stakeholders. The illustrations are based on best available information and expert analysis to date and offer a good early indication of where change might be required, what it could look like, as well as the potential implications of that change. The illustrations provide an understanding of what level of residual risk can be expected with each combination and this will in turn assist in identifying what is considered unacceptable risk for the South Dunedin community. In future phases, the viability of these futures and the limits of when further intervention is required will be further considered.

More work will occur over the next two years of the SDF programme, including detailed assessment of a shortlist and then preferred adaptation futures, which will confirm the locations, timing, scale and pathways for the recommended adaptation options. While a preferred future and pathway will be recommended through this work, the plan remains an adaptive one – allowing flexibility to shift to other pathways, accelerate or slow down as the climate and our communities change in order to avoid unacceptable risk. This will be documented in a final Adaptation Strategy for South Dunedin by December 2026.

Make it happen

Following completion of the final adaptation strategy for South Dunedin, and conclusion of the SDF programme, implementation will occur via a range of separate processes. This may include, for example, infrastructure investments, new council policies, and changes to the District Plan.

Is it working?

A range of processes will also be put in place to monitor progress, to determine how well the adaptation strategy is working, and whether changes are required to remain fit for purpose.

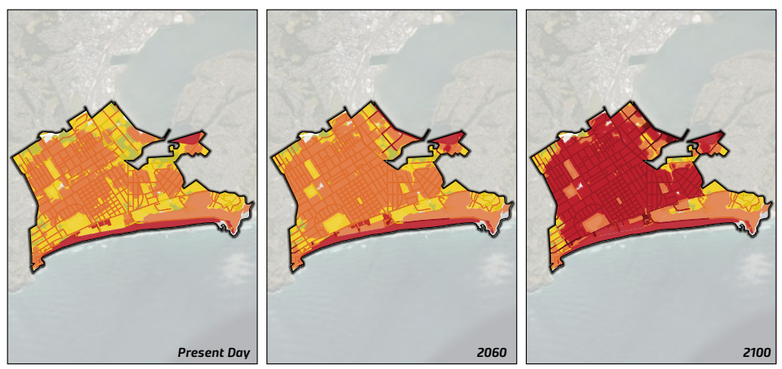
Immediate next steps

The next steps for the SDF programme include:

- Community engagement on the seven Potential Adaptation Futures.
- Refine the Potential Adaptation Futures into a shortlist of three or four futures and potential pathways to get there, followed by another round of community engagement.
- Further refine the shortlist of Potential Adaptation Futures into a preferred future and agreed pathway, supported by a final round of community engagement.
- Present the preferred adaptation future and pathways in an Adaptation Strategy for South Dunedin, which is expected by late-2026.

Summary of Risks to South Dunedin

Buildings, Parks & Transport



South Dunedin Future Boundary

Buildings, Transport & Parks
- 0 hazards
- 1 hazard
- 2 hazards
- 3 hazards
- 4 hazards

Hazards
Coastal erosion
Coastal inundation
Groundwater
Landslide
Liquefaction
Pluvial flooding

0 0.4 0.8 1.2 1.6 2 (km)

SOUTH DUNEDIN FUTURE

Summary of Risk Explainer: *These hotspot maps show locations in South Dunedin where buildings, roads, and parks are at high or medium risk due to one or more hazards. They show that many areas of South Dunedin are already subject to such risk from two or more hazards, which increases to three or more hazards over time, particularly on The Flat. Note: Illustrating an 'overall picture' of risk can be problematic in a South Dunedin context, given the large number of hazards assessed (6) and elements at risk (11) (i.e. 66 different risk layers would be needed, resulting in a convoluted image). Using a subset of selected risks can help illustrate a clearer overview. For example, buildings, roads, and parks are three elements at risk that collectively represent 100% of the geographical area in South Dunedin, so they offer a useful overview and can act as a proxy for identifying risk hotpots.*

Disclaimer: *These hotspot maps are intended to provide a visual overview of risk in South Dunedin but are not intended to be an accurate property-level assessment of risk, which requires much more detailed information and analysis. Using these hotspot maps in this way could lead to false or misleading conclusions about property-level risk (e.g. high risk areas may include many low risk properties, or the reverse).*

South Dunedin Future Adaptation Workstream:
Adaptation Planning Steps 1-5

Adaptation Planning Steps 1-5
Research and development of 16 adaptation approaches

The diagram to the right outlines how the SDF programme is moving through the five steps of "What can we do?" on the way to producing an Adaptation Strategy for South Dunedin.

Steps 1 & 2
Research on climate adaptation around the world was combined with ideas crowd-sourced from the community and stakeholders to develop 280 options consolidated into a list of 16 generic adaptation approaches. Community engagement on the 16 approaches occurred in early-2024.

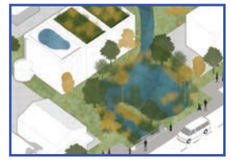

1. Ground Reinforcements

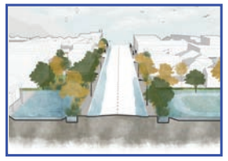

2. Ground water/ Lowering


3. Land Grading


4. Water Flow Improvements


5. Remove wastewater Network Overflow


6. Dedicated Water Storage


7. Floodable Infrastructure


8. Increase permeability


9. Coastal Protection


10. Behavioural/ Societal Changes


11. Readiness and Response


12. Property Interventions


13. Reactive Retreat


14. Managed Relocation


15. More Restrictive Standards


16. No New Development

Step 3: 7 Potential Adaptation Futures (Longlist)

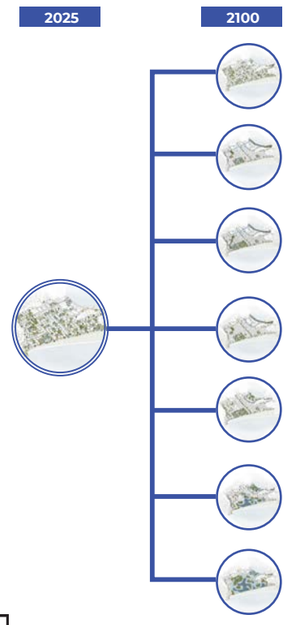
The 16 adaptation approaches have been refined and categorised as shown in the diagram on the next page, following community feedback and further technical analysis, then combined in different ways to form seven potential adaptation futures. Each of the seven possible adaptation futures represents what South Dunedin could look like in 75 years (the year 2100), noting that as conditions change over time, these futures could be realised earlier or later than 2100. Community engagement on the seven futures is planned for early-2025.

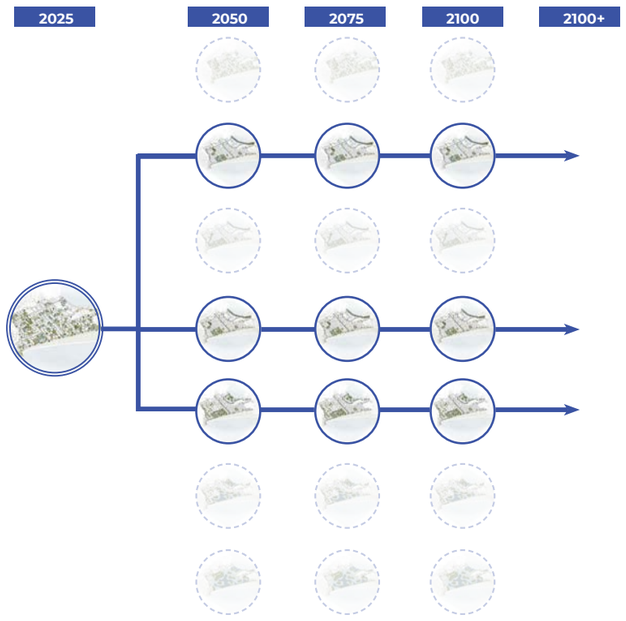
Step 4: 3-4 potential adaption futures and pathways (Shortlist)

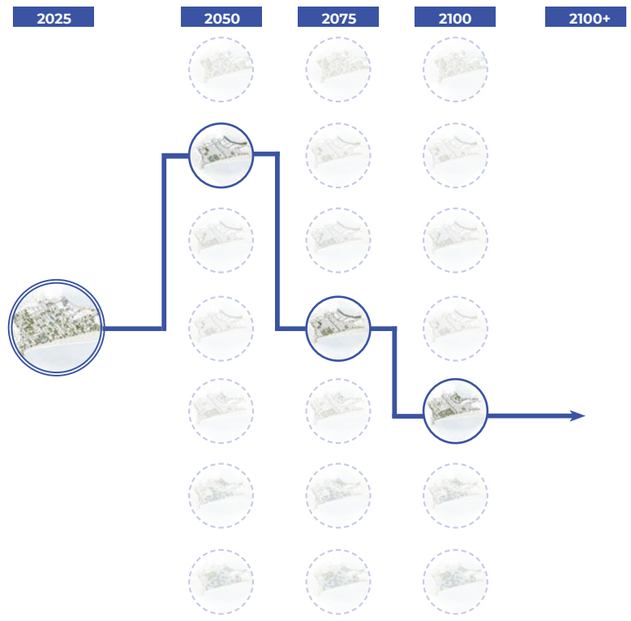
Feedback from community engagement, and further technical and economic analysis, will be used to refine the seven potential adaptation futures into a shortlist. Each of the shortlisted futures will include pathways showing what changes could look like at 2050, 2075, 2100 and beyond with more detailed information regarding the useful life for adaptation actions over time. New actions along the pathway begin when conditions signal the need for change. Community engagement on the shortlisted futures and pathways is planned for early-2026.

Step 5: Preferred adaptation futures and pathways

Feedback from community engagement and a final round of technical and economic analysis will be used to refine the shortlist into a preferred adaptation future and pathway. As shown, the other pathways still remain "on the table" if the climate or communities change in unexpected ways. Community engagement is planned for late-2026. The final version of the preferred adaptation future and pathway will be presented in an Adaptation Strategy for South Dunedin, which is expected by the end of 2026.







SOUTH DUNEDIN FUTURE

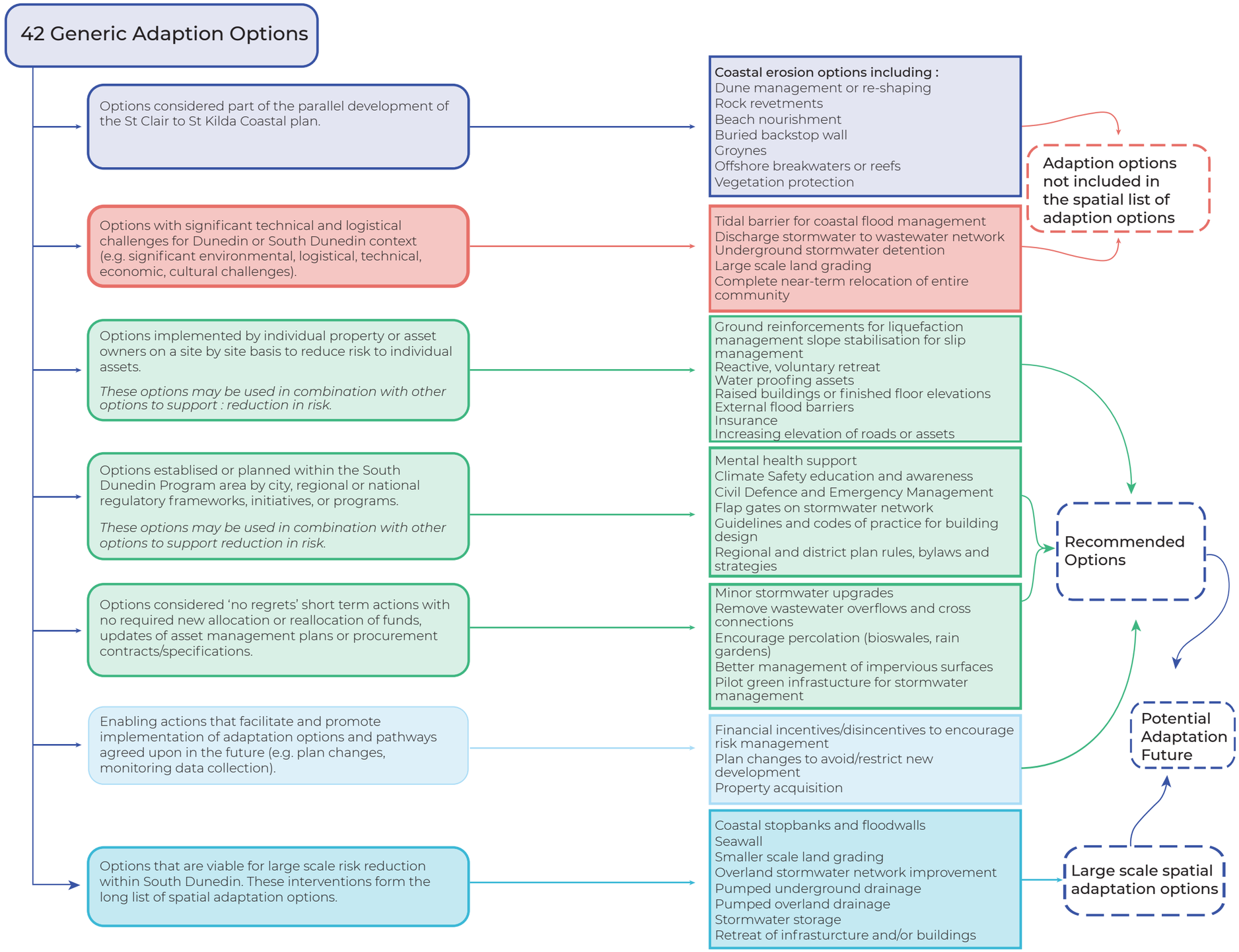
South Dunedin Future Adaptation Workstream:
Developing Potential Adaptation Futures

