SOUTH DUNEDIN FLOOD ALLEVIATION - SHORT-TERM OPTIONS

Department: Climate and City Growth

EXECUTIVE SUMMARY

1 The purpose of this report is to present options for undertaking short-term, ostensibly no-regrets actions, to support flood mitigation in South Dunedin. The options described in this report respond to requests from the Mayor and Councillors, reflect community calls to combat short term flood risk, and are complementary to long-term flood resilience and climate adaptation work being undertaken as part of the South Dunedin Future (SDF) programme.

2 Flood issues in South Dunedin are well documented, are the subject of much council investigation, and are of high public interest. In addition to day-to-day management of the 3 Waters network, council is currently tackling flood South Dunedin flooding issues through three key workstreams: (i) long-term, large-scale planning under South Dunedin Future; (ii) mid-term, mid-scale infrastructure work to explore a stormwater system reconfiguration to split the catchment in two; and (iii) a series of short-term, smaller scale options outlined in this report.

3 Concept designs have been developed for a range of short-term options that may provide a degree of flood alleviation for South Dunedin. The options presented in this report are not 'solutions' to South Dunedin's flood challenges, which would require larger-scale, longer-term investments of the nature being investigated under the SDF programme. There is no budget in the 9YP for the options presented in this report.

RECOMMENDATIONS

That the Council:

a) **Notes** the South Dunedin Flood Alleviation – Short-Term Options report.

b) **Decides** which of the following options to proceed with:

i) Provide additional budget to undertake short-term capital works to mitigate flood risk in South Dunedin as a stand-alone workstream separate to, but complementary to, and ultimately integrated with the SDF programme.

ii) Wait for the SDF adaptation plan to be completed before commencing any capital works.

iii) Make an alternative decision.

BACKGROUND

4 South Dunedin is exposed to a range of natural hazards, due to its location at the base of a catchment, on a low-lying former coastal wetland. South Dunedin has a history of flooding

extending back to the 1920s. Climate change will likely increase this flood hazard over time through rising sea level, rising ground water, and increased frequency and severity of storm events.

5 The current flood risk and potential future impact of climate change on South Dunedin has been the subject of specific investigation by the Dunedin City Council (DCC) and Otago Regional Council (ORC) since the late 2000s. In 2010, the DCC commissioned a report by University of Otago Emeritus Professor Blair Fitzharris to examine the Climate Change Impacts on Dunedin (the 'Fitzharris Report'). In 2009 ORC established the first permanent groundwater monitoring network and in 2012 undertook initial groundwater rise modelling.

6 The major flood event in June 2015, which caused widespread flooding across South Dunedin, proved to be a catalyst for councils adopting a more integrated approach for responding to flooding and climate-related issues. In June 2016, incumbent Mayor Dave Cull wrote to the residents of South Dunedin outlining key challenges and describing a suite of responses from the DCC and ORC. This included research into natural processes, maintenance and optimisation of existing infrastructure, and consideration of medium-term options to reduce the risk of flooding due to rising groundwater and severe rainfall events. Specific actions included:

- Replacement of screens at Portobello Stormwater Pump Station with an improved, high-capacity screen.
- Installation of additional alarms at the Portobello SWPS to give earlier warning if pump screens are becoming blocked.
- Improved maintenance and cleaning of mud tanks and screens.
- Strengthening of the Forbury Road stormwater pipeline in areas where this has previously failed.
- Updating and improving the stormwater and wastewater hydraulic models in South Dunedin to improve accuracy and confidence in their use for option assessment and design.
- Investigating 'medium term' options to address wastewater flooding in South Dunedin, including diversion of wastewater flows from Kaikorai Valley to Green Island Wastewater Treatment Plant.

Large scale, long-term planning

7 This collection of research and infrastructure-focused activities, coupled with renewed communications and community engagement efforts, would subsequently become known as the 'South Dunedin Future' (SDF) Programme. The SDF programme is a joint initiative between the DCC and ORC to develop a climate adaptation plan for South Dunedin and includes a detailed risk assessment, development of options for mitigating risks over the long term (next 100 years), and extensive community engagement. The SDF programme will produce a climate adaptation plan for South Dunedin by December 2026.

8 It is envisaged that the South Dunedin adaptation plan will inform a range of strategic land use and infrastructure decisions from 2026 onwards, including short-, medium-, and long-term decisions about 3 Waters investments in flood alleviation. Previous SDF programme reporting has signalled that many different infrastructure investments may be required to effectively

manage flood risk over the long term, the details of which will become more clear following completion of the South Dunedin adaptation plan.

Mid-scale, medium term infrastructure

9 Mid-scale investments in 3 Waters infrastructure in South Dunedin have been scheduled to commence after completion of the South Dunedin adaptation plan in 2026. This is to ensure such investments are fit for purpose, aligned to the outcomes of the SDF programme, and reflect the anticipated future land use and infrastructure needs in South Dunedin. In the interim, $32.5 million (uninflated) has been proposed for mid-scale 3 Waters infrastructure in South Dunedin in the draft 9 Year Plan 2025-34 (9YP), with capital expenditure ramping up in 2027/28. This would be an initial investment in the first decade of the South Dunedin adaptation plan, with further investments to follow as required, subject to business cases and funding availability.

10 The mid-scale infrastructure investment currently in development would likely seek to effect a system reconfiguration, whereby two large diameter pipelines would split the South Dunedin stormwater catchment area into two, smaller, more manageable areas. Preliminary assessments suggest this option is the most likely 3 Waters infrastructure option to alleviate mid-term flood risk (10-30 years) in South Dunedin. Under indicative scheduling this option would commence in 2027/28, following completion of the South Dunedin adaptation plan in 2026, and would be completed by 2033/34. These details are subject to change, based on the outcomes of the South Dunedin adaptation plan, and more detailed modelling and design work.

Shorter-term flood alleviation options

11 The South Dunedin risk assessment and potential adaptation options will be presented to Councils in March 2025. While it will be a further two years until completion of the South Dunedin adaptation plan, sufficient technical work has now been undertaken to identify some short-term actions that could support flood alleviation, irrespective of what long-term option is eventually adopted for South Dunedin. Coinciding with this, the flood event on 3-4 October 2024 that affected much of South Dunedin has triggered renewed calls from the community and other stakeholders for DCC to undertake additional flood alleviation work in South Dunedin in the short-term.

12 In response to these developments, and following requests from The Mayor and Councillors, staff have undertaken an assessment of a range of options to mitigate flood risk in South Dunedin using the 3 Waters computer hydraulic models of the stormwater network. The options developed are conceptual in nature, are broadly consistent with shorter term ‘no regrets’ actions endorsed by SDF programme work to date, and could be considered complementary to longer-term work being undertaken as part of that programme. The nine short term options investigated have an estimated total cost of $270 million and details are provided in the discussion section below and attachments to this report.

Potential central government funding

13 Preliminary conversations have been undertaken with the Ministry of Business, Innovation & Employment (MBIE) in relation to the Regional Infrastructure Fund (RIF), which is a potential source of funding for resilience-focussed activities – including flood alleviation – in South Dunedin. MBIE has however cautioned that the RIF has a range of criteria which would need to be met to secure funding. For example, the RIF requires co-investment from councils, is restricted from directly funding 3 Waters infrastructure (with some exceptions), and is predominantly for loans rather than grants. The RIF can however support flood-resilience

initiatives such as stop banks, sea walls, and nature-based solutions like swales, parks, and wetlands. As such, the RIF could be a potential part-funding source for some of the options presented in this report, including water detention at Bathgate and Forbury parks.

DISCUSSION

14 Key components of South Dunedin's stormwater network are:

- Portobello Stormwater Pump Station (SWPS) – this is the drainage system for the flat areas of South Dunedin, St Kilda and lower Tainui.
- Tainui SWPS – this is located at a low point in Tainui and pumps water from this area to a discharge point further in the stormwater network, upstream of the Portobello SWPS.
- Wilkie Road Conduit – this runs along South Rd from Caversham, picks up Glen Creek at Glen Rd and continues to the Harbour via Wilkie Rd and Kind Edwards St under the Caledonian Ground and Andersons Bay Rd and along Orari St.
- Forbury Road Aqueduct – this runs along Forbury Rd from the Forbury roundabout to the sea near St Clair Saltwater Pool. It picks up drainage from the St Clair hills west of Forbury Rd (Corstorphine, Kew and upper Caversham).
- The Wilkie Road and Forbury Road Conduits act to capture rainfall from the hills surrounding South Dunedin and divert it to the ocean rather than allowing it to flow into South Dunedin.

Additional detail can be found in Attachment A.

