Memorandum

To	Jonathan Rowe – Programme Manager, South Dunedin Future Programme, DCC
Copy	Kia Rōpine
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Subject	Efficacy Modelling – Task 1 deliverable: Stormwater modelling inputs and outputs
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1 Background

Hydraulic modelling is required to test the efficacy of each of the shortlisted proposed South Dunedin Futures. This report sets the scene for the modelling to enable it to be as efficient as possible while still meeting the wider SDF teams requirements.

Establishing which configurations of options will be modelled is a key focus. Configurations are likely to include some combination of potential futures (late century) and the short- and medium-term changes in infrastructure that could lead to the potential futures. What is meant by the descriptions of each potential Futures (e.g. 'keep land dry') will be needed prior to developing the short-, medium- and long-term pathways to be modelled. This includes the establishment of the basis for each option in terms of the design 'level of service' to be met by each solution (e.g. rainfall return period), and the model runs required to explore the efficacy of each option in reducing flood risk (e.g. climate change scenario).

It will also seek to define the model outputs required to undertake the residual risk assessments.

The following requirements have been developed in collaboration with Dunedin City Council, Kia Rōpine and Otago Regional Council, including inputs from GNS Science in respect of groundwater modelling.

2 Model scenarios

2.1 Scenarios

The current South Dunedin model was updated during the ICMP project in 2024. The most significant change in this model from the previous (2010 ICMP) is the inclusion of sump/mud pits to assess inlet capacity. The inclusion of sumps resulted in smaller subcatchments draining to them. Newer LiDAR information was also used in the model to represent overland flow. An allowance of groundwater entering the network was added to the model which relates to the groundwater level (supplied by GNS). Therefore, this model should form the basis of the SDF runs.

The base model will include the "quick win options" proposed by DCC. These are described in Section 3. The Base model will then be adapted to meet the following time horizons:

- Present Day
- Medium Term - 2060
- Long Term – 2100

The model for each shortlisted Potential Future will assume the options are fully developed in the 2100 horizon, the two proceeding timeframes will include upgrades to work towards that goal. Model runs are provided in Table 1. Time horizons and climate scenarios have been selected to align with the baseline climate change risk assessment.

2.2 Rainfall

Previous flooding of South Dunedin has occurred during long duration (over 12hrs) rainfall events. The South Dunedin System Performance Report (Beca, 2025) states that the critical duration (rainfall duration that created the greatest depth of flooding) was the 6 hour event. The 6 hours event showed the largest number of surcharging manholes and the largest flood extent. Consideration should be given to testing a longer duration event or the most recent event in October 2024 as a sensitivity (runs SD2b or c). This will be discussed with council before running.

The rainfall return periods to be tested will be:

- 10 year ARI – Used to size the pipe network. As agreed in the meeting (4-7-2025) the network will be sized allowing for approximately 150mm (of less if deemed suitable) of water to remain on roads to reduce the cost and extent of the network upgrades. The stormwater network may require sections that have a greater, than the 10 year, level of service such as conveyance to a storage basin
- 50 year ARI – This will be used to define options that contain formalised overland flow paths. It is also the level of service for storage and land raising options
- 100 year ARI – This is the model that will provide results for the residual risk assessment. The model will contain the infrastructure sized in the 10yr and 50yr ARI events. Consideration will also be given to design to this level of service if the residual risk is considered too high or if the additional upgrades required aren't significant. This will be discussed with DCC/SDF before progressing, therefore no runs haven been allowed for in the scoping.

2.3 Climate change

A climate change allowance will be added to the rainfall event. As agreed in the workshop (13th June 2025) the Scenarios will use SSP5-8.5 with a sensitivity test using SSP2-4.5.

Each rainfall event will have climate change added to match the horizon of each option e.g RCP8.5 to 2025 (Present day), RCP 8.5 to 2060 (Medium Term), RCP 8.5 to 2100 (Long Term).

2.4 Tides

Previous modelling has used the Mean High Water Springs (MWHS)[1] as the tide boundary in the model. It has been applied as a fixed tide level as a conservative approach.

Following this, approach MHWS level will be used alongside an allowance for sea level rise; these are:

- Present Day – MHWS
- Medium Term – MHWS + 0.5m SLR
- Long Term – MHWS + 1.1m SLR (although Long term 100yr is MWHS + 1.5m SLR)

The tide will be applied as a sinusoidal time series in the long duration sensitivity runs and as a fix tide level in the shorter critical duration runs.