Developing Adaptation Futures

The seven potential adaptation futures developed during this stage reflect the spatial understanding of hazard and risk provided by the South Dunedin Risk Assessment (released February 2025). The Risk Assessment has highlighted the complex interrelated nature of the risks to South Dunedin and how they may change over time. It is clear that a holistic approach to the consideration of what we can do about the identified risks is needed and that there will be opportunities and implications with each, including the residual risk that remains (e.g. it is often not possible to completely eliminate risk, and 'residual risk' is the amount of risk remaining after efforts to reduce or eliminate it, such as the risk of a larger than planned flood event overtopping a stop bank).

A multi-step approach was used to develop adaptation futures starting with expanding the list of sixteen generic adaptation approaches to forty-two individual options. These options were screened to remove those considered in a parallel process in St. Clair/St Kilda (e.g., dune management or reshaping) as well as options that presented significant technical or logistic challenges rendering them not suitable (e.g., tidal barrier for coastal flood management).

The remaining options were divided into individual property-level interventions, existing or planned actions, recommended short-term actions, and viable community-scale interventions that could be effective into the long term. The viable community-scale interventions have been grouped into the seven potential adaptation futures, nothing that South Dunedin will continue to evolve in response to changing risks and communities beyond 2100.



SOUTH DUNEDIN FUTURE

South Dunedin Future Adaptation Workstream:
Potential Adaptation Futures Micro-business Cases Introduction

Summary of micro-business cases

The microbusiness cases provide an initial assessment of the potential adaptation futures. They serve as a tool for informed discussions with the community about how different combinations of adaptation options may help reduce risk, as well as what residual risks remain under each future, and the high-level costs and benefits. There is also an assessment against what matters most – what the community has told us is important and alignment with strategic objectives.

The seven potential adaptation futures each provide a snapshot in time. They sit on a spectrum, with an emphasis on infrastructure investment at one end and land use change at the other. There are infinite other potential adaptation futures, where different combinations of infrastructure and land use change could produce any number of new futures. These futures represent the spectrum from full reliance on traditional engineering interventions to reduce risk to making space for water relocating away from risky areas, with options that use blue-green networks and nature-based solutions in the middle. There are variations on these futures that include land elevation to create more space outside of the floodplain and above groundwater levels over the next 100 years.

The locations of adaptation options (e.g. seawalls, inland defences, waterways, elevated areas) shown in the visualisations are indicative and will be subject to further technical analysis, but are presented based on a high-level understanding of geography, hazards, and land use in South Dunedin.

Using cells to understand spatial adaptation options:

By dividing the SDF Programme area into smaller, manageable units (termed “cells” for this programme), climate impacts and adaptation options can be reviewed at an appropriate level of detail. This enables a more tailored approach and could support the delivery of targeted interventions that respond to the specific conditions of each cell. The risk assessment utilises census area units due to the availability of more refined data to support the detailed analysis. The cells were defined based on hazards and land use, namely:

Cell 1 – represents the area exposed to at least a medium risk of groundwater emergence (levels with 0.5m of the surface) for the 2060 SSP5-8.5 scenario that show a broadly similar pattern to the rainfall flooding exposure.

Cell 2 – covers the remaining area within the SDF project area that is lower than the water level of the 2100 SSP5-8.5 scenario (1.1m of sea level rise) and 1% coastal AEP event – to represent the maximum identified area of exposed area to coastal inundation.

Cell 3 – represents all other areas with the SDF project area higher than the level set for Cell 2.

Cell 4 – includes coastal areas from St Clair to St Kilda Beaches, Lawyer’s Head, and adjacent sand dunes. This cell is outside the scope of the SDF programme in this phase of work, but will be incorporated into Stage 4 Potential Adaptation Futures and Pathways (Shortlist).

Over time, the proportion of land contained within each of these cells would change in line with the potential options and futures invested in as the risk profiles change, with options that include land raising taking land from Cells 1 or 2 into Cell 3. This is illustrated in shifting cell boundaries in the visualisations of each future.

Mana Whenua partnership and collaboration

DCC and ORC each have partnership commitments with Mana Whenua. These partnerships are operationalised in a number of ways through the SDF programme, including in establishment of Mana Whenua Panel (the ‘Panel’) that provides Kāi Tahu inputs and oversight on behalf of Te Rūnaka o Ōtākou, and technical advice and operational support from Aukaha Ltd. Te Taki Haruru – the DCC’s Māori Strategic Framework – has also guided the SDF programme, helping councils to incorporate inputs and direction from the Panel.

A cultural values framework and assessment of risk from a mana whenua perspective have informed development of potential adaptation futures for South Dunedin, providing for rūnaka values, associations, and aspirations for South Dunedin to be captured in the overall assessments.

Throughout the assessments, a number of Te Reo words and concepts are used. These include:

- Wai - water
- Moana - ocean
- Mahika kai - food and resource gathering sites and practices
- Mauri - life force and vitality
- Te Mana o Te Wai - concept that protecting the health and mauri of water bodies is paramount to the health of wider natural ecosystem environment and health of people
- Ki Uta Ki Tai - a holistic, inter-connected and or catchment-wide approach to natural resource management
- Marae - meeting area hosted by mana whenua in front of a wharenui (meeting house), also used to refer to surrounding land and buildings
- Kaitiakitaka – exercise of guardianship by mana whenua
- Hauora – health and wellbeing.

SOUTH DUNEDIN FUTURE

South Dunedin Future Adaptation Workstream:
How to interpret the dashboard

Potential Adaptation Futures and Option Name

The seven Potential Adaptation Futures are presented in the dashboard and in the following micro-business cases. They include continuing with the status quo, hard infrastructure actions to keep the land dry through to land-use change enabling retreat to let water in.

Main components

Each of these Potential Adaptation Futures represent a combination of many actions to manage risk. The main components within each Potential Adaptation Future are presented in order of importance. The scale of relocation (land-use change) is a captured within key components such as elevated land, additional water storage (or wetlands), and open channels in particular – with the extent of change mostly represented through the 'properties potentially affected' figures. The components are colour coded to match icons within the visualisations presented in the micro-business cases.

Explanation of costs, benefits and benefit to cost ratio

Costs and benefits have been provided in the micro business cases to enable consideration of the possible implications of each potential adaptation future. The costs are based on a spatial mapping exercise undertaken to create one potential visualisation of the Potential Future scenarios presented in the microbusiness cases – noting that each 'Future' consists of multiple Adaptation Options. The identified options / assets incorporated within each potential future are one possible version of the quantity and type of options / assets included, their alignments, and locations. These have been utilised to create the quantities of each type of option (intervention) and the totals presented as the likely costs for each potential future.

The costs are high-level estimations and are intended to be comparative only at this long-list stage of the SDF Programme given the high associated uncertainty, particularly in relation to the pathways of short-, medium- and long-term options that may combine as part of each scenario. The cost estimates will become more accurate as the project progresses as options are further refined.

Each cost estimate is based on a typical detail for that option, calculated in accordance with available rates from a range of similar projects across New Zealand. The cost estimates follow established good practice methodologies adopted in Better Business Case processes in New Zealand. Costs are assumed to occur within the near future, with the costs presented at 2024 present values.

Costs

For the seven potential futures costs considered include:

- Construction capital costs – a build-up of costs per option included within each potential future. The costs include demolition and site clearance, utility services replacement and reinstatement
- Construction preliminaries
- Operation and maintenance costs
- Professional and internal fees
- Contingency and optimism bias
- Acquisition of properties - landholdings and buildings.

Capital costs have been adjusted including an optimism bias for a non-standard civil engineering project at this stage in accordance with Better Business case practice. Given the nature of this work and the early stage in an investment cycle, an upper bound for this bias range has been applied. This increases the expected net costs by 66%1. This is in line with Treasury advice for projects at this stage of development and this factor can be progressively reduced.

Exclusions at this stage of development include GST, contaminated waste disposal, unexpected ground conditions, rebuild of existing properties in new location, escalation or operational costs/downtime due to operations.

Failing to adapt will result in widening inequalities, with Potential Adaptation Future 1, showing a future where responses are primarily driven by individual actions and responses with minimal planned Council (or public) investment. This has been estimated to result in a $2 billion cost when accounting for damage to properties (insured and uninsured), lost productivity, work to fix infrastructure, etc. Notably, it is expected that the costs will climb higher still once social costs including stress suffered by affected residents and business owners are factored in, or in response to major weather events where the costs of recovery could be substantially higher still.

It is worth noting that economic assessments of benefits and costs are one method for evaluating potential benefits and disbenefits of actions, but given the complexities associated with changing urban environments, benefit cost ratios of 0.8 are generally accepted as being a good return on investment (based on experience from other jurisdictions and New Zealand). Additionally, other benefits that are traditionally hard to monetise could easily add further impetus to one of the potential adaptation futures.

The PV was calculated as the discounted sum of the annual average damages over the project horizon, where:

The discount rate applied is 2%, consistent with the social rate of time preference (SRTP) as prescribed by the New Zealand Treasury for cost-benefit analysis purposes.

The project horizon applied is 75 years.

Benefits

The main sources of benefits are monetised and grouped broadly as follows:

- Benefits associated with avoided fatalities
- Avoided residential and commercial property damages
- Avoided trauma
- Improved water quality
- Ecosystem Services benefits
- The value of new open spaces created
- Hedonic analysis – changes in property values and redevelopment premia within South Dunedin
- Avoided income loss from displacement
- Avoided emergency services costs.

Each potential adaptation future will have a different mix and makeup of the above monetised benefits, but the benefits are measured using the same methodology between the potential adaptation futures to ensure comparability between the scenarios.

Benefit to cost ratio

Irrespective of which potential adaptation future pathway is followed, these additional costs represent a considerable future delivery challenge for the local market when contrasted with the current Dunedin City Council capital delivery budget of $200m per annum for the entire city. If these costs were spread evenly over the next 50 years, the additional capital investment would be between $50m to $220m per annum within South Dunedin only.

For each of the seven potential adaptation futures, costs and benefits have been estimated based on present value (PV) in '$ billions of dollars'. This helps understand the 'estimated benefit to cost ratio' (BCR), whereby a BCR of zero or just above that is not viable and not likely to be funded, and a BCR close to 1 or more demonstrates more positive outcomes and as such more likely to be funded. Notably, it is acknowledged that the BCR should not be 'the' determining factor in the options selection process. Rather, it is one of the factors informing the evaluation of options through a multiple criteria assessment (MCA) exercise. BCR focuses on quantifiable costs and benefits. It may not capture important qualitative factors like environmental impact, social equity, or strategic alignment.

In summary, the BCR is a valuable tool for evaluating the financial viability of projects and decisions. However, it should be used in conjunction with other analyses and a thorough consideration of qualitative factors to make informed and well-rounded decisions.

Going forward, potential futures with a stronger performing BCR could be further refined through participatory public engagement and consideration of potential value uplift opportunities.

SOUTH DUNEDIN FUTURE

South Dunedin Future Adaptation Workstream:
How to interpret the dashboard

Properties potentially affected

The 'properties potentially affected' information presented on the dashboard represents the number of properties likely to be part of a managed relocation effort to enable reduction of risk to the surrounding area.

