greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

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Te Awa Kairangi / Hutt River Flood Forecasting Trial

1. Purpose

To brief the Committee about the flood forecasting system that has been developed for the Te Awa Kairangi / Hutt River.

2. Background

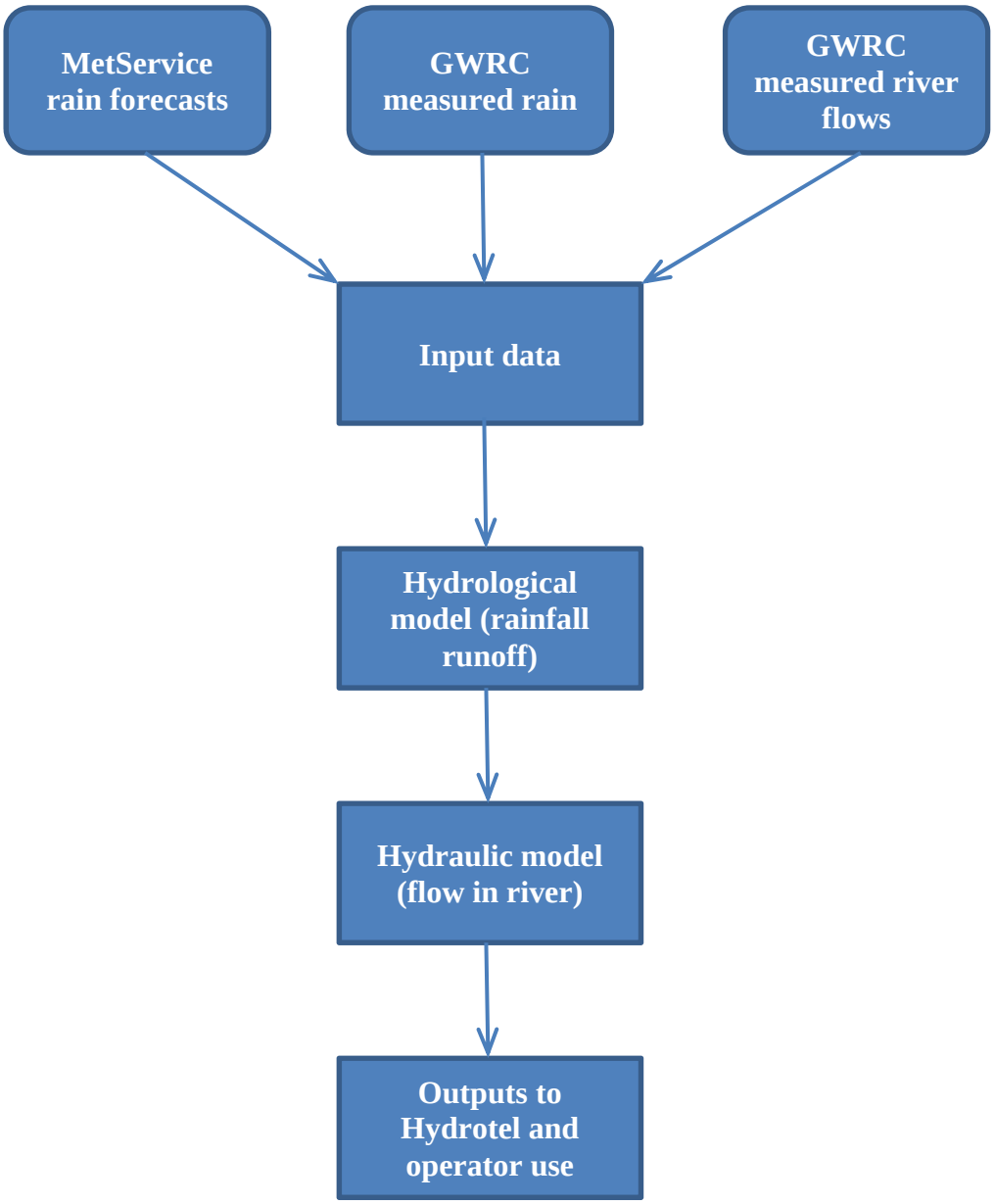
With the exception of the lower Ruamahanga River, where the onset of flooding takes longer, our current level of flood warning provides at best a few hours' notice of a flood event. Some significant streams have no flood warning system at all. The current system is based on responding to measured flows and rainfall that has already fallen. Suitable technology now exists to forecast flooding (timing, location, magnitude) based on weather forecasting. This would extend warning times out to many hours and even days. Many Regional Councils and Unitary Authorities are already providing flood forecasting and we find that many of our stakeholders have this expectation of us.

Greater warning times will allow WREMO, landowners and other stakeholders to respond more effectively to flood events and will help the community to take actions to minimise risk to life and property.