2.5 Ground Water

The South Dunedin hydraulic model contains an allowance for the groundwater that infiltrates into the stormwater network. These inputs were developed during a calibration of the system performance project. The groundwater levels that feed into the network model are based on the groundwater levels developed by GNS. These network groundwater levels will align with the sea level rise allowance for each scenario and therefore the hydraulic modelling assumes that no wide-scale groundwater controls will be in place.

Where storage is included (e.g Forbury Park) as a future it is assumed localised groundwater controls will be in place allowing basins to be lowered below current groundwater levels. An allowance (likely a fixed inflow) will be made in the model for the flow generated by the groundwater controls.

[1] MHWS is the average height of the high tides that occur during spring tides.

Table 1 Model run scenario table.

Model run #	Rainfall Duration		Scenario				Return Period			Climate Change					Tides							Mapping		
	Critical	Long Dur (24hr?)	Base + Quick wins	Present Day	Medium Term - 2060	Long Term - 2100	10yr	50yr	100yr	Historic	RCP4.5 -2100	RCP 8.5 -2025	RCP 8.5 -2060	RCP 8.5 - 2100	MHWN + SLR (0.6m)	MHWS	MHWS + SLR (0.3m)	MHWS + SLR (0.5m)	MHWS + SLR (0.6m)	MHWS + SLR (1.1m)	MHWS + SLR (1.5m)	Residual Risk	Network Sizing	Sensitivity
SD1a	x			x			x					X				X							X	
SD1b	x				x		x						x					x					X	
SD1c	x					x	x							X						X			X	
SD1d	X			x				X				x				X							X	
SD1e	X				x			X					x					x					X	
SD1f	x					x		X						x						X			X	
SD1g	x			X					x			x				X						X		
SD1h	x				x				X				x					x				X		
SD1i	x					x			X					X						X		X		
SD2a	x					x			x		x								x					x
SD2b		X				x	x							x		X								x
SD2c		x				x		x						x		X								x
SD3a	X		x	x			x					X				X							X	
SD3b	X		x		x		x						x					x					X	
SD3c	X		x			x	x							X						X			X	
SD3d	X		X	x				X				x				X							X	
SD3e	X		X		x			X					x					x					X	
SD3f	X		X			x		X						x						X			X	
SD3g	X		X	X					x			x				X						X		
SD3h	X		X		x				X				x					x				X		
SD3i	x		x			x			X					X						X		x		

SD1 Runs for each future
SD2 Sensitivity runs, assumed a matching RCP(mid)4.5 and 2 long duration runs
SD3 Base runs for Residual Risk and network comparison. These are run once (9 runs) unlike SD1&2 which are run for each of the 3 Futures (36 runs).

3 Model inputs

The current South Dunedin model produced during the ICMP project is missing the short-term solutions announced by DCC. These are:

- Upgrade of the Forbury Rd aqueduct
- Hillside Rd main pump to Orari St outfall
- Portobello Rd bypass pipe to Portobello pump station.

These options will be included in the base model assuming these will be constructed regardless of the outcome of the SDF work. The inclusion of these projects does create some risk as they are still in the early stages of design and will change as they progress. DCC will provide the model inputs for these upgrades.

Most model inputs (rainfall, tide etc) were developed during the South Dunedin System Performance (2025) so these will be retained. One aspect that needs to be agreed with council is the level of additional development for each of the horizons.

WSP has supplied some general layouts for aspects of some of the options. These will create a starting point for modelling an option unless a more suitable layout if found.

4 Level of service

The level of service (LoS) gives the modellers a target to achieve when developing infrastructure upgrades.

The agreed LoS for upgrades are:

- Primary network (pipes) is the 10 year ARI. This applies to network locations where larger conveyance isn't required for a pump or storage option. Based on previous work upgrading the existing network to capture the full 10 year event with no surcharging may not be feasible therefore an allowance for some surcharging in roads of up to 150mm has been assumed. This may change once modelling has begun but we will inform council on our findings before progressing to far with proposed options.
- Secondary system (overland flow) is the 50 year ARI. This applies to options that contain formal overland flow paths. The 50 year LoS will also apply to main conveyance to storage that will also be sized for the 50 year event. The target for the 50 year is to reduce surface flooding as much as practicable

The infrastructure upgrades will use a model flagging system to enable the easy identification of new network. This will allow for lists of required upgrades to be produced for costs estimate, although not part of this project.