We have based our analysis on GIS overlays for residential and commercial property boundaries provided by Dunedin City Council. Overall, it has been assessed that there a total of 5,800 residential properties within South Dunedin (within the study area). For Potential Future 1, we have assumed that some 2,500 residential properties may need to be retreated with the total number of properties likely affected overall exceeding 5,000 properties. For Potential Futures 2 – 7 involving interventions, we have assessed the indicative number of properties likely to be part of a managed relocation effort to enable reduction of risk to the surrounding area.

We note that some of the affected properties may intersect with an identified option such as a potential wetland or a potential blue green corridor. An intersection may require relocation to enable the option to be delivered.

Ultimately, the true number of properties to be affected will only be known later once efficacy studies undertaken to test the place, size and number of adaptation options required. This will also determine the efficacy of the interventions and enable the benefits to be firmed up.

Difficulty of implementation

Difficulty of implementation includes considerations of constructability, phasing, and general feasibility of Council to action the potential adaptation future. Futures that require large scale property acquisition and/or land elevation will generally be challenging to execute and will require careful planning as well as community support.

Residual risk

A high level, qualitative assessment of how much risk remains unmitigated in each future is also presented, noting that this residual risk will evolve over time. Futures that include large scale managed relocation and/or land grading are likely to reduce risk to communities the most in the long-term, while futures that maintain the status quo or try to manage flooding via a hard engineering network are likely to have the highest residual risk.

Potential Adaptation Futures		Option Name	Properties Potentially Affected	Difficulty of Implementation	Residual Risk
	1.	Status quo	5000+		
	2.	Keep the land dry - pipes and pumps	700-900		
	3.	Keep the land dry - elevating land and pumping water	800-950		
	4.	Space for water - waterways and wetlands	600-700		
	5.	Space for water - waterways and raised land	800-950		
	6.	Let water in - relocation to raised land	2500-3000		
	7.	Let water in - large scale retreat	3500-4000		

- Low
- Medium
- High
- Extreme

SOUTH DUNEDIN FUTURE

South Dunedin Potential Adaptation Futures - Dashboard

Potential Adaptation Futures		Option Name	Main Components	Cost in Billions $ (2025-2100)	Benefit in Billions $ (2025-2100)	Benefit to Cost Ratio(BCR)	Properties Potentially Affected	Difficulty of Implementation	Residual Risk
	1.	Status quo	Pipes and pumps (minor stormwater network), reactive retreat, individual interventions 	$2.0B ($1.5B-$2.5B)	$0.2B ($0.1B-$0.3B)	0.1 (0.05-0.2)	5000+		
	2.	Keep the land dry - pipes and pumps	Pipes and pumps, coastal protection, storage 	$3.2B ($2.5B-$4.0B)	$2.3B ($1.5B-$2.5B)	0.7 (0.3-1.0)	700-900		
	3.	Keep the land dry - elevating land and pumping water	Pipes and pumps, land elevation, coastal protection, storage 	$5.8B ($5.0B-$8.0B)	$3.8B ($3.5B-$4.5B)	0.6 (0.4-0.8)	800-950		
	4.	Space for water - waterways and wetlands	Pipes and pumps, coastal protection, open channels, storage 	$2.8B ($2.0B-$4.0B)	$2.8B ($2.5B-$3.5B)	1 (0.6-1.6)	600-700		
	5.	Space for water - waterways and raised land	Pipes and pumps, coastal protection, open channels, storage, land elevation 	$7.1B ($6.0B-$10B)	$4.5B ($4.0B-$5.5B)	0.7 (0.4-0.9)	800-950		
	6.	Let water in - relocation to raised land	Pipes and pumps, coastal protection, open channels, storage, land elevation 	$6.8B ($6.0B-$10B)	$3.7B ($3.5B-$5.5B)	0.6 (0.3-0.9)	2500-3000		
	7.	Let water in - large scale retreat	Pipes and pumps, open channels, storage 	$5.0B ($4.5B-$8B)	$3.7B ($3.5B-$4.5B)	0.7 (0.4-1.0)	3500-4000		

SOUTH DUNEDIN FUTURE

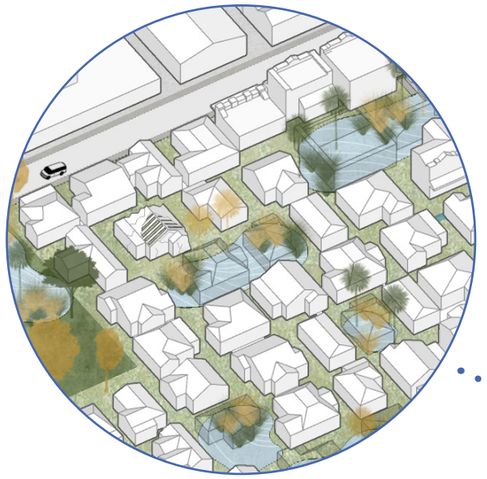
Pipes and pumps
Coastal protection
Open channels
Individual interventions
Storage
Land elevation
Reactive retreat

Note: Cost, benefit, properties potentially affected, implementation and residual risk are estimated over a 75 years period 2025-2100.

Low **High**
Medium **Extreme**

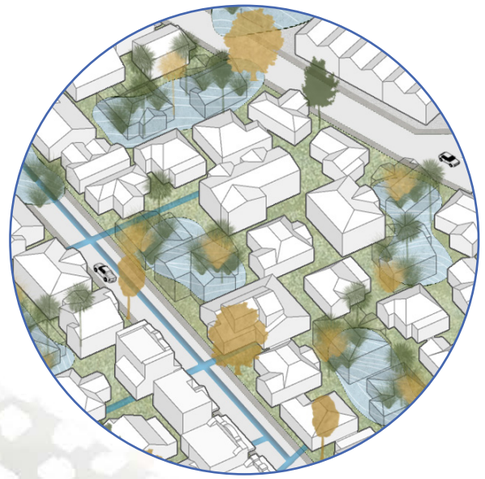
Potential Adaptation Future 1 : Status quo

Main Component	Cost in Billions $	Benefit in Billions $	Benefit to Cost Ratio (BCR)	Properties Potentially Affected	Difficulty of Implementation	Residual Risk
Pipes and pumps (minor stormwater network), reactive retreat, individual interventions	$2B	$0.2B	0.1	5000+		



Reactive retreat (relocation)

Over time, residents who have the financial means to move would relocate from South Dunedin as they become less willing to endure damp conditions with increasingly frequent flooding and associated costs of repairs. For residents who cannot afford to retreat or make changes to their properties, they will live in increasingly damp and flood prone conditions.



Minor stormwater network upgrades

Minor stormwater network upgrades, such as increasing pipe sizes at bottle necks and installing check-valves to help control the flow of water, would be actioned with continued and improved maintenance of the network.

Changes to individual properties

Because there are no significant community scale flood risk management actions, people would need to self-fund changes to their own properties so they're more resilient to flooding. This might include waterproofing or raising first floors or installing small pumps to manage groundwater and flooding around private property. Changes to building foundations to manage liquefaction and seismic risks would also be likely to be needed.

KEY

- Retreat
- Property-level intervention
- Civil Defence and Emergency Preparedness
- Better management of impervious surfaces
- Minor stormwater network upgrades
- Cell 1
- Cell 2
- Cell 3

Civil Defence and Emergency Preparedness

The Civil Defence team would need to become increasingly active in supporting communities before, during and after emergency events.

Slowing the flow of stormwater

Better management of surfaces that don't absorb water could be achieved by property owners adding more tanks to their individual properties to capture rain or green roofs in the upper catchment. This would help to reduce the flow of rain into the stormwater network and to the Flat, during small rainfall events as it would not be effective during extreme rain.

Disclaimer: Options shown are not limited to the spatial locations shown but are rather intended to provide indicative examples.

Potential Adaptation Future 1:
Status quo

Overview

In this future, there would be a focus on people individually adapting their properties to become more resilient to flooding. Existing ways of managing flooding by Council would continue, with minor stormwater upgrades and more reliance on Civil Defence and emergency preparedness. Increasing flood risk over time would increase insurance costs, impacting lower socio-economic and vulnerable groups in particular. Conditions in South Dunedin would decline, and there would likely be pressure on Council for action.

Because of the individual nature of this future, it is likely that some residents would decide to move away from South Dunedin, others would stay and modify their property, and the remainder would live in housing exposed to increasingly damp and flood prone conditions. Rising groundwater, sea-level, and flood risk would disrupt council services and infrastructure and increase delivery costs.

Interventions in order of importance

- Changes to individual properties
- Reactive retreat
- Minor stormwater network upgrades
- Civil Defence and emergency preparedness

How much could it cost?

- Key capital and operational costs are estimated at 2024 PV $1.5 - 2.5bn* over a 75-year period. While this is a relative low cost in comparison to other options, this is only Council's costs and excludes the significant costs borne by individual property owners.
- The expected cost of inaction spread over a 75-year period is estimated at 2024 PV of $1.2bn, including an anticipated reduction in available properties across the area.
- Quantified benefits are estimated at 2024 PV $0.2 - 0.4bn* over a 75-year period, noting that not all benefits have been quantified.

Advantages:

- Lower public sector investment
- Maintains existing urban fabric.

Disadvantages:

- Highest residual risk from flooding impacts on properties
- High likelihood of insurance retreat
- High likelihood of economic blight and potential finance withdrawal.
- High likelihood of decline in property values and decreased economic vitality
- Higher likelihood of injuries and fatalities
- Lower levels of social cohesion
- Higher likelihood of labour displacement
- Heavy reliance on private interventions.

* There is a high degree of uncertainty around these costings and analysis to offset costs from potential land value uplift or redevelopment premium arising from these works has not been included.

What else do we need to action it?

- **Financial incentives or enforcement:** Financial incentives or enforcement would be needed to support changes to individual properties and manage insurance premiums.
- **Land use regulations:** Changes to land use regulations may be necessary to facilitate raising buildings, installing rainwater tanks, and green roofs.

Timeframes

Timelines for implementation are based upon community ability to finance property-level improvements. Council actions such as minor upgrades to the stormwater network would begin as soon as possible.

SOUTH DUNEDIN FUTURE

Impacts and Outcomes

Sustainable urban development

- Unlikely to result in substantial reductions in whole-of-life emissions and energy use. This is due to the lack of long-term planning and collective efforts to optimise materials use and reduce emissions.
- Limits any changes from current urban form and would not provide improved spaces for people, water or wildlife.
- Relies on individual uptake for integration of water sensitive design into urban design. There would be a potential decrease in amenity due to reliance on individual change and the risk of area deterioration.

Promote community safety

- Likely significant negative impacts on community hauora, health and wellbeing due to frequent flooding, damp conditions and future uncertainty which can lead to health issues, stress and anxiety, especially for vulnerable populations and those unable to afford property-level interventions.
- Changes in community safety driven by enhancement of awareness due to frequent hazard events but are limited by individual uptake of preventative measures.

Environmental and cultural restoration

- Offers minimal ecological improvements in the long-term (i.e., ecological state in this future would be like the existing state) likely enabling continued degradation and loss of biodiversity, wai, moana and cultural practices such as mahika kai.
- Possible improvement in the water quality of runoff to marine ecosystems during regular rainfall events, likely outweighed by the negative impacts of frequent flood events.
- Negative impacts on cultural connection to places and spaces in South Dunedin as deterioration and possible pockets of green space would occur as groundwater emerges and some opt to abandon buildings.
- Negative mauri effects in the harbour and coastal waters due to ongoing contamination. Misalignment with Te Mana o Te Wai due to the continued changes to watercourses and with ki uta ki tai approach due to heavy reliance on hard infrastructure to move water, and lost opportunities for mana whenua to work as a partner in developing adaptation responses.

Just transition

- Limits opportunities for the community by gradual loss of employment and residential land (including assets) due to increasing hazards. This would result in decreased capital value affecting the ability to draw-down finance and insure property.
- Potential for significant disadvantages for vulnerable communities unable to afford property-level interventions or increased insurance premiums, which may result in increasing the socio-economic gap.
- Misalignment with just / equitable transition outcomes, as substandard conditions are the driver for people reactively retreating with no strategic approach to supporting relocations. Poor intergenerational equity as problem will become worse over time with fewer benefits.
- Disruption to transport links within and beyond South Dunedin become more frequent over time, including to Ōtākou marae and the peninsula.