GWRC began a project in 2015 to develop a trial flood forecasting system for the Te Awa Kairangi / Hutt River. This has been a team effort between Flood Protection, Environmental Science and ICT, in partnership with WREMO.

3. The system

We have used DHI's "MIKE Workbench" system for developing the flood forecasting model. This makes use of GWRC's existing flood models which have already been developed using DHI software. The following diagram illustrates how the system works.


MetService rain forecasts
GWRC measured rain
GWRC measured river flows
Input data
Hydrological model (rainfall runoff)
Hydraulic model (flow in river)
Outputs to Hydrotel and operator use

The forecast runs three-hourly. It looks 48 hours ahead and takes:

- Hourly rainfall forecasts from MetService (for each GWRC rain gauge site)
- Recent rainfall amounts at each rain gauge site
- Current river and stream flows at flow gauge sites

These inputs are then fed into a hydrological model (looking at rainfall and runoff) and a linked hydraulic model (flow in rivers and streams). This allows us to forecast the flow at a number of locations along the Te Awa Kairangi / Hutt River and in tributaries.

The map in **Attachment 1** shows the model layout, with rain gauges as red triangles and flow gauges as blue circles. Note that not all of the flow gauges shown on the map are used in the operational model; some are not telemetered, which means that real-time data is not available. These gauges were still used in building and calibrating the model.

The hydrological model was built by GWRC with support from DHI. The hydraulic model is a simplified version of the model previously updated by DHI for the Riverlink (Hutt City Centre) project. DHI pulled the various components together into an operational flood forecasting model and set up all the processes to manage the flows of data in and out.

GWRC has recently taken delivery of the model and it runs on one of our PCs located at Shed 39.

4. Where are we?

We now have an operational flood forecasting model and we are waiting for some high flows to test it!

The flood forecasting model itself runs three-hourly and corrects itself for the measured rainfall and flows from the GWRC telemetered monitoring sites. Because of this, we expect that we will have a good degree of accuracy for forecasts out to several hours but that forecasts beyond that will be highly reliant on the accuracy of the rainfall forecasts. MetService rainfall forecasts are issued 6- or 12-hourly. What this means in effect is that the longer-term river flow forecast can change markedly every 12 hours if the rainfall forecasts change significantly.

Each model run also includes scenarios for 20% less rainfall than forecast, and 20% more. This gives the users a way of taking into account the uncertainty in rainfall forecasts.

Users have received some training in how to access the forecast data and how to use the system. A few users will receive additional training in how to use the system in more detail, including how to trigger additional runs or customised scenarios as needed.

The current focus is on making tweaks to the system and ironing out any bugs. Following this, we will integrate the flood forecasting system into our flood warning processes and assess its performance. The results are not currently available for public viewing.

5. Where to next?

As we assess the performance of the model, we will be able to draw conclusions about where best to invest our resources. Further recommendations will be made once we've had a period of time (and some floods) to assess the model. Areas for future development include:

5.1 Telemetry/network improvements

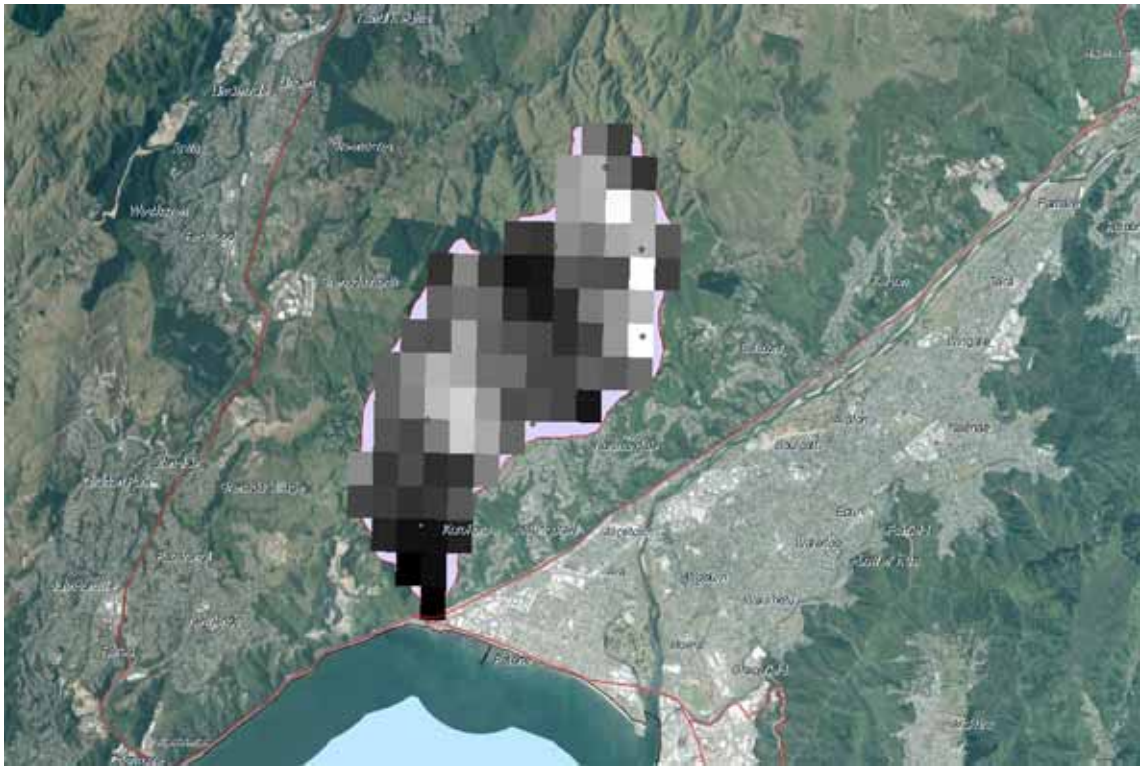
During the development of the model, the project team identified that additional rainfall or flow gauges would be beneficial. The map in **Attachment 1** reveals some large gaps, especially in our rainfall network in the upper Hutt and Mangaroa catchments. Some existing gauges could be better located, and adding telemetry to two existing river flow gauges would make them available in real-time for refining the model forecasts. The related Flood Warning Review and Hydrology Network Review projects will also influence the future network.