5 Model outputs

5.1 Residual Risk assessment

The critical model results are those that feed into the residual risk assessment. The results required for the assessment are:

- Max velocity
- Max water depth
- Max water surface elevation

These will be exported from the model and converted to .shp files for delivery. The residual risk results are the 100-year long-term scenario only.

5.2 Base and Futures

Maximum depth maps will be made for each of the current, medium- and long-term scenarios (for each Future). The same will be produced for the Base results also. This allows for a comparison to be made between the future and the base model but also between each horizon of a Future.

We have also allowed for 3 difference maps (10 year, 50 year and 100 year) to be produced per Future that compares the Futures runs with the Base model.

If the maps are not suitable to show the scale of change, reporting points within the network (primary and secondary) will be chosen and results tabulated to highlight changes.

5.3 Sensitivity runs

A difference map (of water depth) will be produced to the showing the difference in the flood extent between the sensitivity run and the corresponding Futures run. Differences at key infrastructure will also be tabulated and will feed into the report that will accompany the results. This will be similar process for the long duration event.

5.4 Report

A brief report (est. 10-20 pages) will be produced highlight the modelling work completed for each of the Futures. This will include a brief description of the upgrades required and their performance, using maps and tabulated results. The primary audience is Kia Rōpine (to inform cost estimates) and Dunedin City Council (to inform future stormwater projects).

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TASK 1: REQUIREMENTS SETTING SCOPE, FOR REFERENCE

Establishing which configurations of options will be modelled is a key focus. Configurations are likely to include some combination of potential futures (late century) and the short and medium-term changes in infrastructure that could lead to the potential futures. What is meant by the descriptions of each potential Futures (e.g. 'keep land dry') will be needed prior to developing the short-, medium- and long-term pathways to be modelled. This includes clarification to establish the basis for each option in terms of the design 'level of service' to be met by each solution (e.g. rainfall return period), and the model runs required to explore the efficacy of each option in reducing flood risk (e.g. climate change scenario).

To support requirements, we have proposed a half day, online workshop to discuss the options being modelled in detail. Attendees at the meeting will include DCC SDF programme manager (Jonathan Rowe), DCC 3-Waters lead (Jared Oliver), DCC 3-Waters modeller (Murray McLeod), ORC Natural Hazards lead (Jean-Luc Payan), and GNS Science groundwater advisor (Simon Cox), Kia Rōpine modelling team (represented by Elliot Tuck) and Kia Rōpine key specialist representatives (Laura Robichaux, Joao Machado, Katherine Cowper-Heays, Carrie Hartley and Liam Foster). Alternative attendees may be accommodated in case any of the identified specialists are unexpectedly not available – e.g. due to illness. We will use the indicative spatial layout and sizes of pumps, pipes, channels and detention zones that were produced in the previous phase to support the development of a cost estimate for each potential future. This GIS based layout with sizes will serve as the base for the model schematisation statement for each scenario to be modelled.

A second online meeting is also proposed (2hrs) to define the model outputs required for each of the stakeholders including files required for the residual risk assessment.

Laura Robichaux, as Kia Rōpine Workstream 4 lead, will work collaboratively with the model team (up to 16hrs) to confirm the understanding of the requirements. The options modelled will include short-, medium- and long-term configurations for three shortlisted Futures (e.g. testing a maximum of 9 model configurations representing short-, medium- and long-term components of three shortlisted futures). Time horizons for short, medium and long term will be selected in alignment with the risk assessment to compare to the baseline.

Collaboration with Kia Rōpine throughout the initial stages of the project (12hrs of meetings and provision of data has been assumed in addition to the half day workshop) will be essential to establishing the basis for modelling, and the assumptions to be made. For example, the pipes and pumps option would likely be designed to provide a 1 in 10-year flood Level of Service, and the wetlands and waterways option to a 1 in 50 year flood level of service, representing DCC's required levels of service for primary and secondary networks respectively or the level of service may be based on a reduction of the number of properties flooded.

By setting this framework before the models are created, allows minor adjustment to be made to the model to optimise each of the scenarios.

The deliverable from Task 1 will be a summary reports including:

- Model scoping report including the model run table and confirmation of the required model inputs, model outputs and the expected level of service of the model configuration.
- Residual risk assessment scoping report (e.g. number of properties, residual risk maps, inclusion of building floor levels).

There will be one iteration of this deliverable between DCC/ORC and Kia Rōpine.

At the completion of Task 1 there will be a hold point for the SDF council team and Kia Rōpine representatives to redefine Tasks 2-4 as well as time frames and costs based on the outcomes of Task 1.