Social and economic resilience

- Reduced community cohesion and fragmenting of networks as frequent floods and deteriorating conditions cause those who can afford to leave to leave.
- Likely enhancement of adaptive capacity via knowledge of what is happening with direct climate hazard experiences and personal responsibility with property-level interventions, but people leaving erodes collective understanding of long-term risks.
- Businesses are likely to experience varying impacts due to their different financial situations that limit the ability to implement risk reduction measures on their properties. Deteriorating property conditions reduce resilience, and people leaving diminishes the collective understanding of long-term risks.
- Likely variable impacts to individuals as unequal financial situations limits ability to incorporate property level risk reduction, deteriorating property conditions reduce resilience, and out-migration erodes communities. Reliance on individuals to make changes to their properties may be uncoordinated and produce unintended consequences for their neighbours.

How it will reduce risk:

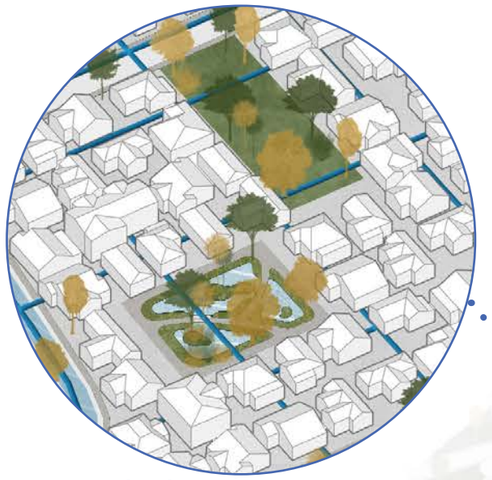
- **Community cultural hubs:** Present and long-term high risk associated with coastal inundation would not change. Pluvial and groundwater flooding risk may be reduced; however, it will be site specific, and further groundwater modelling is necessary.
- **Cultural sites/features:** Present and long-term high risk associated with coastal inundation would not change. Pluvial and groundwater flooding risk may be reduced; however, it will be site specific, and further groundwater modelling is necessary.
- **Social networks and exposure of community features:** In the long-term, this option does not reduce exposure to flooding hazards and maintains high long-term risk rating to communities' capacity to participate in community networking activities and accessibility to goods, services, and amenities. Damage to property increases with frequent flooding events.
- **Community safety:** In the long-term, it does not reduce risks to residents' health and wellbeing, as accessibility to work, education, insurance and property finance decreases with frequency of flooding events.

What we've heard from the community:

- ✖ The community wants action, many say doing nothing is unacceptable.
- ✖ Many say they feel nervous every time it rains; they do not want people to be stranded in a flood.

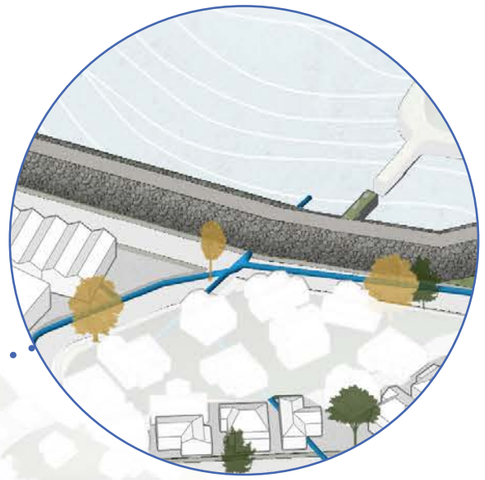
Potential Adaptation Future 2 : Keep the land dry with pipes and pumps

Main Component	Cost in Billions $	Benefit in Billions $	Benefit to Cost Ratio (BCR)	Properties Potentially Affected	Difficulty of Implementation	Residual Risk
Pipes and pumps, coastal protection, storage	$3.2B	$2.3B	0.7	700-900		



Managed relocation

Managed relocation requires the strategic and proactive buyout of properties and assets to reduce risks. Managed relocation via strategic acquisition (buyouts) of properties in key areas of the Flat would be needed to make space for risk management infrastructure (e.g., wetlands or ponds and pump stations).



Coastal protection

The seawall along Portsmouth Drive is made bigger and extended to protect Bayfield Park and the rest of South Dunedin from future coastal flood events. This is not likely to be required until mid to late century.

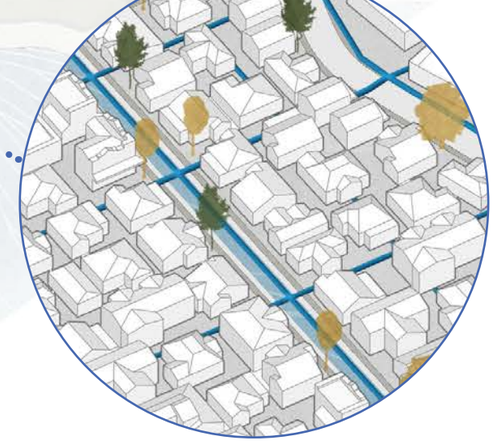
Storage

This would include conversion of open spaces in the Flat (e.g., Forbury Park) to intentional water storage that manages high groundwater and provides flooding attenuation. This option is connected to the pumped drainage network and provides additional capacity to the system.

KEY

- Retreat
- Storage
- Overland Flowpath
- Sub-surface Drainage
- Coastal Protection
- Pump

- Cell 1
- Cell 2
- Cell 3



Pipes, pumps and flow paths

Sub-surface drainage network improvements include pipes or permeable underground layers to manage groundwater and stormwater throughout South Dunedin. These systems would lower groundwater daily via pumping while also having sufficient capacity to drain water when it rains. Overland flow paths along roadways or other open spaces would improve drainage capacity and reduce the risk of pluvial flooding hazard to properties.

Disclaimer: ***Options shown are not limited to the spatial locations shown but are rather intended to provide indicative examples.***

Potential Adaptation Future 2:
Keep the land dry with pipes and pumps

Overview

A network of pipes and pump stations would be used to manage stormwater and groundwater in this future. It would be supported by overland flow paths, wetlands and/or ponds for storage during large rainfall events. The existing seawall along Portsmouth Drive would be made larger and extended to protect from future coastal flooding. While this infrastructure investment can reduce some risk, some will remain during extreme events.

Interventions in order of importance

- Pipes, pumps and overland flow paths
- Coastal protection
- Storage
- Managed retreat (relocation)

How much could it cost?

- Key capital and operational costs are estimated at 2024 PV $3 - 5bn* over a 75-year period.
- Quantified benefits are estimated at 2024 PV $1.5 - 2.5bn* over a 75-year period, noting that not all benefits have been quantified.

Advantages:

- Reduced property damages
- Reduced levels of trauma
- Redevelopment potential
- Increased economic vitality
- Lower likelihood of deaths/injuries
- Opportunity for economic regeneration and job creation
- Maintain and enhance existing community structures
- Maintains insurance coverage.

Disadvantages:

- Significant disruption during construction
- Lower topography still at risk from flooding
- Potential for over design events or infrastructure failure to have significant impacts on the community
- Increased carbon intensity of replaced infrastructure with additional assets.

* There is a high degree of uncertainty around these costings and not undertaken analysis to offset costs from potential land value uplift or redevelopment premium arising from these works.

What else do we need to action it?

- **Funding mechanisms:** Financial incentives or enforcement would be needed to support changes to individual properties and manage insurance premiums.
- **Property acquisition (buyouts):** Buyouts will be needed to make space for stormwater management.
- **District plan changes:** Plan changes, such as amending zoning laws would be needed to restrict development in high-risk flood zones.
- **Financial incentives or penalties:** Changes in regulations and financial incentives would encourage managed relocation.

Timeframes

Buyouts to make space for storage and elements of the pumped network occurs over the next 10-20 years to enable management of groundwater and flooding. Increase in capacity of the pipe network begins in the highest risk parts of the catchment and grows to include all of South Dunedin. These capacity increases should be designed to enable future addition or changes over time to respond to climate change. The seawall would be upgraded between 2060 and 2100 depending on the rate of sea level rise.

SOUTH DUNEDIN FUTURE

Impacts and Outcomes

Sustainable urban development

- Likely to result in high operational and embodied emissions associated with reliance on pipe and pump based sub-surface drainage, limiting potential for long-term sustainability.
- Misses most of the opportunities for improving the urban and natural environment by maintaining current urban form.
- Limited application of water sensitive design and enhancement of amenity.

Promote community safety

- Likely positive impacts to hauora, health and wellbeing due to reducing extents of high-risk areas, reducing health risks from flooding and damp conditions, alleviating the burden on health services and maintaining access to essential services. Visible improvements can reduce anxiety and foster safety.
- Positive reductions in risk and improvements in safety; however, risks during extreme events and if infrastructure (e.g. pumps) fail remain significant.

Environmental and cultural restoration

- Moderate increase in ecological benefits from the creation of green spaces and freshwater ecosystems but limited due to lack of direct connectivity with lost opportunities to restore and enhance biodiversity, wai, moana and cultural practices such as mahika kai. Coastal fauna will likely be impacted by seawall footprint, but incorporating design features like living seawalls could improve habitat quality.
- Likely improvements to discharge water quality due to integration of modern treatment devices in pipe network.
- Limited enhancement of cultural connections to place as the natural environment would not be integrated into the urban framework, and while open spaces may become more naturalised, the changes of their existing use may damage connections to place.
- Missed opportunity for restoration of mauri due to focus on piped solutions, misalignment with Te Mana o Te Wai due to the continued watercourse modification and with ki uta ki tai approach due to heavy reliance on hard infrastructure to move water, and lost opportunities for mana whenua to work as a partner in developing adaptation responses.
- Missed opportunities for a tikaka approach to water management and limited opportunities for mana whenua to re-establish connections and enhance rakatirataka and kaitiakitaka.

Just transition

- Better enables retention of local employment and income generation by reducing scale of retreat and preserving existing infrastructure, business and commercial areas, resulting in lower impacts on employment and income generating opportunities.
- Reduced financial burden on individuals with community-level infrastructure, reducing direct financial impacts of floods especially for low-income communities.
- Potential for inequitable transitions where only some properties and assets are proactively acquired. Poor intergenerational equity as in the long- term, piped solutions will require increased maintenance and become less effective, and as climate change continues, the risks will compound requiring further interventions beyond this century.
- Access to key facilities and economic opportunities around and beyond South Dunedin is maintained along existing transport routes with some temporary disruption during storms.

Social and economic resilience

- Maintains community cohesion by allowing communities to remain in place and access to services and social hubs retained, including to Ōtākou marae and the peninsula.
- Likely minimal change to adaptive capacity via knowledge of what is happening beyond knowledge sharing during plan development.
- Minor impacts to businesses as existing infrastructure is maintained and risks are reduced with low levels of disruption.
- Positive impacts to individuals and communities as existing infrastructure is maintained and risks are reduced with low levels of disruption.

How it will reduce risk:

- **Community cultural hubs:** Likely reduces long-term pluvial and groundwater flooding risk from high to medium and for coastal inundation from high to low. It may increase cultural impacts associated with access to coast on the harbourside.
- **Cultural sites/features:** Likely reduces long-term pluvial and groundwater flooding risk from high to medium and reduces coastal inundation risks from high to low.
- **Social networks and exposure of community features:** In the long-term, this option does not reduce exposure to flooding hazards and maintains high long-term risk rating to communities' capacity to participate in community networking activities and accessibility to goods, services, and amenities. Damage to property increases with frequent flooding events.
- **Community safety:** Likely long-term reduction in risks to residential buildings from high to medium or low risk. Requires a strong understanding of social and cultural dynamics associated with connection to coastal area on the harbourside. There is potential for damage and harm associated with potential over-design events or failure.

What we've heard from the community:

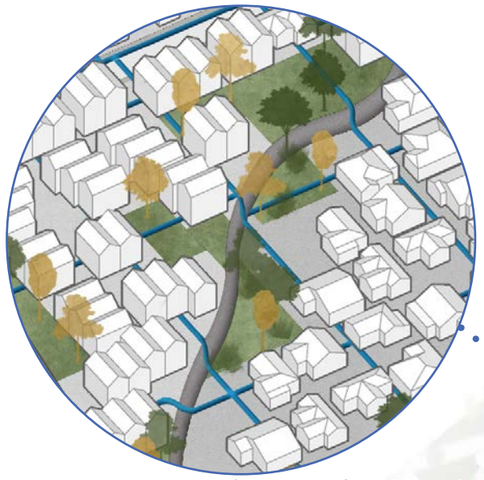
✓ Many thought that water flow improvements like subsurface drainage networks and open channels are a must.

✓ There is an interest in wetlands and ponds providing opportunities for a more attractive natural environment.