15 Since the stormwater system was designed and installed, significant changes have occurred that impact the performance of the system as there is more water for the system to have to deal with. These include:

- Impervious surfaces have increased from around 45% to approximately 60%. This results in more stormwater run-off entering the stormwater network when it rains.
- The system is generally around 60 years older than when most of the infrastructure was installed. The infrastructure deteriorates over time, making it more prone to increasing levels of erroneous inflow and infiltration.
- Climate change impacts have begun to take effect – increasing rainfall intensities and groundwater levels meaning the stormwater system experiences ever increasing design capacity exceedances.

OPTIONS

16 A range of infrastructure options have been evaluated, some of these are based on previous work undertaken by 3 Waters and some are new. A summary of the options is presented below in Table 1, with further detail contained in Attachment B.

Option	Option Description
1	Discharge to Orari Street SW main
2	Divert Tainui flow to outfall, bypassing Portobello SWPS
3	Hillside Road mains disconnected and pumped to Orari St outfall
4	Bathgate Park detention pond
5	Combination of Options 3 and 4
6	Bay View Road to Portobello SWPS
7	Option 6 plus upgrade to Portobello SWPS
8	Upsize Forbury Road pipeline
9	Forbury Park detention pond

Table 1: short-term options

17 The above options have been assessed using the 3 Waters computer hydraulic models of the stormwater network. The options developed are conceptual in nature and are not intended to replace or supersede work currently being undertaken as part of the SDF programme. Option performance has been evaluated in terms of future climate change for 1-in-10 year and 1-in-100 year storms with the assessment primarily focussed on:

- Reduction in total flood area
- Reduction in total flood volume

18 Each option has been costed at a high level (-50%/+100%, Estimate Class 5, AACE International Recommended Practice No.18R-97).

19 Results of the options assessment (1-in-10 year only) and costing are contained in Attachment C.

20 The most cost-effective option is Option 6, diversion of the Bayview Rd and New Rd stormwater systems to a new pipe directly to the Portobello PS, although this option has a relatively minor impact on South Dunedin flooding overall (4% flood area reduction).

21 Option 3, Hillside Road mains disconnected and pumped to Orari St outfall, and Option 8, Upsize Forbury Road pipe are the next most cost-effective options (with 11% and 8% flood reductions respectively).

22 It should be noted that options have not been tested in combination with each other and so flood reductions should not be considered to be cumulative if multiple options are implemented.

23 Option 6 and 8 involve pipeline construction only, making them less complex than Option 3 which involves a new pump station. This makes them more favourable as short-term options as they are likely to be quicker to implement.

24 Option 8, which would improve the capture of stormwater running off St Clair Hills into South Dunedin is expected to be effective in the short and long term, is considered to be "no-regrets" and is anticipated to integrate well with the SDF adaptation plan. Portobello SWPS is expected to be a key infrastructure asset for South Dunedin for at least the short to medium term and so Option 6 could also be considered a "no-regrets" option, although it's benefit to South Dunedin as a whole is lower.

25 It is estimated that each of Options 6, 8 and 3 would take 3-5 years to investigate, design and construct with Option 3 taking the longest due to it's additional complexity due to the need for a pumping station.

26 The discounted options are described below in Table 2.

Option Discounted	Description
1	High cost, particularly versus benefit achieved. Also, this option is physically impracticable or unfeasible as a short-term option as there is insufficient readily available space in the location to build a large pump station.
2	Relatively high cost for benefit achieved. Options with a better cost/benefit ratio are preferred.
4	Relatively high cost for benefit achieved. Spatial and community benefits unquantified. Draining detention pond likely to be impeded without a free discharge location being identified.
5	Determined by concerns relating to option 4.
7	Relatively high cost for benefit achieved. Options with a better cost/benefit ratio are preferred.
9	High cost for benefit achieved. Spatial and community benefits unquantified. Draining detention pond likely to be impeded without a free discharge location being identified.

Table 2: discounted short-term options

27 All options will require further investigation, which may indicate that benefits are less than initially thought or that costs are higher.

28 If Council wish to progress the short-term options, the next steps would be to:

- Allocate staff and financial resources to further investigating the options in more detail.
- Develop a project management plan and timeframes.
- Continue discussions with Central government, with a view to making an application for funding from the RIF, noting criteria (co-funding requirements, 3 Waters restrictions, and limits on grants) may not be well aligned to council interests.

Option One – provide additional funding to implement short-term options

29 This option would seek additional capital funding for any or all of the options proposed, and in particular:

- Total additional funding for all three options below is $29.214 million (Class 5 Cost Estimate).
- Option 6 - Diversion of the Bay View Rd and New Rd stormwater systems to a new pipe directly to the Portobello PS at a Class 5 Cost Estimate of $1.916 million.
- Option 8 - Upsize Forbury Road pipe at a Class 5 Cost Estimate of $12.000 million.
- Option 3 - Hillside Road mains disconnected and pumped to Orari St outfall at a Class 5 Cost Estimate of $15.298 million.

Impact assessment

Debt

- Would require borrowing of between $1.916 million (for Option 6) to $29.214 million (for all options) over the next 5 years. If all options are selected, debt increases as follows:

Year 1 2025/26	$0.750 million
Year 2 2026/27	$1.000 million
Year 3 2027/28	$9.768 million
Year 4 2028/29	$9.000 million
Year 5 2029/30	$8.696 million

Rates

- Rate funding would be required for this option. Cost of borrowing is estimated to be 4.12% annually from year 1 to year 4, then 5% from year 5. Cost of depreciation is estimated to be 3.19% of the capital cost. Operating costs flowing from the projects, including a project manager during the implementation are estimated in the table below. From the 2030/31 year the costs are ongoing.

Year	Interest	Depreciation	Operating Costs	Total
Year 1 2025/26	$15,000	$0	$120,000	$135,000
Year 2 2026/27	$52,000	$24,000	$135,000	$211,000
Year 3 2027/28	$273,000	$56,000	$155,000	$484,000
Year 4 2028/29	$660,000	$367,000	$350,000	$1,377,000
Year 5 2029/30	$1,243,000	$654,000	$530,000	$2,427,000
Year 6 2030/31	$1,461,000	$931,000	$250,000	$2,642,000

Zero carbon

- If funding is secured and the projects were to proceed this option is likely to temporarily increase DCC emissions due to embodied carbon from building the infrastructure. Operational carbon increases are likely to be minor.

- Efforts would be made in the design and construction to minimise embodied carbon, in alignment with the Zero Carbon policy.

Advantages

- Minor reduction of flood risk in South Dunedin, though does not eliminate it.

Disadvantages

- Potentially results in wasted effort (staff and funds).
- Potentially does not align with SDF adaptation plan, although this would be known before the construction phase and so abortive physical work could still be avoided.
- Diverts staff resource away from other 3 Waters activities.

Option Two – Status Quo – wait for SDF adaptation plan

30 No further investigation of short-term options would be undertaken until completion of the SDF programme and production of the South Dunedin adaptation plan in December 2026.

Impact assessment

Debt

- No debt funding is required for this option.

Rates

- There are no impacts on rates.

Zero carbon

- This option is unlikely to impact city or DCC emissions.

Advantages

- Ensures alignment of any short-term actions with the South Dunedin adaptation plan.
- Keeps staff resource focussed on the SDF programme and adaptation plan and other 3 Waters activities.
- No abortive costs or efforts.

Disadvantages

- Flood risk reduction in South Dunedin takes longer to implement.

NEXT STEPS

31 Staff will carry out the preferred option of the Council.

Signatories

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Attachments

	Title	Page
A	South Dunedin Stormwater & Wastewater Overview	
B	Options overview and maps	
C	Results including result maps for Options 3,6,8	

SUMMARY OF CONSIDERATIONS

Fit with purpose of Local Government

This decision enables democratic local decision making and action by, and on behalf of communities.
This decision promotes the social well-being of communities in the present and for the future.
This decision promotes the economic well-being of communities in the present and for the future.

Fit with strategic framework

	Contributes	Detracts	Not applicable
Social Wellbeing Strategy	✓	☐	☐
Economic Development Strategy	✓	☐	☐
Environment Strategy	☐	☐	✓
Arts and Culture Strategy	☐	☐	✓
3 Waters Strategy	✓	☐	☐
Future Development Strategy	✓	☐	☐
Integrated Transport Strategy	☐	☐	✓
Parks and Recreation Strategy	☐	☐	✓
Other strategic projects/policies/plans	✓	☐	☐

This paper also contributes to the South Dunedin Future programme.

Māori Impact Statement

There has been no specific consultation on this report, however the South Dunedin Future programme has engaged with mana whenua on a range of implications which has assisted the pathway to develop the medium and long-term options.

Sustainability

There is the potential for negative or positive long-term economic and social implications depending on the decision made as progressing the work may support or detract from the outcomes of the SDF adaptation plan.

Zero carbon

The proposal has the potential to temporarily increase DCC carbon emissions, mostly through embodied carbon from building infrastructure. Opportunities to reduce emissions would be explored in the design and construction phases. There is no material impact on city emissions.