5.2 Improvements in rainfall forecasts

The field of rain forecasting is developing rapidly, with increasingly powerful computers and more detailed models. Rainfall forecasts are generated on a grid with an hourly rainfall total estimated for each cell in the grid. An example of gridded rain data on a small catchment is shown below.

The model currently uses rainfall forecasts at points that coincide with the locations of our rain gauges (ie. the value of the grid cell at that point) and these single values are applied across nearby subcatchments. In the model, each subcatchment has a rain gauge or gauges assigned to it and the rainfall in the catchment is estimated by weighting the rain forecast or observed rainfall at each gauge. This means that major assumptions are made about the spatial distribution of rainfall across the catchment and subcatchments.

In the future we may move to directly using 'gridded' rain forecasts which may better represent the variability in rainfall across a catchment. Much as with hydraulic modelling, grid cell sizes are decreasing (the grid is becoming more detailed) as computing power and weather modelling technology improve.



We could also consider obtaining weather forecasts from more than one agency in the future. Using a range of forecasts may help us to better understand the uncertainties for a given event (and some forecasts may prove better than others over time).

5.3 Better hardware resilience

For the operational trial, it is acceptable to have the model running on a single physical PC at Shed 39. The PC is backed up regularly to prevent data loss and to allow us to re-establish the model on another computer in the case of hardware failure.

Once the model has been integrated into our normal systems and is being relied on more, and especially if the results are being made publicly available, we will need to move to a solution that provides better resilience and redundancy. There are a range of options to achieve this.

Overall resilience and reliability of our hydrometric network and related ICT systems is being considered by the Flood Warning Review and Hydrology Network Review projects.

5.4 Publicly available information

The outputs from the Te Awa Kairangi / Hutt River flood forecasting model are currently only available to GWRC staff with access to our Hydrotel system or the modelling PC itself. The model is still in a trial phase and will likely require more work before being considered trustworthy.

Our intention is to make the forecast information publicly available once we are satisfied that the model is sufficiently reliable. The information would need to be provided with appropriate guidance and disclaimers. The trial phase will help to establish bounds of confidence/reliability and how the model results are best presented.

5.5 Additional rivers

Having purchased the MIKE Workbench software, GWRC has the ability to develop other flood forecasting models. Experience gained in developing the Hutt forecasting model applies equally to the other rivers around the region. Once we have successfully demonstrated the system on the Te Awa Kairangi / Hutt River we will consider the benefits, feasibility and priority of adding more rivers to the system.

6. Communication

The focus has been on internal communication with users and with WREMO who will be provided with flood forecast information as part of GWRC's flood warning service.

Once successfully implemented, we would like to publicise the system amongst stakeholders and the community. However, we need to be mindful that we manage expectations of access to the forecasts.

7. The decision-making process and significance

No decision is being sought in this report.

7.1 Engagement

Engagement on this matter is unnecessary.

8. Recommendations

That the Committee

1. ***Receives** the report.*
2. ***Notes** the content of the report.*

Report prepared by:	Report approved by:	Report approved by:
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Attachment 1 Te Awa Kairangi / Hutt River Flood Forecasting Model – Rainfall and river sites