✗ There's concern over hard engineering solutions like seawalls and other infrastructure upgrades being costly, in some cases impacting access to coastal areas and possibly only providing short- term relief.

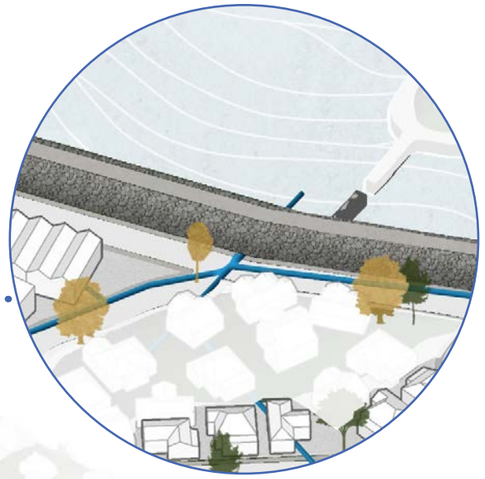
Potential Adaptation Future 3: Keep the land dry - elevating land and pumping water

Main Component	Cost in Billions $	Benefit in Billions $	Benefit to Cost Ratio (BCR)	Properties Potentially Affected	Difficulty of Implementation	Residual Risk
Pipes and pumps, land elevation, coastal protection, storage	$5.8B	$3.8B	0.6	800-950		



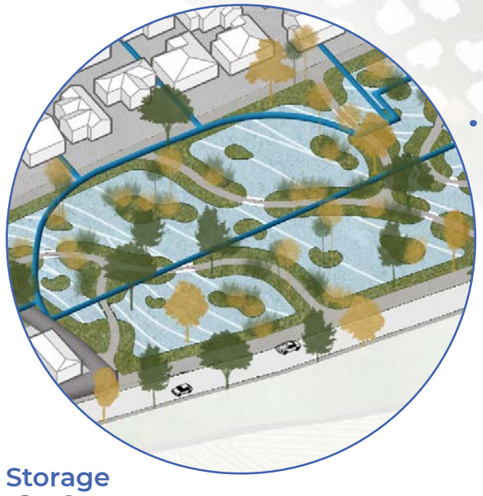
Managed relocation to raised land

Land grading involves making ground levels higher through placement of fill material to reduce risk to pluvial, groundwater and coastal flooding. The managed relocation of communities to raised land would require strategic and proactive acquisition (buyouts) of properties and assets to clear build up and redevelop a safe elevated area.



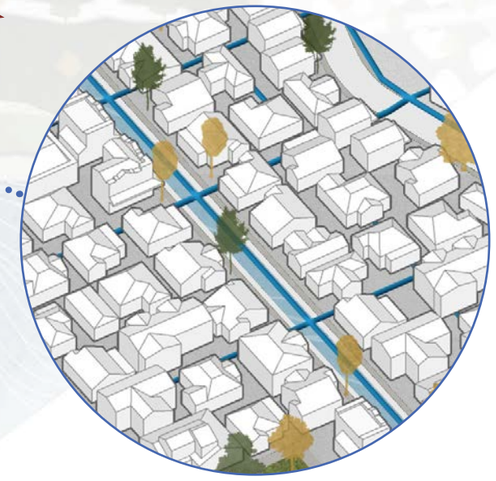
Coastal protection

The seawall along Portsmouth Drive is enlarged and extended to protect Bayfield Park and the rest of South Dunedin from future coastal flood events. This is not likely to be required until mid to late century.



Storage

Open spaces in the Flat, such as Forbury Park, would be turned into areas designated for water storage. This approach helps reduce the risks associated with pluvial and groundwater flooding, as well as liquefaction. The system would be supported by pipes and pumps.



Pipes, pumps and flow paths

Sub-surface drainage network improvements include pipes or permeable underground layers to manage groundwater and stormwater throughout South Dunedin. These systems would lower groundwater daily via pumping while having sufficient capacity to also drain water when it rains. Overland flow paths along roadways or other open spaces improve drainage capacity.

KEY

- Retreat
- Storage
- Overland Flowpath
- Sub-surface Drainage
- Coastal Protection
- Pump

- Cell 1
- Cell 2
- Cell 3

Disclaimer: ***Options shown are not limited to the spatial locations shown but are rather intended to provide indicative examples.***

Potential Adaptation Future 3:

Keep the land dry - elevating land and pumping water

Overview

This future would manage stormwater and groundwater mainly via a network of pipes and pump stations, supported by overland flow paths and wetlands or ponds for storage during large rainfall events. A seawall along Portsmouth Drive is made bigger and extended to protect from future coastal floods. To support this, an area of land is raised and intensified to provide space for people to relocate to, away from areas of highest risk.

Interventions in order of importance

- Pipes, pumps, and overland flow paths
- Storage
- Managed relocation to raised land
- Coastal protection

How much could it cost?

- Key capital and operational costs are estimated at 2024 PV $5 - 8bn* over a 75-year period.
- Quantified benefits are estimated at 2024 PV $3 - 4.5bn* over a 75-year period, noting that not all benefits have been quantified.

Advantages:

- Significantly reduced property damages
- Reduced levels of trauma
- Redevelopment potential
- Opportunity to Increase economic vitality
- Lower likelihood of deaths/injuries
- Opportunity for economic regeneration, job creation and recreating new communities
- Opportunity for reduced insurance premiums.

Disadvantages:

- Significant carbon and cost implications from importing additional material to elevate land safely
- Significant loss of existing dwellings to enable raising of land
- Potential for over design events or infrastructure failure to have significant impacts on the community within the lower elevations.

* There is a high degree of uncertainty around these costings and analysis to offset costs from potential land value uplift or redevelopment premium arising from these works.

What else do we need to action it?

- **Changes in land use regulations:** Changes in land use regulations to avoid risky new developments or to facilitate elevation by providing access to consented fill sources (e.g. new quarries) may also be required.
- **Financial incentives or penalties:** Financial incentives or penalties will encourage behaviour change and relocation.
- **Property acquisition (buyouts):** Properties would need to be purchased to create space for stormwater storage and land raising.
- **Funding mechanism:** Agreeing on funding mechanisms would be essential for managed retreat.

Timeframes

Where land elevation will occur, property buyouts may be accelerated (e.g. next 20 years) to allow time to build up the land and build homes and businesses prior to the increase in emergent groundwater mid-century. Retreat to make space for storage and elements of the pumped network occurs more slowly to manage groundwater and flooding. This allows for a slow transition of communities to outside of the South Dunedin area but requires careful consideration and planning to avoid social impacts and loss of cohesion. The seawall will be upgraded between 2060 and 2100 depending on the rate of sea level rise.

SOUTH DUNEDIN FUTURE

Impacts and Outcomes

Sustainable urban development

- Likely to result in very high embodied and high operational emissions due to land raising and ongoing reliance of pipe and pump based sub-surface drainage, limiting potential for long-term sustainability.
- Provides opportunities to improve the urban environment and allow South Dunedin to grow with safer areas for development, with limited opportunity for restoring the natural environment but will temporarily displace many people and businesses out of South Dunedin.
- Limited application of water sensitive design but enhanced amenity in raised area.

Promote community safety

- Likely positive impacts to hauora, health and wellbeing due to reducing extents of high-risk areas, reducing health risks from flooding and damp conditions, alleviating the burden on health services and maintaining access to essential services.
- Visible improvements can reduce anxiety and foster safety, and land raising creates lower risk areas; however, retreat and infrastructure changes to make space for land raising are likely to disrupt communities and cause temporary inconvenience, including access to health services.
- Positive reductions in risk and improvements in safety; however, risks during extreme events and if infrastructure (e.g. pumps) fail remain in the areas not elevated.

Environmental and cultural restoration

- Moderate increase in ecological benefits from the creation of green spaces and freshwater ecosystems but limited due to lack of direct connectivity with lost opportunities to restore and enhance biodiversity, wai, moana and cultural practices such as mahika kai.
- Likely improvements to discharge water quality due to integration of modern treatment devices in pipe network.
- Limited enhancement of cultural connections to place as the natural environment is not integrated into the urban framework, and while open spaces may become more naturalised, the changes of their existing use may damage connections to place.
- Missed opportunity for restoration of mauri due to focus on piped solutions and major earthworks, misalignment with Te Mana o Te Wai due to the continued watercourse modification, and limited opportunities for mana whenua to work as a partner in developing adaptation responses.
- Missed opportunities for a tikaka approach to water management and limited opportunities for mana whenua to re-establish connections and enhance rakatirataka and kaitiakitaka.

Just transition

- Enables choice in risk level and type of housing for community by reducing risk substantially via elevation of land for intensified development and retaining housing in higher risk areas in the Flat.
- Reduced financial burden on individuals with community-level infrastructure, reducing direct financial impacts of floods especially for low-income communities. However, properties on lower risk, raised land could enhance existing inequities as some people will not be able to afford to move.
- Potential for inequitable transitions where only some properties and assets are proactively acquired. Moderate intergenerational equity as in the long-term, piped solutions will require increased maintenance and become less effective, but elevated land provides a lower-risk area for long-term use.
- Access to key facilities and economic opportunities around and beyond South Dunedin is maintained along existing transport routes with some temporary disruption during storms, including to Ōtākou marae and the peninsula.

Social and economic resilience

- Changes to community cohesion as residents will need to temporarily retreat, causing fragmentation, to enable land raising and development, but potential cohesion improvements in the long-term as there are long-term lower risk options for housing.
- Likely minor enhancements to adaptive capacity via knowledge of what is happening as visible interventions like land raising will raise awareness and provide education on climate resilience.
- Positive impacts to businesses as existing infrastructure is generally maintained, risks are reduced and elevation of land supported with higher density zoning likely to attract a redevelopment premium, signalling that building high density housing is both profitable and the best use of the land.
- Positive impacts to individuals and communities as existing infrastructure is maintained and risks are reduced with potential for higher density, lower risk development.

How it will reduce risk:

- **Community cultural hubs:** Likely reduces long-term pluvial and groundwater flooding risk from high to medium and coastal inundation risk from high to low.
- **Cultural sites/features:** Likely reduces long-term pluvial and groundwater flood risk from high to medium and reduces coastal inundation risk from high to low.
- **Social networks and exposure of community features:** Increases long-term impacts on the ability of communities to access the coastal environment along the harbour side. Likely reduces pluvial flood, coastal flood and groundwater risk to community.
- **Community safety:** Likely reduces long-term risks to relocated residential buildings from high to low risk. Requires a strong understanding of social and cultural dynamics associated with connection to coastal area on the harbour side. There is potential for damage and harm associated with potential over-design events or failure.

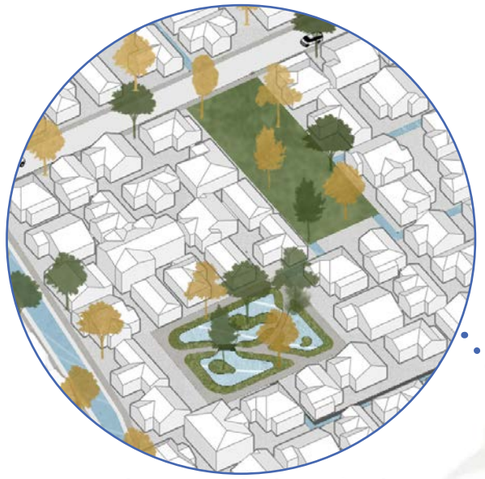
What we've heard from the community:

✗ Engagement on land grading received the largest number of 'dislike' comments with concerns over cost, disruption, and practicality of achieving land elevation.

✓ Many thought that water flow improvements like subsurface drainage networks are a must.

Potential Adaptation Future 4: Space for water - waterways and wetlands

Main Component	Cost in Billions $	Benefit in Billions $	Benefit to Cost Ratio (BCR)	Properties Potentially Affected	Difficulty of Implementation	Residual Risk
Pipes and pumps, coastal protection, open channels, storage	$2.8B	$2.8B	1	600-700		



Managed retreat (relocation)

Some managed relocation will be needed to make space for risk management infrastructure, like stormwater storage. This will require strategic and proactive buyouts (property acquisition) of properties to provide more space for water.

Pipes, pumps and flow paths

Limited pipes and pump stations will be required to support functionality of the waterways and wetlands. Overland flow paths along roadways or other open spaces improve drainage capacity to reduce the risk of pluvial flooding hazard to properties.