LTP/Annual Plan / Financial Strategy /Infrastructure Strategy

No funding for the recommended option has been allocated in the draft 9-Year Plan 2025-34 for the short-term options contained in this report. Proceeding with the recommended option would result in a minor improvement in current levels of service for stormwater in South Dunedin.

Financial considerations

The cost of the recommended options is between $1.9M to $29.2M. This is unbudgeted. Rate funding of up to $15.202 million would be required to fund this option. The growth portion of the project is expected to be approximately 9% of total costs.

Significance

The recommendations of this report are considered to be medium in terms of Council's Significance and Engagement Policy.

SUMMARY OF CONSIDERATIONS
Engagement – external There has been no specific consultation on this report, however the South Dunedin Future programme has engaged with the community and specific community and interest stakeholders which has assisted the pathway to develop the medium and long-term options.
Engagement - internal There has been internal engagement between 3 Waters and South Dunedin Future. As South Dunedin Future is also considering short-term, no-regrets options solution convergence may be compromised. Further work is therefore necessary to align the efforts on 3 Waters and South Dunedin Future on short-term, no-regrets options.
Risks: Legal / Health and Safety etc. There are no anticipated legal or other risks associated with the recommendations of this report.
Conflict of Interest There are no known conflicts of interest.
Community Boards There are no direct implications for Community Boards.

OVERVIEW OF SOUTH DUNEDIN STORMWATER AND WASTEWATER SYSTEMS

History

Permanent development and settlement in South Dunedin began from the mid to late 19th century when European settlers undertook 'reclamation' activities. Reclamation of the area between Andersons Bay Road and Portsmouth Drive was completed more recently (1960s – 1970s).

South Dunedin's stormwater pipes have been installed progressively since the early 1900's with the majority being constructed in the 1960s. The Forbury aqueduct was built prior to the 1923 flood. The Wilkie Road Conduit was largely built prior to World War Two and was completed in 1957. The Portobello Stormwater Pump Station (SWPS) was completed in 1964.

Most of the wastewater pipes in South Dunedin were installed in the early 1900's with some areas being built later in the 1960's and a small number being renewed in the 1990s.

What they were designed for

Stormwater

The South Dunedin stormwater network consists of approximately 65km of pipes (ranging between 100mm and 2.7m diameter) and box culverts with widths up to 2400mm.

Figure 1: South Dunedin Stormwater Network (Note: only large diameter trunk mains shown)

Key components of South Dunedin's stormwater network are:

- Portobello SWPS – This is the drainage system for the flat areas of South Dunedin, St Kilda and lower Tainui. Several large pipes ranging between 0.75m and 1.5m diameter run along the full length of Bay View Rd, MacAndrew Rd, McBride St, Hillside Rd and Grosvenor St and carry stormwater to two large aqueducts, one in Andersons Bay Rd and one in Timaru St. These aqueducts are interconnected and function together as an interceptor to convey stormwater to the Portobello Rd – Timaru Rd intersection. Here flows combine with stormwater pumped from the lower Tainui area. The combined flow is taken to the Portobello SWPS along two 2.1m x 1.2m conduits, passing through a silt trap and screen. The pump station is equipped with seven pumps ranging in capacity from 0.2m^3/s to 1.5m^3/s each and giving a combined total capacity of 6.3m^3/s (could fill an Olympic swimming pool in less than 7 minutes).
- Wilkie Road Conduit – this conduit runs along South Rd from Caversham, picks up Glen Creek at Glen Rd and continues to the Harbour via Wilkie Rd and Kind Edwards St under the Caledonian Ground and Andersons Bay Rd and along Orari St. It is a semi-elliptical 2.7 m pipe in it's lower reaches. It drains the Mornington hillside north of Caversham Valley Rd-South Rd, the Glen and the Corstorphine Creek catchment south of Caversham Valley Rd.
- Forbury Road Aqueduct – This is a 1.6m x 1m box culvert running along Forbury Rd from the Forbury roundabout to the sea near St Clair Saltwater Pool. It picks up drainage from the St Clair hills west of Forbury Rd (Corstorphine, Kew and upper Caversham).

The original design of the Portobello Road SWPS was intended to be sufficient to keep all stormwater within the piped network for a design rainstorm of 14.3mm over 43 minute storm (1 in 3 year return period) and to cope adequately with a design rainstorm of 19.7mm over a 43 minute

storm (1 in 10 year return period) with some water backing up into the street kerb and channel. The original design relied on a number of key assumptions.

- Firstly, at the time of the design, the surface area of the catchment was determined to be 45.7% impervious (roofs, roads, hard surfaces that water runs off and is not absorbed through). That is to say that 45.7% of all stormwater falling on the catchment would be conveyed into the stormwater system with the remainder would soak into the ground. Since the Portobello Road SWPS was completed in 1964 there has been more development in South Dunedin, this has increased impervious surfaces to approximately 60% of the catchment. This means more run-off that the Portobello Road SWPS has to cope with when it rains. The piped network within South Dunedin has the space to store approximately 20,950m^3 of stormwater (more than 8 Olympic swimming pools). It is now estimated that with the higher imperviousness the maximum runoff that the whole stormwater system can convey in a longer duration rainfall event once the available storage in the piped network is full is around 4.1mm per hour of runoff across the catchment.
- That the most critical and challenging storm the stormwater network would have to cope with was a short but intense 43 minute storm. While short, intense storms are typically the most challenging for stormwater networks of this nature to manage, in more recent years, storms of longer durations such as 24 hour storms have caused the most challenges for the stormwater system.

Currently we design new pipes to meet a 10% Annual Exceedance Probability (AEP) rainfall event. That is, we aim to keep stormwater in the pipes (and not flooding) in rainfall events approximately equivalent to a 1-in-10 year event (level of service). As the existing stormwater pipes are mostly older, the catchment is more impervious and rain storms are becoming more extreme due to climate change it is estimated that the majority of South Dunedin's stormwater network is closer to a 50% AEP or approximately equivalent to a 1-in-2 year level of service.

Wastewater

Much of Dunedin's critical wastewater infrastructure is located in South Dunedin. This includes:

- The Main Interceptor Sewer (MIS) - starting from Albany St in North Dunedin this pipe ranges between 0.6m to 1.65m and collects the wastewater from West Harbour, all of North Dunedin, the CBD and hill suburbs from Highgate down, conveying them along Timaru St where flows from South Dunedin and the Peninsula join the MIS before flows reach the Musselburgh wastewater pump station (WWPS).
- The Musselburgh WWPS - is where approximately 80% of Dunedin's wastewater is collected before being pumped to the Tahuna wastewater treatment plant (WWTP).
- The Tahuna WWTP – treats that majority of Dunedin's wastewater before the treated effluent is discharged to the sea via a 1.1km long 1.5m diameter outfall pipe.

Another key piece of Dunedin's wastewater infrastructure is the trunk wastewater pipes from Kaikorai Valley. These collect wastewater from Kaikorai Valley and upstream areas (including Wakari, Brockville, Bradford, the hills suburbs from Highgate down to the Valley) and in dry weather these flows go to the Green Island WWTP. In wet weather the wastewater pipes become overloaded and the excess flows are carried in pipes through the old Caversham railway tunnel, and through South Dunedin before reaching the Musselburgh WWPS.