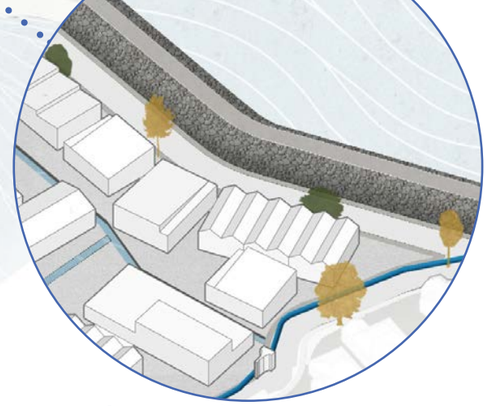
Open channels and storage

A waterway network comprising of canals, streams, or lined channels in strategic areas throughout South Dunedin would help drain groundwater and stormwater. This would be supported by conversion of open spaces in the Flat, such as Forbury Park, to water storage. The storage is connected to both the waterway network and a pumped system, which drains the ponds and adds further capacity to the overall system.

KEY

- Retreat
- Storage
- Overland Flowpath
- Sub-surface Drainage
- Coastal Protection
- Pump
- Open Channels

- Cell 1
- Cell 2
- Cell 3



Coastal protection

The seawall along Portsmouth Drive is made bigger and extended to protect Bayfield Park and the rest of South Dunedin from future coastal flood events. This is not likely to be required until mid to late century.

Disclaimer: ***Options shown are not limited to the spatial locations shown but are rather intended to provide indicative examples.***

Potential Adaptation Future 4:
Space for water – waterways and wetlands

Overview

This future makes space for water by implementing a waterway network supported by storage, pipes, pumps, and overland flow paths. The existing Portsmouth Drive seawall would be made larger and extended to protect South Dunedin from coastal flood events. Some managed relocation of high-risk properties and assets to make space for water would be needed.

Interventions in order of importance

- Managed retreat (relocation)
- Open channels and storage
- Coastal protection
- Pipes, pumps and overland flow paths

How much could it cost?

- Key capital and operational costs are estimated at 2024 PV of $2.5 - 4bn* over a 75-year period.
- Quantified benefits are estimated at 2024 PV $2.5 - 3.5bn* over a 75-year period, noting that not all benefits have been quantified.

Advantages:

- High reduction in property damages
- High reduction in trauma
- High redevelopment potential
- Increased economic vitality
- Lower likelihood of deaths/injuries
- Opportunity for economic regeneration and job creation
- Maintain and enhance existing community structures
- Enhanced water quality, environmental outcomes and carbon sequestration
- Maintains insurance coverage.

Disadvantages:

- Loss of existing dwellings to enable connected green open space
- Significant disruption during construction
- Lower topography still at risk from flooding
- Potential for over design events or infrastructure failure to have significant impacts on the community.

* There is a high degree of uncertainty around these costings and analysis to offset costs from potential land value uplift or redevelopment premium arising from these works.

What else do we need to action it?

- **Changes in land use regulations:** To avoid development in at-risk areas, changes in land use regulations would be required.
- **Property acquisition (buyouts):** Buyouts would be needed to create space for water.
- **Funding mechanism:** To make retreat affordable for communities, funding mechanisms would be needed.

Timeframes

Buyouts to make space for waterways and storage occurs over the next 10-20 years to enable management of groundwater and flooding. Use of spaces already owned by Council, like Forbury Park for water storage, would likely begin as soon as possible with the more integrated network of storage and channels in place around mid-century. These capacity increases should be designed to enable future addition or changes over time to respond to climate change. The seawall would be upgraded between 2060 and 2100 depending on the rate of sea level rise or other triggers for action.

SOUTH DUNEDIN FUTURE

Impacts and Outcomes

Sustainable urban development

- Likely to result in potential for offsetting embodied and operational emissions associated with naturalised waterways drained by pumping by systematically recycling construction waste, using sustainable materials and planted channels and storage areas. Without circular practices, likely significant generation of building waste due to retreat.
- Minimises change to the urban environment while providing minor improvements towards better functioning neighbourhoods and displacing a limited number of people.
- Enhanced water sensitive design, and natural systems are incorporated into the urban framework improving amenity.

Promote community safety

- Likely positive impacts to hauora, health and wellbeing due to reducing extents of high-risk areas, reducing health risks from flooding and damp conditions, alleviating the burden on health services and maintaining access to essential services. Visible improvements can reduce anxiety and foster safety, and access to blue-green spaces improves wellbeing.
- Positive reductions in risk and improvements in safety; however, risks during extreme events and if infrastructure (e.g. pumps) fail remain though blue-green spaces can generally better accommodate over-design events.

Environmental and cultural restoration

- Moderate increase in ecological benefits from the extensive creation of green spaces and freshwater ecosystems throughout South Dunedin, with opportunities for additional biodiversity restoration and enhancement via streams and wetlands for wai, moana and cultural practices such as mahika kai.
- Likely improvements to water quality due to natural systems moderating contaminant load.
- Changes to cultural connections to place are likely through repurposing the existing open spaces into water storage, restoring the natural environment and changing recreational areas for the community.
- Moderate alignment with Te Mana o Te Wai due to favouring relatively natural waterways but still requiring some hard infrastructure, moderate alignment with a ki uta ki tai approaches due to the reinstatement of watercourses, and opportunities for mana whenua to work as a partner in developing adaptation responses. Positive opportunities for mana whenua to re-establish connections and enhance rakatirataka and kaitiakitaka.

Just transition

- Better enables retention of local employment and income generation by reducing scale of retreat and preserving existing infrastructure, business and commercial areas results in less impacts on employment and income generating opportunities.
- Reduced financial burden on individuals with community-level infrastructure, reducing direct financial impacts of floods especially for low-income communities.
- Potential for inequitable transitions where only some properties and assets are proactively acquired. Moderate intergenerational equity as in the long- term, pumped solutions will require increased maintenance and become less effective, but blue-green networks can be readily expanded.
- Access to key facilities and economic opportunities around and beyond South Dunedin is maintained along existing transport routes with some temporary disruption during storms, including to Ōtākou marae and the peninsula.

How it will reduce risk:

- **Community cultural hubs:** Likely reduces long-term groundwater and flood risks to hubs that are relocated from high to low provided their functions are preserved after managed retreat. Seawall reduces coastal inundation risk from high to low but loss of connection to coast may have negative social, cultural, and ecological outcomes.
- **Cultural sites/features:** Likely reduces mid- and long-term groundwater and flood risks to heritage character sites from high to medium.
- **Social networks and exposure of community features:** Likely reduces long-term risk to community features due to groundwater, pluvial flooding, and coastal flooding from high to low. Increased impacts on communities' accessibility and their capacity to participate in community networking activities are likely.
- **Community safety:** Likely long-term reduction in long-term risks to relocated residential buildings and businesses from high to low risk. Seawall likely to reduce coastal inundation hazard but requires a strong understanding of social and cultural dynamics connection to coast access in the harbour. There is potential for damage and harm associated with potential over-design events or failure.

What we've heard from the community:

- ✓ Many thought that water flow improvements are a must.
- ✓ There is an interest in wetlands and ponds providing opportunities for a more attractive natural environment.
- ✗ There was support for a seawall that protects areas allowing more people to remain but concern over hard engineering solutions being costly, impacting access and only providing short- term relief.
- ✗ Concerns were voiced regarding displacement though others expressed support for proceeding with selective retreat where it is most needed.

Social and economic resilience

- Maintains community cohesion by allowing communities to generally remain in place and access to services and social hubs retained. Displacement of some residents may weaken existing social networks as some will remain, but blue-green spaces can foster a sense of community.
- Likely enhancements to adaptive capacity via knowledge of what is happening as visible interventions like blue-green spaces will raise awareness of proximity to water and provide education on climate resilience.
- Minor impacts to businesses as existing infrastructure is maintained and risks are reduced with possible further enhancements of amenity value with low-to-moderate disruption.
- Positive impacts to individuals and communities as existing infrastructure is maintained and risks are reduced by blue-green network corridors with possible greater level of amenity and reduced level of community displacement.

Potential Adaptation Future 5: Space for water – waterways and raised land

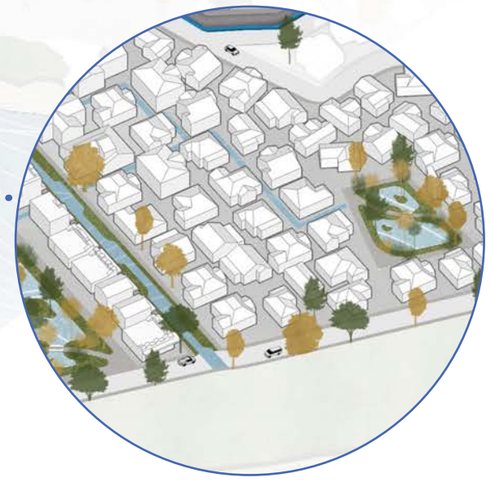
Main Component	Cost in Billions $	Benefit in Billions $	Benefit to Cost Ratio (BCR)	Properties Potentially Affected	Difficulty of Implementation	Residual Risk
Pipes and pumps, coastal protection, open channels, storage, land elevation	$7.1B	$4.5B	0.7	800-950		

Managed relocation to raised land

Land grading involves making ground levels higher through placement of fill material to reduce risk to pluvial, groundwater and coastal flooding. The managed relocation of communities to elevated land would require strategic and proactive acquisition (buyouts) of properties and assets to clear, build up and redevelop a safe, elevated area.

Changes to individual properties

People would need to make changes to their own properties so they're more resilient to flooding. This might include waterproofing or raising first floors, or installing small pumps to manage groundwater and flooding around private property. These are likely to be required around Portsmouth Drive to manage impacts of periodic coastal flooding.



Open channels and storage

A waterway network including canals, streams or lined channels in key areas throughout South Dunedin will encourage drainage of groundwater and stormwater. This is supported by stormwater storage via conversion of open spaces in the Flat (e.g., Forbury Park). Both the waterways and storage will require pumping.

Inland coastal defence

A coastal bund or stopbank would further reduce risk along the raised land by 2150. A bund is also required in the commercial area to stop coastal flooding from flowing into the Flat. The commercial area will periodically flood with seawater during coastal storm events requiring property-level interventions for businesses that remain.

KEY

- Land Grading
- Retreat
- Storage
- Overland Flowpath
- Sub-surface Drainage
- Pump
- Open Channels
- Inland Coastal Defences

- Cell 1
- Cell 2
- Cell 3

Pipes, pumps and flow paths

Limited pipes and pump stations will be required to support functionality of the waterways and wetlands. Overland flow paths along roadways or other open spaces improve drainage capacity to reduce the risk of pluvial flooding hazard to properties.

Disclaimer: ***Options shown are not limited to the spatial locations shown but are rather intended to provide indicative examples.***

Potential Adaptation Future 5:
Space for water – waterways and raised land

Overview
This potential adaptation future uses a network of open waterways and storage to encourage the drainage of stormwater and groundwater, supported by pipes and pumps. It will be combined with raising some land bunds to stop water from entering the Flat from the coast, and property level interventions in the commercial area that will occasionally experience coastal flooding. Managed relocation of certain properties and assets will be required to create space for these interventions.

Interventions in order of importance
- Managed relocation to raised land
- Open channels and storage
- Pipes, pumps, and overland flow paths
- Inland coastal defense
- Property-level intervention

How much could it cost?
- Key capital and operational costs are estimated at 2024 PV of $7 - 11bn* over a 75-year period.
- Quantified benefits are estimated at 2024 PV $4 - 5.5bn* over a 75-year period, noting that not all benefits have been quantified.

Advantages:
- Significantly reduced property damages
- High reduction in trauma
- Significant redevelopment potential for elevated land
- Increased economic vitality
- Lower likelihood of deaths/injuries
- Higher opportunity for economic regeneration, job creation and creating communities
- Enhanced water quality, environmental outcomes and carbon sequestration
- Opportunity for reduced insurance premiums.

Disadvantages:
- Significant carbon and cost implications from importing additional material to elevate land
- Significant loss of existing dwellings to enable raising of land
- Loss of community
- Significant disruption during construction
- Buildings within the Flat still at risk from flooding
- Potential for over design events or infrastructure failure to have significant impacts on the community within the lower elevations.

* There is a high degree of uncertainty around these costings and analysis to offset costs from potential land value uplift or redevelopment premium

What else do we need to action it?
- **Property acquisition (buyouts):** Buyouts will be needed to make space for waterways and raised land. To raise land, buyouts will need to happen in the near future (e.g. next 20 years) to allow time to build up the land, build homes and businesses prior to the increase in emergent groundwater mid-century.
- **Financial incentives or penalties:** Changes in regulations and financial incentives would encourage relocation to raised areas and support property-level interventions.
- **Changes to land use regulation:** To avoid development in at-risk areas or to facilitate the raising of land via access to consented fill sources (e.g. may need to consent new quarries), changes in land use regulations would be required.
- **Funding mechanism:** To enable buyouts and large-scale infrastructure investments, funding mechanisms will be required.

Timeframes
Where land elevation will occur, property buyouts may be accelerated (e.g. next 20 years). Use of spaces already owned by Council, like Forbury Park for water storage begin as soon as possible with the more integrated network of storage and channels in place around mid-century. Retreat and to make space for blue-green networks occurs more slowly to manage groundwater and flooding. This allows for a slow transition of communities but requires careful consideration and planning to avoid social impacts and loss of cohesion.

SOUTH DUNEDIN FUTURE

Impacts and Outcomes

Sustainable urban development
- Raised land results in very high embodied emissions. However, there is potential for emissions reduction through planting of naturalised waterways.
- Significant (and potentially hazardous) waste generated due to removal of buildings, but waste could be minimised through circular practices such as re-use of materials. .
- Balances opportunities for urban improvements and enhancement of landscape and natural systems while limiting displacement of communities.
- Promotes water sensitive design, and natural systems incorporated into the urban framework improve amenity.

Promote community safety
- Likely positive impacts to hauora, health and wellbeing due to reducing extents of risk, reducing health risks from flooding and damp conditions, alleviating the burden on health services.
- Visible improvements can reduce anxiety and foster safety, and land raising creates lower risk areas with access to blue-green spaces improving wellbeing; however, changes to make space for land raising are likely to disrupt communities and cause temporary inconvenience.
- Positive reductions in risk and improvements in safety; however, risks remain in the areas not elevated if during extreme events, infrastructure (e.g. pumps) fail.

Environmental and cultural restoration
- Moderate increase in ecological benefits from the extensive creation of green spaces and freshwater ecosystems with opportunities for biodiversity restoration via streams and wetlands (noting potential biosecurity risks when importing fill material). There may be opportunities to enhance ecological outcomes for coastal fauna, through habitat-focused design features.
- Likely improvements to water quality due to natural systems moderating contaminants.
- Changes to cultural connections to place are likely through repurposing open spaces into water storage, restoring the environment, and creating wetlands for wai, moana and cultural practices such as mahika kai.
- Moderate to high alignment with Te Mana o Te Wai due to favouring relatively natural waterways, moderate to high alignment with a ki uta ki tai approaches due to the reinstatement of watercourses, and opportunities for mana whenua to work as a partner.
- Positive opportunities for mana whenua to re-establish connections and enhance rakatirataka and kaitiakitaka through a tikaka approach to watercourse management, noting that the change in access to the Peninsula may have negative impacts.

Just transition
- Enables choice in risk level and housing type by reducing risk via land elevation for intensified development and retaining housing in the Flat.
- Reduced individual financial burden , reducing direct financial impacts of floods especially for low-income communities. However, properties on lower risk, raised land may result in inequities as some parts of the community may not be able to afford to move.
- Potential for inequitable transitions where only some properties are proactively acquired, or some residents are unable to relocate within the area. Moderate-to-high intergenerational equity as in the long term, pumped solutions become less effective but blue-green networks can be expanded, and elevated land provides a lower-risk area for long-term use.
- Access to key facilities and economic opportunities around and beyond South Dunedin is maintained along diverted transport routes with potential access restrictions and temporary disruption during storms, including to Ōtākou marae and the peninsula.

Social and economic resilience
- Changes to community cohesion due to temporary relocation required to enable land raising, resulting in fragmentation, but potential cohesion improvements as there are long-term lower risk housing options. Displacement of some residents may weaken existing social networks as some will remain, but blue-green spaces can foster community.
- Likely enhancements to adaptive capacity via knowledge of what is happening, as visible interventions will raise awareness.
- Positive impacts to commercial businesses and individuals as infrastructure is generally maintained, risks reduced and elevation of land supported with higher density zoning likely to attract redevelopment. The extent of retreat and intensification enables retention and enhancement of employment and commercial activities as well as individual opportunities.
- It is likely that the current industrial area will be negatively impacted. During raising land, there will be high disruption.

How it will reduce risk:
- **Community cultural hubs:** Likely reduces long-term risks to hubs that are relocated or raised from high to low, as long as their functions are preserved after managed relocation.
- **Cultural sites/features:** Likely reduces long-term groundwater and flood risks to heritage character sites from high to medium risk. Short-term risks are not significantly reduced. Substantial changes in landscape occur along the harbour side, but provide an opportunity to enhance the cultural value of the area through natural restoration.
- **Social networks and exposure of community features:** Likely reduces long-term risk due to groundwater, pluvial flooding, and coastal flooding of community features from high to low risk. Likely increases impacts on communities' accessibility and their capacity to participate in community networking activities due to significant change in community identity associated with relocation.
- **Community safety:** Flood hazard risks are likely reduced from high to low in areas where land is raised or retreat occurs, resulting in increased community safety. Land grading may negatively impact the existing population living in and around the area, particularly during construction.

What we've heard from the community:
✗ Land grading received the largest number of 'dislike' comments with concerns over cost, disruption, and practicality.

✓ Dedicated water storage was popular with an interest in seeing wetlands, basins, and ponds and 'working with' water rather than 'against'.

✗ Concerns remained around the space required and their viability with groundwater.

Potential Adaptation Future 6: Let water in - relocation to raised land

Main Component	Cost in Billions $	Benefit in Billions $	Benefit to Cost Ratio (BCR)	Properties Potentially Affected	Difficulty of Implementation	Residual Risk
Pipes and pumps, coastal protection, open channels, storage, land elevation	$6.8B	$3.7B	0.6	2500-3000		

Pipes, pumps and flow paths

Limited pipes and pump stations will be required to support functionality of the waterways and wetlands. Overland flow paths along roadways or other open spaces improve drainage capacity to reduce the risk of flooding.

Coastal Inland Protection

Small scale inland coastal protection could be constructed along the perimeter of the elevated commercial area near Porstmouth Drive to reduce the risk of coastal flooding impacting the Flat.

Managed relocation to raised land

Land grading involves making ground levels higher through placement of fill material to reduce risk to pluvial, groundwater and coastal flooding. The managed relocation of communities to elevated land would require strategic and proactive acquisition (buyouts) of properties and assets to clear, build up and redevelop a safe, elevated area.

KEY

- Land Grading
- Retreat
- Storage
- Overland Flowpath
- Sub-surface Drainage
- Pump
- Open Channels
- Coastal Inland Protection

- Cell 1
- Cell 2
- Cell 3

Open channels and storage

Parts of the Flat and the commercial area around Portsmouth Drive would become floodable green spaces with some permanent water features for water storage. The area near Portsmouth is usually dry and floods temporarily with seawater during coastal storms. A waterway network including canals, streams or lined channels through the green spaces in the flat to encourage drainage of groundwater and stormwater, reducing risk of pluvial flood hazard and groundwater hazard. Both require pump stations.

Disclaimer: ***Options shown are not limited to the spatial locations shown but are rather intended to provide indicative examples.***

Potential Adaptation Future 6:

Let water in – Let water in - relocation to raised land

Overview

In this future, managed relocation away from areas in the Flat where groundwater will become too high is required. Land in the surrounding area is built up, and intensification of development occurs to provide space for businesses and homes relocating to higher ground within South Dunedin to manage coastal flooding through 2150. The low-lying areas in the Flat are converted to open spaces for recreation and flood risk management.

Interventions in order of importance

- Managed relocation to raised land
- Open channels and storage
- Pipes, pumps and overland flow paths
- Inland Coastal Protection

How much could it cost?

- Key capital and operational costs are estimated at 2024 PV $7 - 11bn* over a 75-year period.
- Quantified benefits are estimated at 2024 PV $3.5 - 5.5bn* over a 75-year period, noting that not all benefits have been quantified.

Advantages:

- Significantly reduced property damages
- High reduction in trauma
- Opportunity for redevelopment potential for elevated land
- Opportunity for partial increased economic vitality
- Lower likelihood of deaths/injuries
- Opportunity for economic regeneration, job creation and creating communities
- Enhanced water quality, environmental outcomes and carbon sequestration through creation of extensive open space and wetland system
- Opportunity for reduced insurance premiums.

Disadvantages:

- High social impact on the community through retreat
- Loss of community
- High levels of income loss from displacement and regional economic impacts
- Significant carbon and cost implications from importing additional material to elevate land safely
- Significant loss of existing dwellings to enable raising of land.

* There is a high degree of uncertainty around these costings and analysis to offset costs from potential land value uplift or redevelopment premium arising from these works.

What else do we need to action it?

- **Changes in land use regulations:** Changes in land use regulations to avoid risky new developments or to facilitate elevation by providing access to consented fill sources (e.g. may need to consent new quarries) may also be required.
- **Financial incentives or enforcement:** To support behaviour changes and property-level interventions.
- **Property acquisition (buyouts):** Buyouts will be needed for land raising and in high-risk areas to make space for water (e.g., creating blue-green spaces).
- **Funding mechanism:** To enable buyouts and large-scale infrastructure investments, funding mechanisms will be required.

Timeframes

Where land elevation will occur, property buyouts may be accelerated (e.g. next 20 years) to allow time to build up the land and build homes and business prior to the increase in emergent groundwater mid-century. Retreat and conversion of rest of the Flat to blue-green space occurs slowly over time as groundwater becomes emergent. This allows for a slow transition of communities to outside of the South Dunedin area but requires careful consideration and planning to avoid social impacts and loss of cohesion.

SOUTH DUNEDIN FUTURE

Impacts and Outcomes

Sustainable urban development

- Possible substantial reductions in operational emissions due to potential for new, efficient development. Embodied emissions can be reduced and waste reduction will be possible through reuse of materials. Without circular practices, likely significant generation of potentially hazardous building waste.
- Creates well-functioning urban environments with the opportunity to restore the natural environment, but will temporarily displace many people and businesses out of South Dunedin.
- Promotes water sensitive urban design and enables improved amenity through large-scale green spaces.

Promote community safety

- Likely positive impacts to hauora, health and wellbeing due to retreat from high-risk areas, reducing health risks from flooding and damp conditions, alleviating the burden on health services and maintaining access to essential services. Relocation may also help reduce stress/anxiety about future weather events.
- Visible improvements can reduce anxiety and foster safety, and land raising creates lower risk areas with access to blue-green spaces improving wellbeing; however, relocation and infrastructure changes to make space for land raising are likely to disrupt communities and cause temporary inconvenience.
- Significant positive reductions in risk and improvements in safety via retreat from high-risk areas.

Environmental and cultural restoration

- High increase in ecological benefits from the extensive creation and restoration of green spaces and freshwater ecosystems with opportunities for biodiversity restoration via streams and wetlands (noting potential biosecurity risks when importing fill). Opportunities to restore and enhance biodiversity, wai, moana, and cultural practices such as mahika kai.
- Likely improvements to water quality due to natural systems moderating contaminants.
- Likely changes to cultural connections to place as these blue-green areas offer recreation opportunities for people to connect more deeply with nature but change recreational areas for the community.
- Moderate to high alignment with Te Mana o Te Wai due to favouring relatively natural waterways, high alignment with a ki uta ki tai approaches due to the reinstatement of watercourses and a more natural interface with moana, and opportunities for mana whenua to work as a partner.
- Positive opportunities for mana whenua to re-establish connections and enhance rakatirataka and kaitiakitaka through a tikaka approach to watercourse management, but there are both advantages and disadvantages from a rakatirataka perspective, as the return of the area to a more natural state and enhancement of mauri of the taiao is weighed against the significant population displacement and reduction of community assets and businesses.

Just transition

- Enables choice for Portsmouth Drive area to adapt in place or shift to elevated land or beyond South Dunedin. Provides options for lower risk, intensified housing for those that want to continue to live in South Dunedin.
- Benefits to vulnerable residents as relocating offers safer housing if property swaps enable access.
- High likelihood of inequitable transitions where only some properties and assets are proactively acquired, or some residents unable to relocate within the area. High intergenerational equity as benefits extend beyond this century.
- Access to key facilities and economic opportunities are maintained along diverted transport routes with temporary disruption during storms with the potential for restricted access, including to Ōtākou marae and the peninsula.