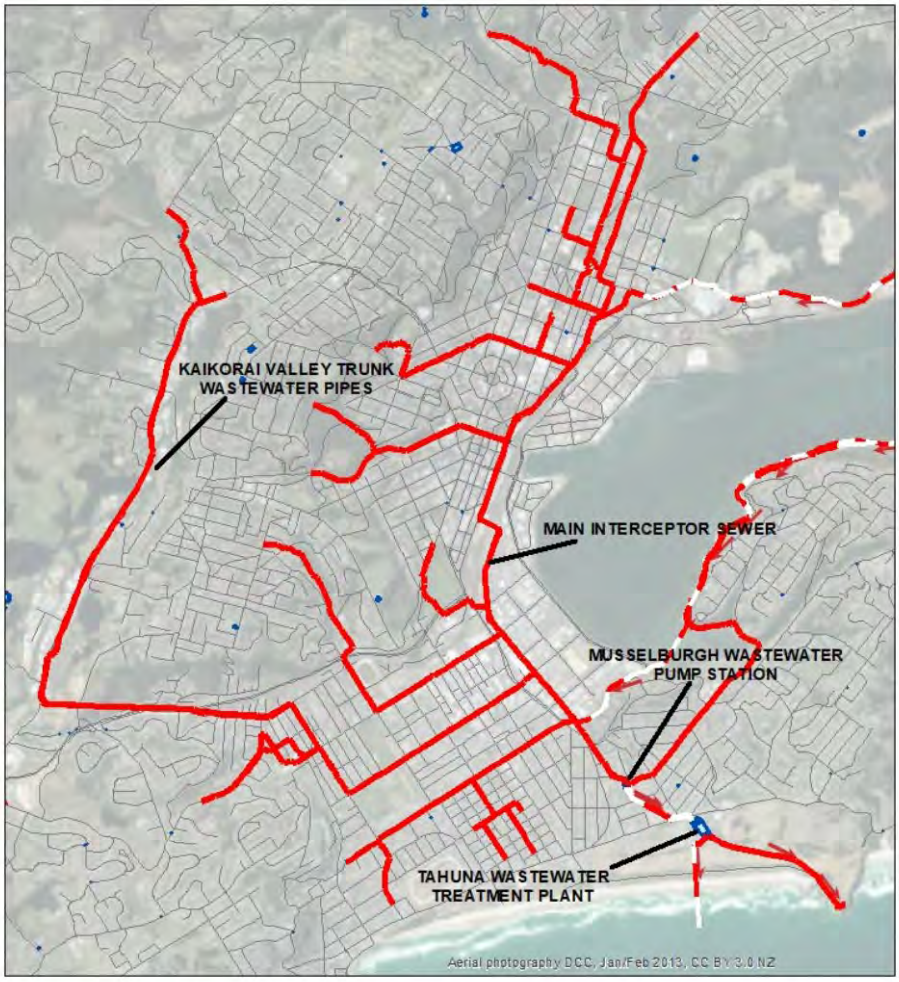


Figure 2: South Dunedin Wastewater Network (Note: only large diameter trunk mains shown)

The system is designed to ensure that in dry weather, all wastewater stays in the pipes. The system can cope with some wet weather however, in significant wet weather parts of the piped network can get overloaded, this results in some diluted wastewater having to be discharged into the environment to prevent wastewater flooding in people's properties. Currently we design new pipes to meet a 10% Annual Exceedance Probability (AEP), 24-hour rainfall event. This is approximately equivalent to a 1-in-10 year, 24 hour rainfall event (level of service). As Dunedin's existing wastewater pipes are mostly older and rain storms are becoming more extreme due to climate change there are parts of the city where we have problems with wastewater flooding in wet weather. The include some areas in Kaikorai Valley, North East Valley, Anderson's Bay and South Dunedin.

What the issues are

Aging pipes: A lot of the pipes are old and are made of older materials. Over time these pipes deteriorate, creating openings that allow rainfall and groundwater to get in. This mean the pipes get overloaded more quickly in wet weather, increasing the risk of flooding. There are a lot of these old pipes and it will take a number of years to replace them all with new pipes made of modern materials that have capacity to allow for growth and climate change.

Rainfall: Scientific and central government advice tells us to expect more frequent and severe weather events in the future as a result of climate change. This means we can expect to get more severe rain events that our stormwater and wastewater systems cannot cope with, even when we have it working as well as it can.

Groundwater - The ground acts as a sponge soaking up rainwater until it is saturated. The ability of the ground to absorb water is partly determined by the level of groundwater. Groundwater is the water found underground in the cracks and spaces in soil, sand and rock. South Dunedin has always had high levels of groundwater, which reduces the ability for rainwater to soak into the ground. The Parliamentary Commissioner for the Environment's report into sea level rise released late last year predicts that rising sea levels will continue to push up the groundwater levels in South Dunedin. This means, over time, the ground will be able to absorb even less rainwater. The recent work done by GNS supports this, showing that as sea level rises groundwater levels in South Dunedin will also rise. This will mean that more groundwater will get into the wastewater and stormwater pipes (unless they are upgraded), reducing the capacity of the pipes to contain wastewater and stormwater flows. This could lead to more flooding and wastewater overflows.

Water running in from other catchments: South Dunedin is part of a large natural catchment. This is divided up into blocks that drain stormwater independently from each other in small scale rain events. However, in larger events, rainwater from other catchments–especially those on nearby hills–runs down into South Dunedin making the flooding there even worse.

More hard surfaces in the area: In 1968, 45.7% of the area of South Dunedin was surfaced in a way that meant rain couldn't soak into the ground. Now it's 60%, so the stormwater system has to cope with much more run-off now. Development of private infrastructure such as more hard surfaced driveways, carports and garages has also contributed.

Tidal influence: The South Dunedin area is low-lying and in some places the stormwater network is below the tidal level for some or all of the time. This can mean that when significant rainfall occurs at the same time as a high tide the stormwater network can't be drained and there is a higher risk of flooding than at low tide.

Improvements made

- Mud tanks throughout Dunedin are more regularly checked and are thoroughly cleaned when needed. Critical mudtanks are checked even more frequently.
- Screen's at pipe inlets are more regularly checked and are thoroughly cleaned when needed. Critical screens are checked even more frequently.
- A high-capacity screen that is easier to clean in high flows was installed at the inlet to the Portobello SWPS in 2016.
- Additional alarms have been installed at the Portobello SWPS to give earlier warning if pump screens are becoming blocked.

- Part of the Forbury Aqueduct in an area that has failed several times previously in significant rainfall events and resulted in flooding has been strengthened to reduce the risk of future failure.
- Investigating the potential for short-term improvements to the Portobello SWPS and Forbury Aqueduct.
- The computer hydraulic models of our pipe networks that are used to support the testing of future options to alleviate flooding are being improved, giving more confidence for decision-making, considering the amount of investment likely to be required.
- Planning for improvements to monitoring of flows in our wastewater and stormwater pipes, so that we understand the problems better (e.g. how much groundwater is getting into our pipes) and can make more informed investment decisions for the future.
- Completing Integrated System Planning (ISP) for our water, wastewater and stormwater systems to develop long-term investment plans that address known issues and prepare for future challenges.

SUMMARY OF OPTIONS ASSESSED

An overview of all the options is provided in Table 1. Each of the options are schematically depicted in figures attached to this memo as Appendix A and described in the sub-sections below.

Table 1. Overview of SD stormwater modelling options considered in this study.

Option	Source of previous work (date completed)	Option Number in Previous Study	Description
0	Current scenario	N/A	Current system (December 2024)
1	"Stage 3B" – Contract 6736	Option 7B	Discharge to Orari Street SW main
2	"Stage 3B" – Contract 6736	Option 9	Divert Tainui flow to outfall, bypassing Portobello Pump Station
3	SD ICMP – Contract 2993	Option SD5	Hillside Road mains disconnected and pumped to Orari St outfall
4	SD ICMP – Contract 2993	Option SD6	Bathgate park detention pond
5	SD ICMP – Contract 2993	Option SD6a	Combination of Options 3 and 4
6	SD ICMP – Contract 2993	Option SD14	Bay View Road to Portobello PS
7	New/Unmodelled	N/A	Option 6 and upgrade Portobello PS
8	New/Unmodelled	N/A	Upsize Forbury Road pipe
9	New/Unmodelled	N/A	Forbury Park detention

3.1 Option 1 – Discharge to Orari Street stormwater main:

This option was first explored in 2017 by WSP (then Opus) in the 'South Dunedin Stormwater Modelling – Stage 3B Modelling Report' where it was referred to as option 7B. In this option flows are redirected from the Wilkie Rd and Hillside Rd stormwater systems along King Edward St via 1050mm pipes to a new pump station in Cameron St, which pumps flows towards the Orari St outfall via the 2700mm trunk main. The pump station modelled in this exercise is capable of moving 8m^3/s. For comparison the existing Portobello stormwater pump station can pump up to 6.3m^3/s. Much further work would be required to optimise the pump sizing and design.

Refer to Appendix A, Figure 1. For more details.

3.2 Option 2 – Divert Tainui flow to outfall, bypassing Portobello Pump Station:

Like the previous option, this was also investigated in the Stage 3B report where it was referred to as option 9. In this option flow is diverted from the Tainui area near the Andersons Bay Rd/Portobello Rd intersection by being pumped directly to the Portobello Rd outfall via a 1200mm pipe, bypassing the Portobello pumpstation. The additional pump station modelled in this exercise is capable of moving 2m^3/s. Much further work would be required to optimise the pump sizing and design.

Refer to Appendix A, Figure 2. For more details.

3.3 Option 3 – Hillside Road mains disconnected and pumped to Orari Street:

This option was first investigated in the 'South Dunedin Integrated Catchment Management Plan' report prepared by URS and Opus in 2011 where it was referred to by option SD5. It involves diverting flow at the Hillside Rd/Orari St/Andersons Bay Rd intersection from the Hillside Rd system to the Orari St outfall via a new pump station. The additional pump station modelled in this exercise is capable of moving 1.1m^3/s. Much further work would be required to optimise the pump sizing and design.

3.4 Option 4 – Bathgate Park detention pond:

This option was first investigated in the 'South Dunedin Integrated Catchment Management Plan' report prepared by URS and Opus in 2011 where it was referred to by option SD6. In this option, a detention pond was placed in Bathgate Park and all upstream flow in the Hillside Rd system was diverted to it. The sizing of the pond was given as the "volume equal to the stormwater volume from a current 1-in-10 yr ARI rainfall event". For the purposes of this exercise, a pond was modelled with capacity of 16,500m^3 (this would be equivalent to 0.3m depth over the entire area of Bathgate Park. Further depth is considered unfeasible at this stage of investigation due to elevated groundwater levels). Further work would be required to optimise the sizing of the pond.

3.5 Option 5 – Combination of Option 3 & 4:

This is option is a combination of the Option 3 and Option 4 – Diverting flow from Hillside Rd to Orari St and a detention pond at Bathgate Park. This option was also investigated in 'South Dunedin Integrated Catchment Management Plan' report prepared by URS and Opus in 2011 where it was referred to by option SD6a. All limitations of those modelled options apply to this option.

3.6 Option 6 - Bay View Road to Portobello pump station:

This option was also investigated in 'South Dunedin Integrated Catchment Management Plan' report prepared by URS and Opus in 2011 where it was referred to as option SD14. In this option, the Bayview Rd and New Rd stormwater systems were diverted to a new 1500mm pipe directly to the Portobello PS, adding pipe capacity as a supposed bottleneck location.

3.7 Option 7 – Option 6 with additional pump:

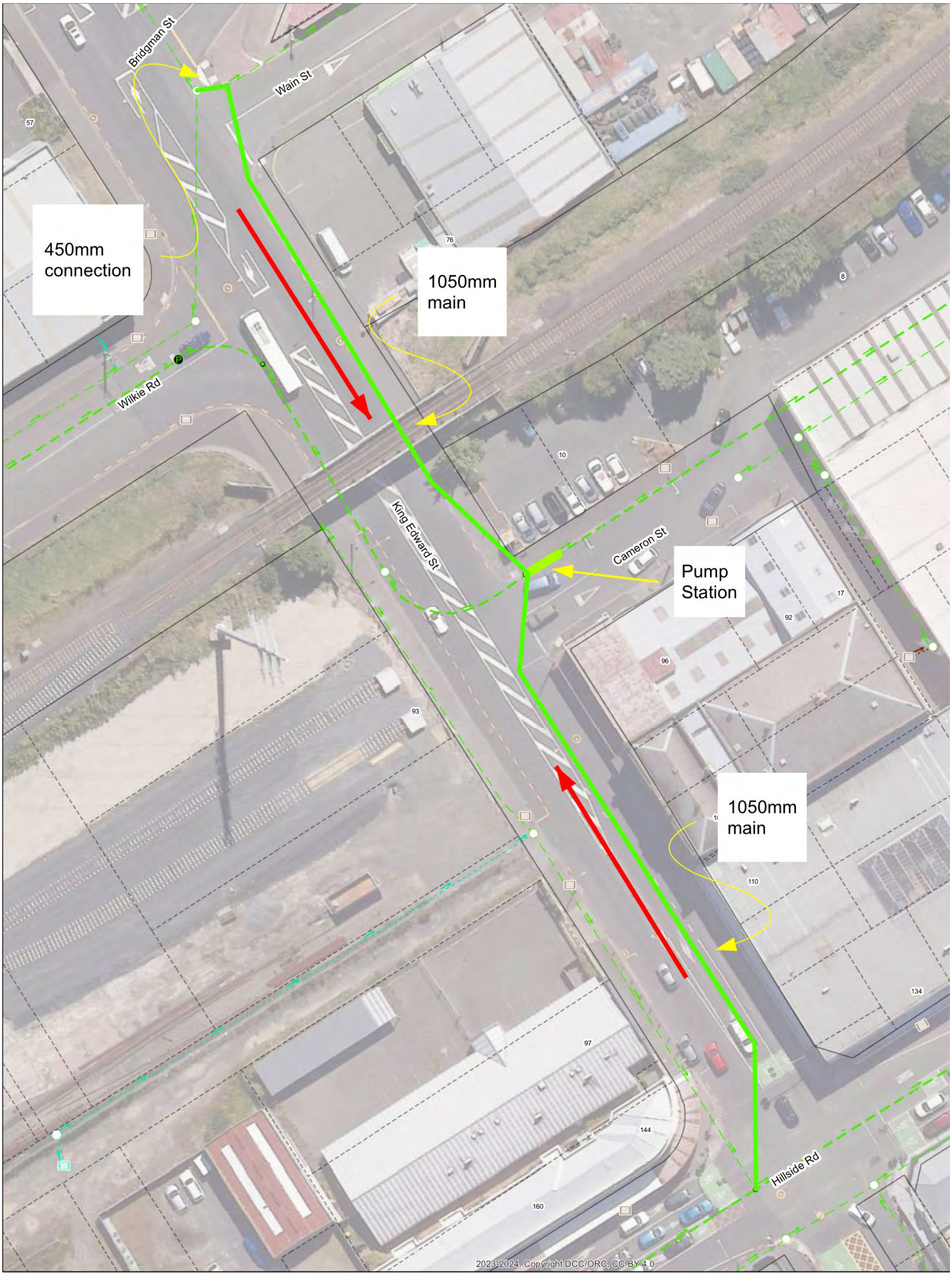
Option 7 is the same as option 6 and but also includes an upgrade of the Portobello PS. As this is a high-level modelling exercise, the largest of the existing Portobello PS pumps was "cloned" and added to the system. This adds approximately 30% capacity over existing. Much further work would be required to optimise the pump sizing and design.

3.9 Option 8 – Upsize Forbury Road aqueduct:

Option 8 involves doubling the size of the existing Forbury Rd aqueduct from Hillside Rd to the outfall at Second Beach.

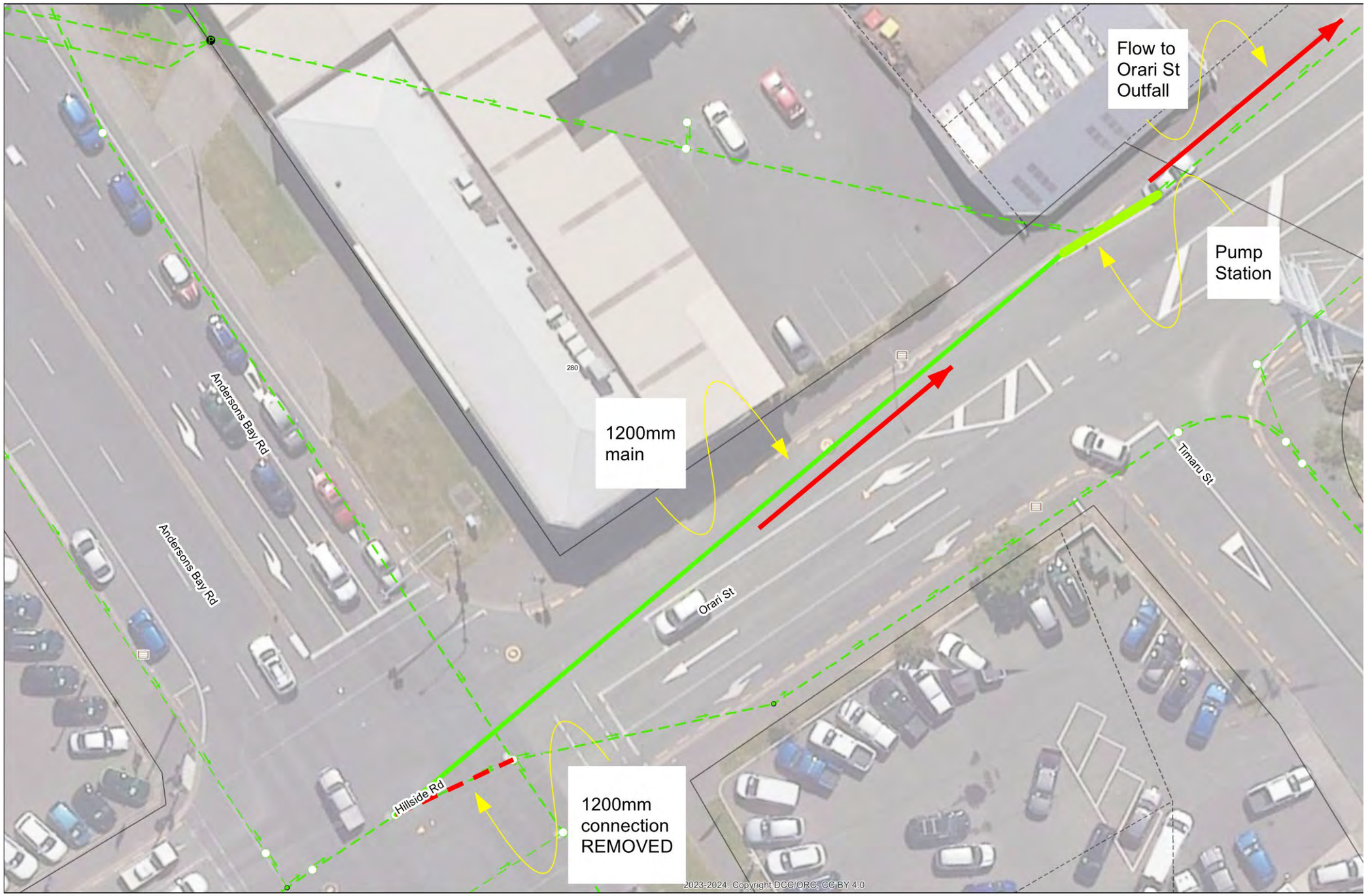
3.10 Option 9 – Forbury Park Detention pond:

Option 9 involves a large detention pond in the location of the former Forbury Park Trotting Club. This option was previously explored by DCC in 2020. In this option, flow has been diverted to a stormwater detention pond in Forbury Park from various parts of the network, primarily in Hargest Crescent.