Social and economic resilience

- Changes to community cohesion as residents will need to temporarily retreat resulting in fragmentation to enable land raising and development but potential cohesion improvements in the long- term as there are long- term lower risk options for housing. Displacement of some residents may weaken existing social networks as some will remain, but blue-green spaces can foster a sense of community.
- Likely enhancements to adaptive capacity as visible interventions like blue-green spaces raise awareness of proximity of water or land raising on future sea levels.
- Risk of negative impacts to businesses due to the disruption and gradual and over time partial loss of medium- and large-format businesses posing a substantial economic risk, as these will be competing with large-format retail and mixed-use residential development for location. It is likely that the current industrial area will be negatively impacted.
- Positive impacts to individuals and communities as existing infrastructure is maintained and risks are reduced with potential for higher density, lower risk development. However, the scale of change presents a risk to individuals and communities due to disruption during land raising for development and transitioning to more blue-green spaces.

How it will reduce risk:

- **Community cultural hubs:** Likely reduces long-term risks to hubs that are relocated from high to low risk, as long as their functions are preserved after managed retreat.
- **Cultural sites/features:** Likely reduces long-term risks to heritage character sites from high to low risk if these can be relocated to raised land. Short-term risks are not likely reduced. This option changes the landscape dramatically but provides an opportunity to enhance the cultural value of the land through natural restoration.
- **Social networks and exposure of community features:** Likely reduces long-term risks to community features due to groundwater and coastal flooding from high to low risk. Likely increases impacts on the accessibility of communities and their capacity to participate in community activities as community identity may change as the landscape changes.
- **Community safety:** Likely reduces long-term risks to relocated residential buildings from high to low risk but requires a strong understanding of social dynamics and potential high short-term psychological impacts due to relocation.

What we've heard from the community:

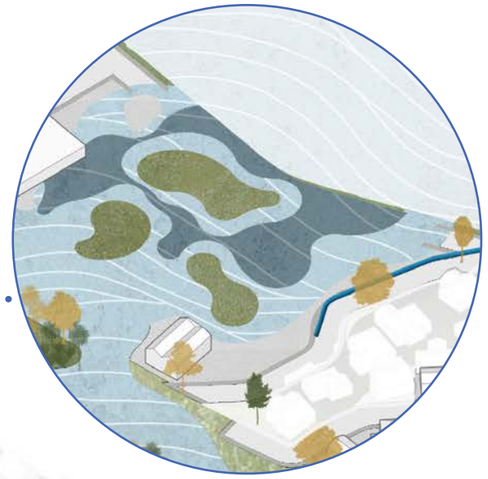
- ✓ There was support for future green spaces and community spaces.
- ✗ There is likely to be stress and trauma associated with displacement of community and relocation away from generational homes, especially for vulnerable communities.
- ✗ Further concern over sufficient support being provided for low-income, vulnerable communities was expressed.
- ✓ Some stated that proactive retreat was better than reacting to a flood.
- ✗ Land grading received the largest number of 'dislike' comments with concerns over cost, disruption and practicality.

Potential Adaptation Future 7: Let water in – Large scale retreat

Main Component	Cost in Billions $	Benefit in Billions $	Benefit to Cost Ratio (BCR)	Properties Potentially Affected	Difficulty of Implementation	Residual Risk
Pipes and pumps, open channels, storage	$5B	$3.7B	0.7	3500-4000		

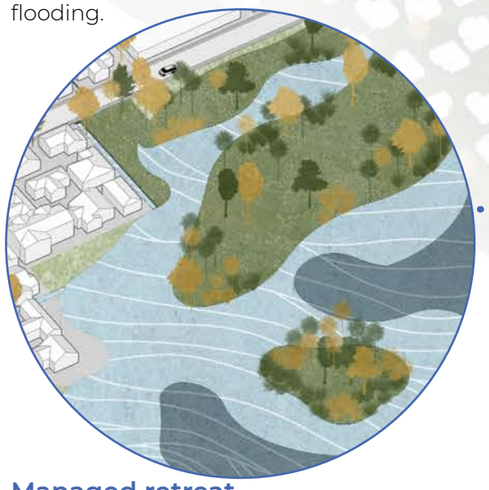
Changes to individual properties

For the remaining properties in high-risk areas, people would need to make changes such as waterproofing or raising first floors, or installing small pumps to manage groundwater and flooding around private property. This is likely to be needed around the commercial area near Portsmouth Drive to manage impacts of periodic coastal flooding.



Pipes, pumps, flow paths

Some minor pipes and pump stations may be required to support the waterways. Overland flow paths will improve drainage.



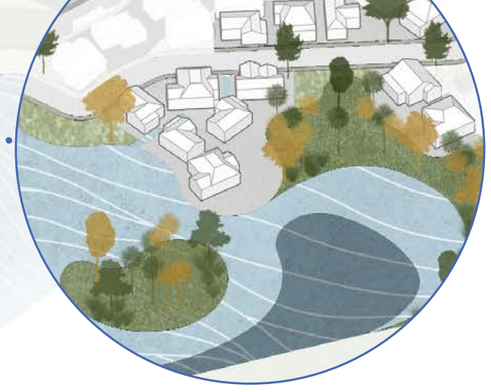
Managed retreat

Managed relocation requires strategic and proactive acquisition of properties and assets to remove risks. In this future, there is no longer sufficient space for housing South Dunedin's current population with South Dunedin. This option allows space for flood management infrastructure (e.g., wetlands and waterways).

KEY

- Property-level Intervention
- Retreat
- Storage
- Overland Flowpath
- Sub-surface Drainage
- Pump
- Open Channels

- Cell 1
- Cell 2
- Cell 3



Open channels and storage

Parts of the Flat would become floodable green spaces with wetlands and ponds to store water. A waterway network including canals, streams or lined channels through the green spaces in the Flat to encourage drainage of groundwater and stormwater, reducing risk to pluvial flood hazard and groundwater hazard. Both require pump stations.

Disclaimer: ***Options shown are not limited to the spatial locations shown but are rather intended to provide indicative examples.***

Potential Adaptation Future 7:
Let water in – Large scale retreat

Overview

In this future, communities will be moved away from the Flat, which will be converted into floodable green spaces and wetlands with a waterway network. The network would include canals, streams, or lined channels layers to encourage drainage of groundwater and stormwater. Remaining properties in high-risk areas would need to take individual action to protect their properties. There will likely not be enough space to house South Dunedin's current population without substantial change in housing density; however, it provides an opportunity to enhance the cultural value of the land through natural restoration. Areas outside of South Dunedin for relocation may need to be identified to support this future.

Interventions in order of importance

- Managed retreat
- Open channels and storage
- Pipes, pumps and overland flow paths
- Property-level interventions

How much could it cost?

- Key capital and operational costs are estimated at 2024 PV of between $5 and 8bn* over a 75-year period.
- Quantified benefits are estimated at 2024 PV between $3.5 and 4.5bn* over a 75-year period, noting that not all benefits have been quantified.

Advantages:

- Highest reduction in property damages
- Highest reduction in trauma
- Lowest likelihood of deaths/injuries
- Opportunity to create green job creation
- Greatest opportunity for water quality, environmental outcomes and carbon sequestration through creation of extensive open space and wetland system.

Disadvantages:

- Highest social impact on the community through retreat
- Highest loss of community
- Greatest income loss from displacement and regional economic impacts
- Largest impact on current housing availability
- Lowest opportunity for recreating communities within South Dunedin area.

* There is a high degree of uncertainty around these costings and analysis to offset costs from potential land value uplift or redevelopment premium arising from these works

What else do we need to action it?

- **Funding mechanisms:** To enable buyouts and large-scale infrastructure investments, funding mechanisms will be required.
- **Property acquisition (buyouts):** Buyouts in high-risk areas would be needed to make space for water (e.g., creating open channels and storage).
- **Financial incentives:** To support behaviour changes and property-level interventions.
- **Changes in land use regulations:** Changes to land use regulations, such as District Plan changes to avoid new developments in areas at risk.

Timeframes

Retreat and conversion of the area to blue-green space occurs slowly over time as groundwater becomes emergent. This allows for a slow transition of communities to outside of the South Dunedin area but requires careful consideration and planning to avoid social impacts and loss of cohesion.

SOUTH DUNEDIN FUTURE

Impacts and Outcomes

Sustainable urban development

- Likely to result in the lowest whole-of life emissions due to large scale retreat and conversion to naturalised spaces minimising energy use and material demands. Without circular practices, likely significant generation of potentially hazardous building waste due to retreat.
- Results in only a fringe of urban environment remaining on higher ground with the remaining area as open space which could result in increased anti-social behaviour issues if not designed/ managed well.
- Promotes water sensitive urban design approaches and provides large scale green spaces for amenity.

Promote community safety

- Likely positive impacts to hauora, health and wellbeing due to retreat from high-risk areas, removing health risks from flooding and damp conditions. However, relocation will likely cause stress and displacement while also helping reduce stress/anxiety about future events and living conditions. Access to blue/green spaces can promote community health and wellbeing.
- Significant positive reductions in risk and improvements in safety via retreat from high-risk areas.

Environmental and cultural restoration

- High increase in ecological benefits with the creation and restoration of green spaces, freshwater and estuarine ecosystems. Opportunities to restore and enhance biodiversity, wai, moana, and cultural practices such as mahika kai.
- Likely improvements to water quality due to natural systems moderating contaminants.
- Likely significant changes to cultural connections to place as these blue-green areas offer recreation opportunities for people to connect more deeply with nature but removing most buildings from South Dunedin changing the local character substantially.
- Moderate to high alignment with Te Mana o Te Wai due to favouring relatively natural waterways, high alignment with a ki uta ki tai approaches due to the reinstatement of watercourses and a more natural interface with moana, and opportunities for mana whenua to work as a partner.
- Positive opportunities for mana whenua to re-establish connections and enhance rakatirataka and kaitiakitaka through a tikaka approach to watercourse management, but there are both advantages and disadvantages from a rakatirataka perspective, as the return of the area to a more natural state and enhancement of mauri of the taiao is weighed against the significant population displacement and reduction of community assets and businesses.

Just transition

- Limits opportunities for the community to stay in South Dunedin by large scale retreat from low-lying areas.
- Benefits to vulnerable residents as relocating offers safer, more resilient housing if property swaps are in place to enable access; however, vulnerable communities may become fragmented if they cannot shift as a unit.
- Very high potential for inequitable transitions as most residents will be displaced, and very high risk to vulnerable populations. High intergenerational equity as while investment in the short- term is expensive, in the longer term, further investment is minimal with benefits extending beyond this century.
- Access to and beyond South Dunedin is maintained along diverted transport routes with some temporary disruption during storms with the potential for restricted access, including to Ōtākou marae and the Otago Peninsula.

Social and economic resilience

- Significant risks to community cohesion as retreat will displace communities, causing fragmentation and strain social networks as people relocate without a clear place to relocate to (both residencies and services) collectively.
- Changes to adaptive capacity via knowledge of what is happening as relocating from high-risk areas fosters community awareness of climate change impacts, but may reduce understanding of localised risks for displaced communities in their new locations.
- Risk of comprehensive loss of business and employment within South Dunedin. It is likely that the current industrial area will be negatively impacted.
- Significant positive reductions in risk to individuals and communities via retreat from high-risk areas; however, risk reduction experienced by individuals and communities will depend on the risk profile of where they relocate to and the mechanisms of the retreat process.

How it will reduce risk:

- **Community cultural hubs:** Likely reduces long- term risks from high to low, as long as the functions of cultural hubs are preserved after managed retreat, noting that this may be outside of South Dunedin.
- **Cultural sites/features:** Likely reduces mid- and long-term risks to heritage character sites from high to low risk. Short-term risks are unlikely to be reduced. This option changes the landscape dramatically. However, it provides an opportunity to enhance the cultural value of the land through natural restoration.
- **Social networks and exposure of community features:** Likely reduces long-term risk to community features from high to low. However, it likely increases impacts on the accessibility of communities and their capacity to participate in community networking activities due to significant change in community identity associated with relocation.
- **Community safety:** Likely reduces long-term risks to relocated residential buildings from high to low risk but requires a strong understanding of social dynamics and potential high short-term psychological impacts on residents due to relocation.

What we've heard from the community:

✗ There is likely to be stress and trauma associated with displacement of community and relocation away from generational homes.

✓ Some stated that proactive retreat was better than reacting to a flood when it happens.

✗ There's concern over how much support will be provided for low-income, vulnerable communities.

✓ There is interest in wetlands and ponds providing opportunities for multiple benefits for community wellbeing, recreation, biodiversity, and the environment.