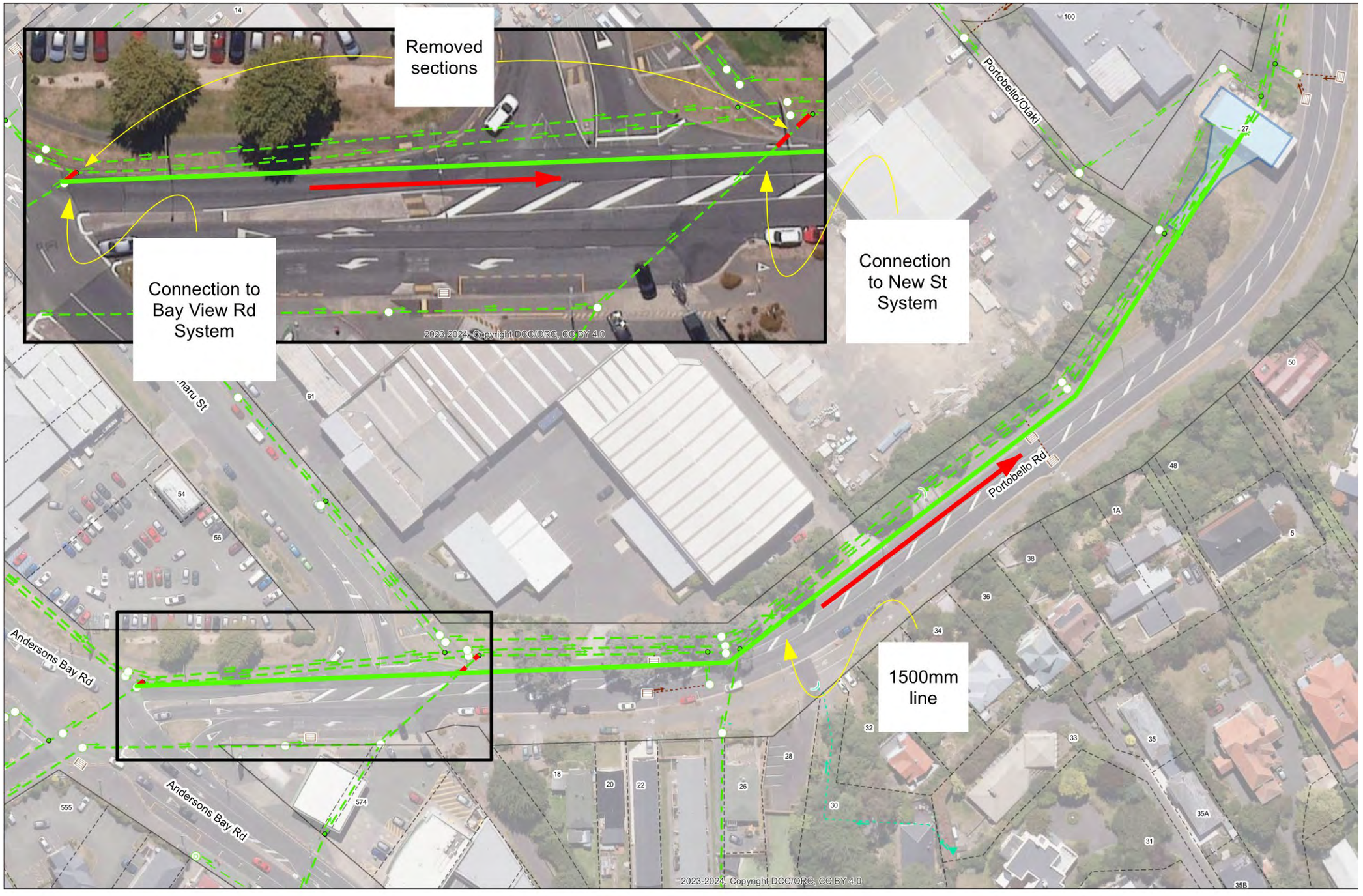
Option 1 - Discharge to the Orari Street stormwater main

Option 2 - Divert Tainui flow



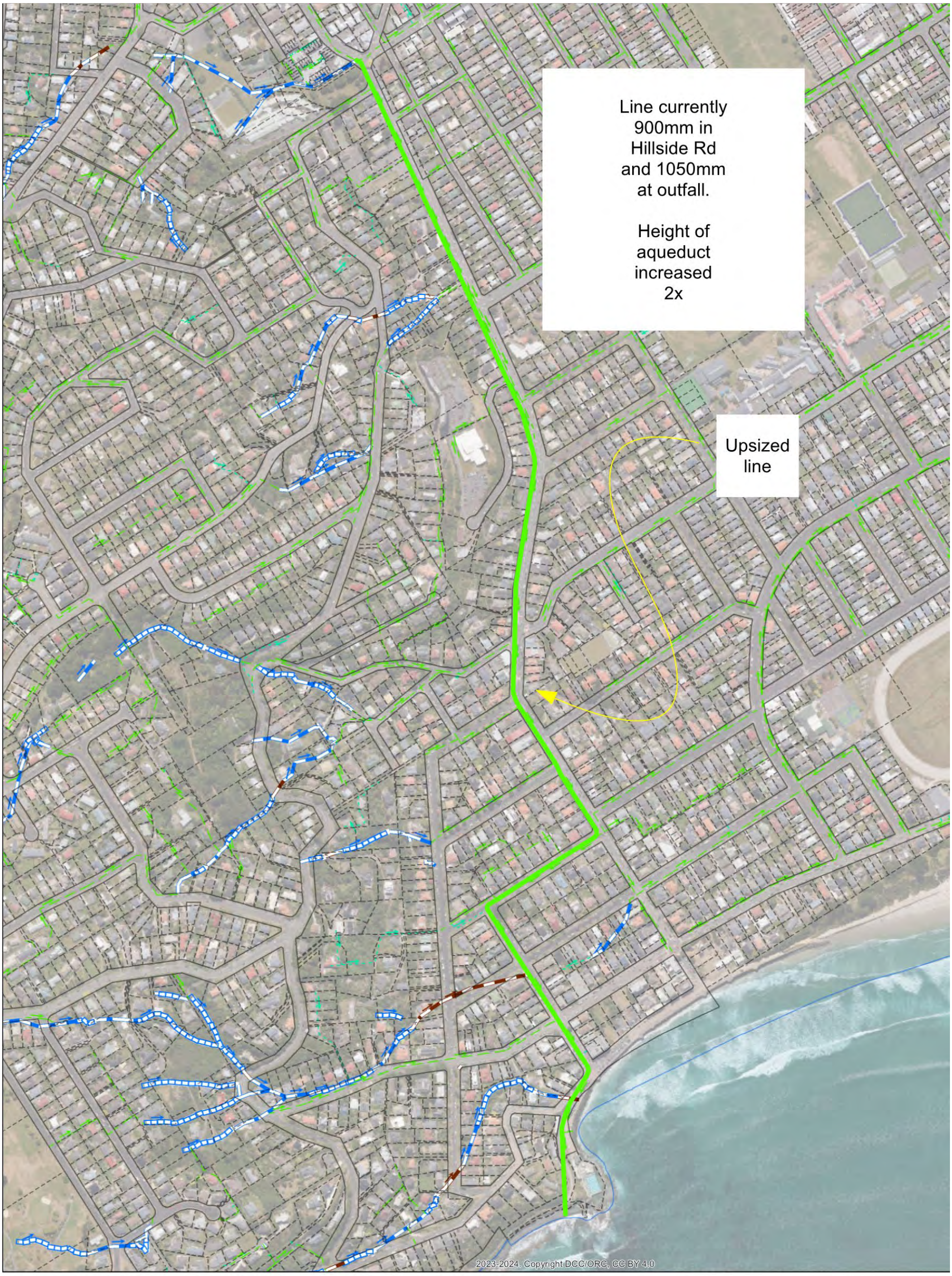
Option 3 - Hillside Road mains disconnected from the system and pumped to Orari St outfall

Option 4 - Detention pond in Bathgate Park



Option 6 - Third line from Bay View Rd and New St to Portobello PS

Option 7 - Remove bottleneck and upgrade Portobello pump station



Option 8 - Upsize Forbury Rd pipe

Option 9 - Forbury Park detention pond

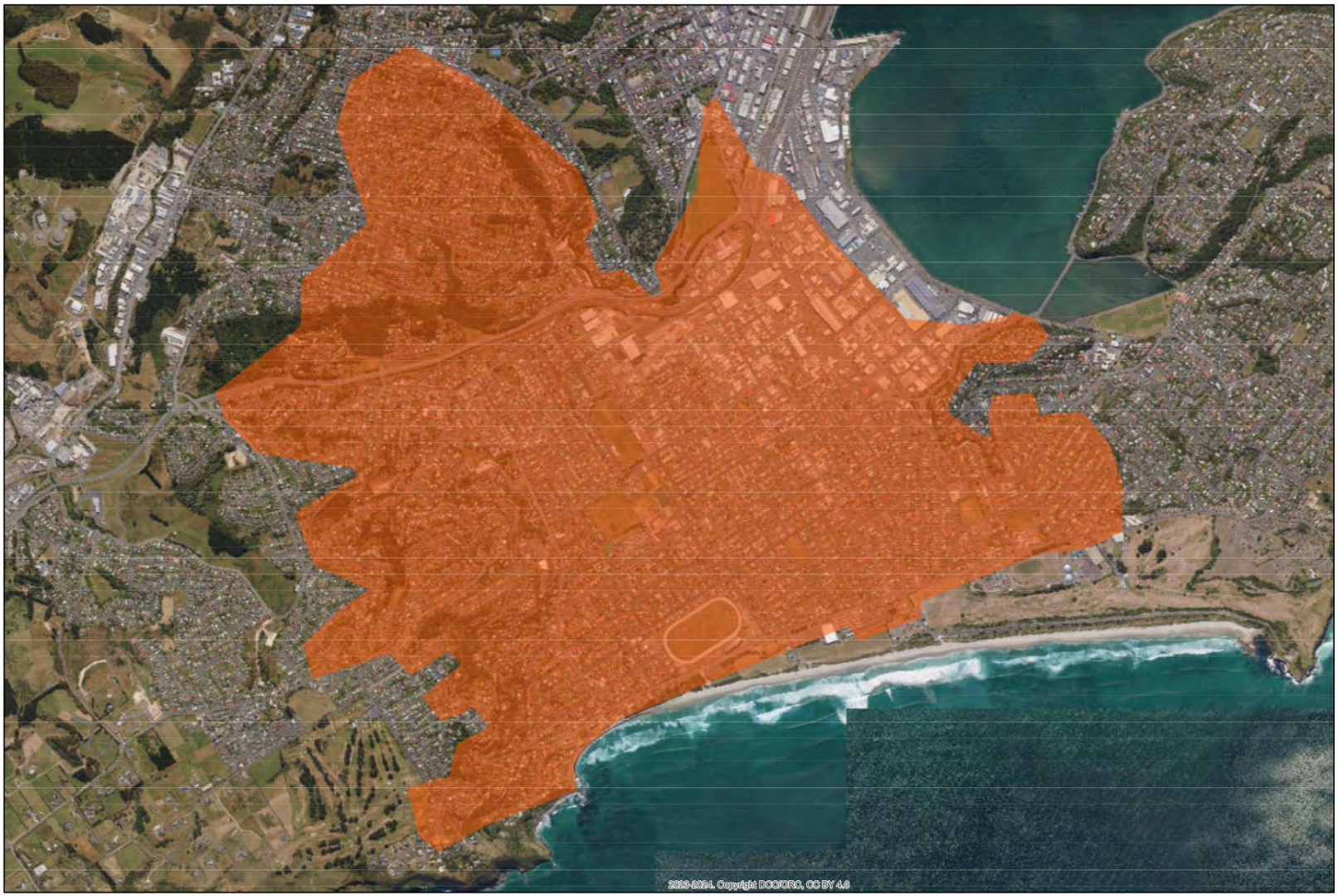
Base Scenario:

A 6 hour duration, 1-in-10 year rainfall event adjusted for the RCP4.5 'intermediate' climate change scenario (2081-2100), 53mm total depth

Total Flood volume: 66,700 m^3

Total Flood area: 570,000 m^2 (57 ha)

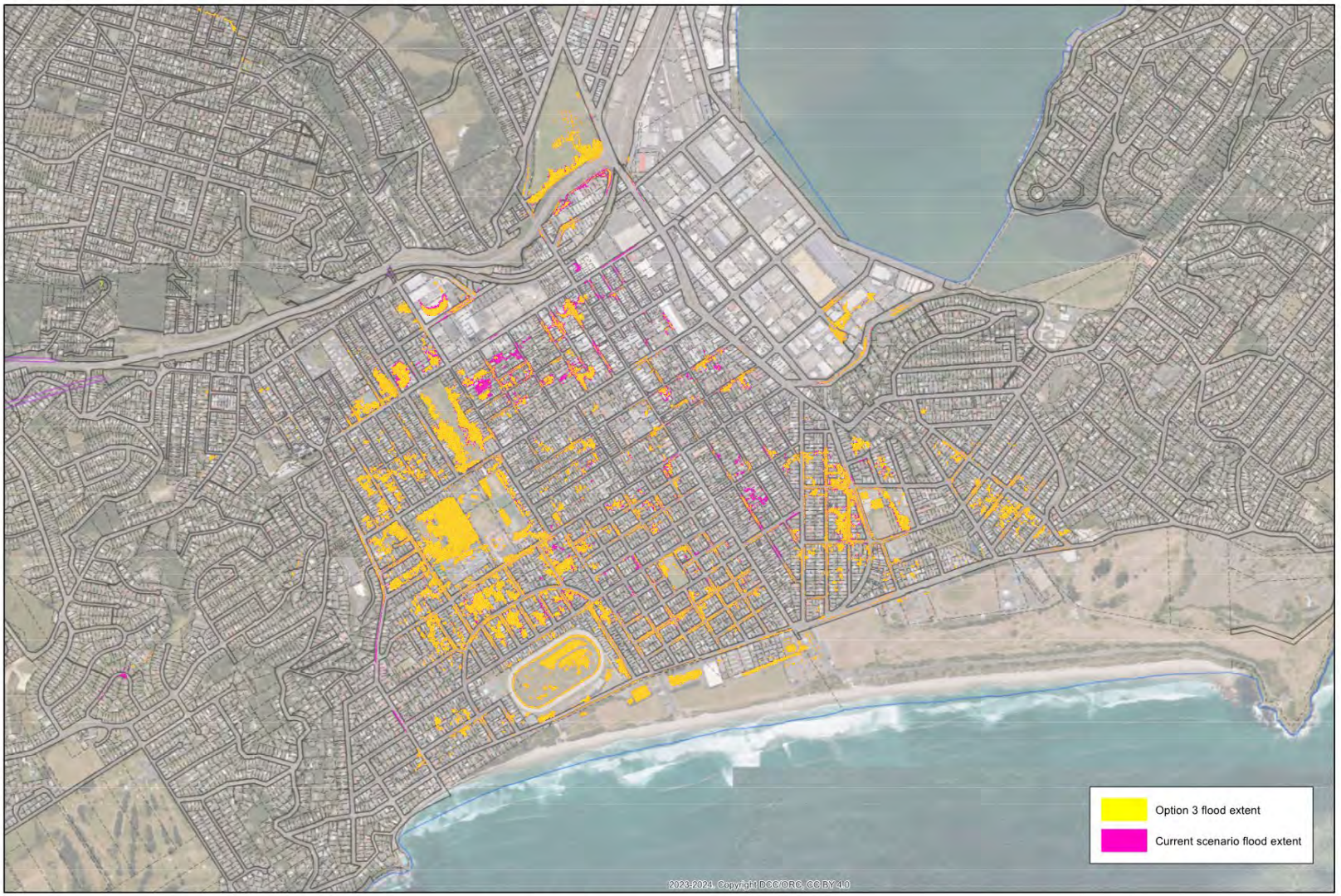
Option	Option description	Flood volume reduction (%)	Flood area reduction (%)	Cost ($ millions)	Cost per flood area reduction ($/$m^2$)
1	Discharge to Orari Street SW main	17%	11%	$88.7	$1,450
2	Divert Tainui flow to outfall, bypassing Portobello Pump Station	15%	9%	$28.8	$570
3	Hillside Road mains disconnected and pumped to Orari St outfall	19%	11%	$15.3	$230
4	Bathgate park detention pond	11%	7%	$25.0	$630
5	Combination of Options 3 and 4	22%	14%	$40.3	$500
6	Bay View Road to Portobello PS	5%	4%	$1.9	$90
7	Option 6 and upgrade Portobello PS	7%	10%	$21.6	$370
8	Upsize Forbury Road pipe	9%	8%	$12.0	$270
9	Forbury Park detention	21%	15%	$38.4	$460



Area of Study

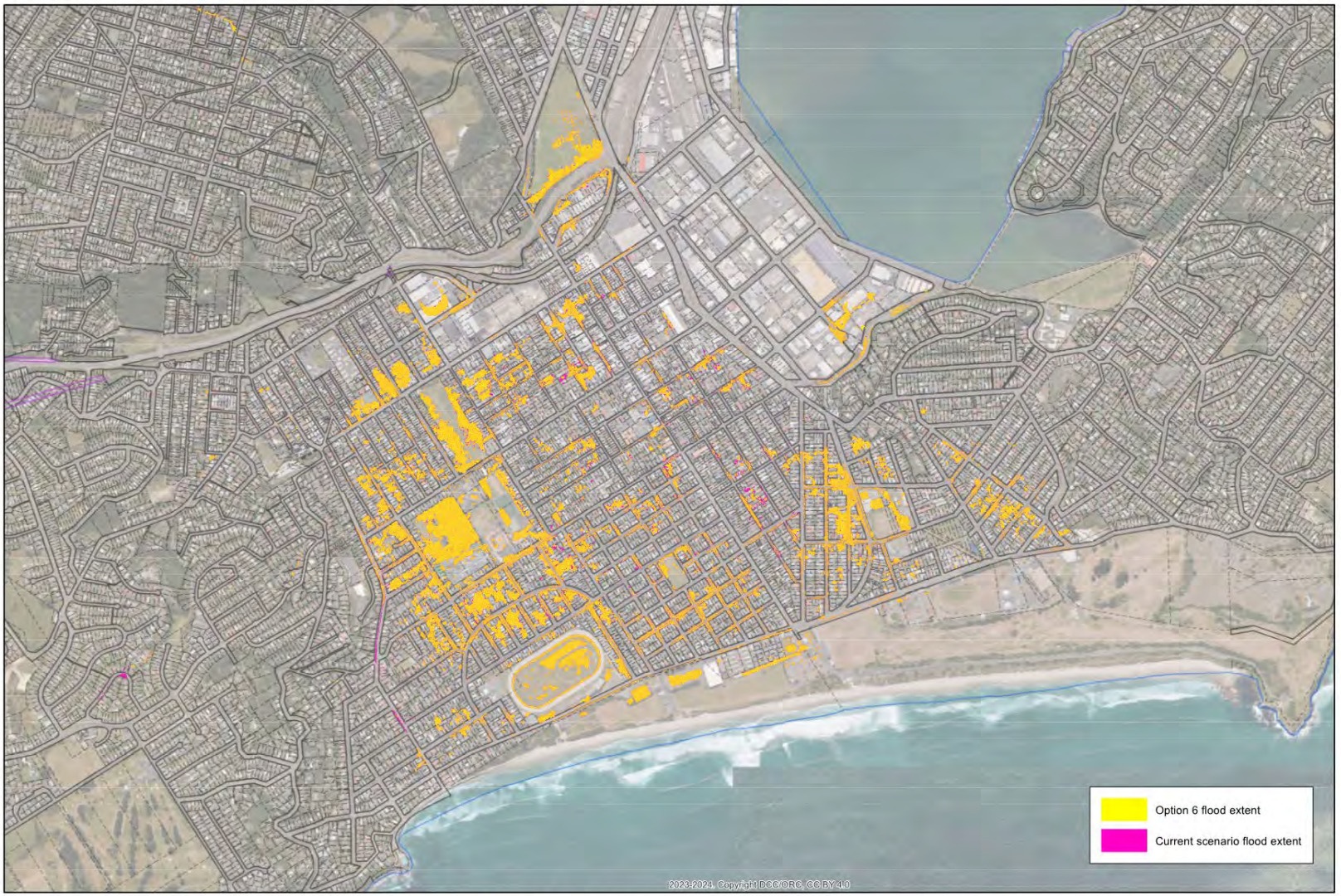
Current Situation - RCP4.5 6Hr 1 in 10Yr ARI Rainfall Event

Option 3 - Hillside Rd mains redirected - RCP4.5 6Hr 1 in 10Yr ARI Rainfall Event



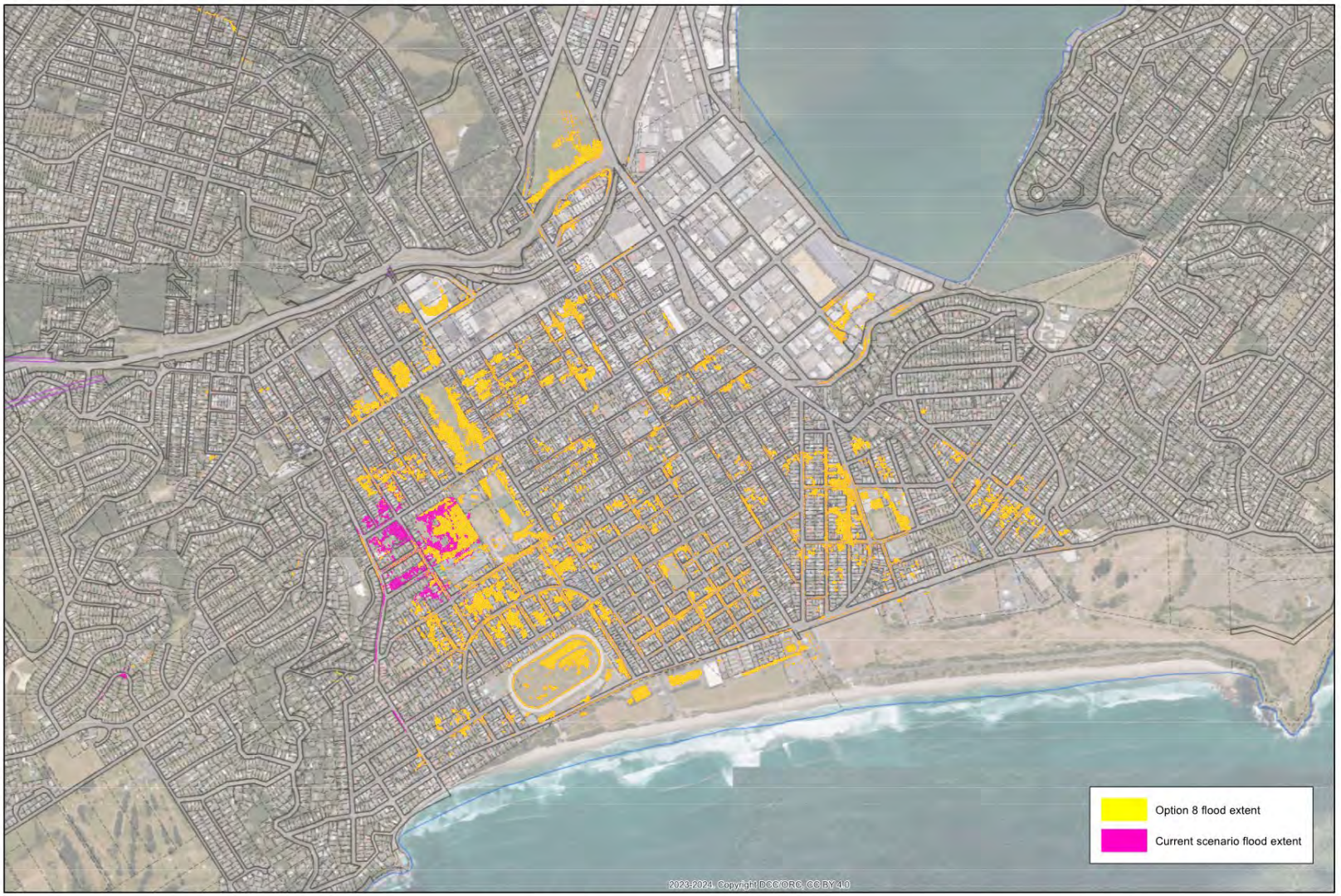
Option 3 - Flood Extent - RCP4.5 6Hr 1 in 10Yr ARI Rainfall Event

Option 6 - Third line from New St and Bay View Rd systems to Portobello PS - RCP4.5 6Hr 1 in 10Yr ARI Rainfall Event



Option 6 - Flood Extent - RCP4.5 6Hr 1 in 10Yr ARI Rainfall Event

Option 8 - Upsize Forbury Rd aqueduct - RCP4.5 6Hr 1 in 10Yr ARI Rainfall Event



Option 8 - Flood Extent - RCP4.5 6Hr 1 in 10Yr ARI Rainfall Event