Mataura River

Flood Modelling

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Client: Environment Southland

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Te Taiao Tonga

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EXECUTIVE SUMMARY

Land River Sea Consulting (LRS) has been contracted by Environment Southland (ES) to develop a detailed flood model of the Mataura River. The purpose of this model is to allow a better understanding of the current level of service that the Mataura protection scheme provides for the Gore and Mataura townships, to investigate the impact of potential stopbank breaches and to investigate the impact of potential upgrades to the scheme.

HYDROLOGY / MATAURA RIVER HISTORY

The Mataura catchment is the second largest in Southland, covering a total area of 5,360 km^2 with the actual river bed running ~240 km from source to sea. Since the late 1840's, the river has produced several significant flood events, inundating its most populated townships – Gore, Mataura and Wyndham – as well as the surrounding rural communities. These events have resulted in heavy losses to crops, animals, homes, shops, roads and the railway. To protect these places, stopbanks have been constructed on both sides of the river, however, these have not been able to prevent inundation from floodwaters during large events such as in October 1978 and February 2020.

Analysis of the historic floods has shown that these large events tend to occur during positive phases of the Interdecadal Pacific Oscillation (IPO) and in some cases prolonged negative periods of the Southern Annular Mode (SAM). Both of these climate oscillations result in the southwest of the South Island being wetter than average. Over the last few years, the IPO is believed to be transitioning into a positive phase, which from the analysis above, will lend towards large flood events like those in the past.

HYDRAULIC MODELLING

A detailed 2D model of the Mataura River system has been built in the MIKE 21 FM software based on a combination of the PGF 2020/21 terrestrial and Landpro 2022 bathymetric LiDAR data. To allow for reasonable run times, it has been split into two parts; upstream Gore, and downstream Mataura.

The crest levels of the Gore and Mataura stopbanks have been adjusted to the surveyed elevations captured in November 2022 by LRS staff. The additional stopbank in South East Gore, and the raised Boundary Creek stopbank, which were built and raised post-February 2020 (the calibration event) have been included in the final design runs in the model.

Flow data has been provided by ES hydrology staff for all sites within the modelled area of interest, with the Mataura Rv at Gore serving as the main model input. For the Mataura model input, flows have been taken from the glass walled version of the Gore model, assuming that the stopbanks (or bridges) in Gore have been upgraded to prevent overflows within this reach, and hence increasing the flows into Mataura compared to what they would be should the banks overtop.

There is considerable uncertainty for the February 2020 event calibration hydrograph due to lack of recent high flow gauging, and changes to this reach of river through Gore as a result of the removal of willows and aggradation. The peak flow for this event has therefore been scaled down from original estimates. At the time of publication of this report, the hydrology for the Mataura was currently being reviewed by NIWA, which may result in a refined estimate of the design flow rates.

Limitations of the model, particularly the uncertainty in the flow inputs and due to the fact that it is a fixed bed model and does not simulate sediment transport do need to be kept in mind, with the results being interpreted by experienced professionals.

Due to the very steep nature of the Mataura Gorge and the high velocities and turbulence that result in a significant flood, levels of uncertainty in results are greater in this reach than in other areas of the model.

Detailed flood maps showing peak depth, speed and hazard have been produced for 2% and 1% annual exceedance probability (AEP; 50-year and 100-year annual recurrence interval) events as well as for nine breach scenarios.

The model has been formally peer reviewed with several recommendations being made in regard to potential improvements in the model. These recommendations have been implemented where possible in consultation with the reviewer. Whilst it must be acknowledged that the model does not perform as well in the Mataura Gorge area as desired, it is likely that due to technical limitations in the software and uncertainty in the data (bed level, flow & calibration) that the model is unlikely to be able to any further improved for now.

MODEL RESULTS

Gore: 2% AEP (50yr ARI)

The results show that the scheme performs reasonably well in Gore for a 2% AEP (50-year ARI) event, with no overtopping visible on either side of the river. However, there is considerable inundation of the farmland upstream of both Gore, with depths peaking up to and above 2.5 m and 3.5 m, respectively, and speeds of up to 1.5 m/s.

Gore: 1% AEP (100yr ARI)

For a 1% AEP (100-year ARI) event, the scheme cannot contain the design peak flow. Results show there is a significant and severe flood risk to the Gore Township in a 1% AEP event with depths and speeds of the inundation to the west of the river peak between 1 and 2 m, and 0.3 and 1.5 m/s, respectively, and to the east up to 1 m, and 0.5 m/s.

The resulting hazard categorisation for the 1% AEP event ranges from H3 to H5 in Gore, and H3 to H4 in Mataura. This is significant. It indicates that the flooding through these towns will be unsafe for vehicles, children and the elderly, and in some areas, all people, with buildings also vulnerable to structural damage.

Mataura: 2% AEP (50yr ARI)

The results show that the scheme is able to contain the Mataura River upstream and through Mataura for a 2% AEP (50-year ARI) event, with no overtopping visible on either side of the river. However, there is considerable inundation of the true right farmland and SH1 upstream of the Boundary Creek stopbank, with depths peaking above 3.5 m in places, and speeds up to 1.5 m/s.

Mataura: 1% AEP (100yr ARI)

For the 1% AEP (100-year ARI) event, the scheme cannot contain the Mataura River. The Boundary Creek stopbank overtops resulting in considerable inundation of the Mataura township, with depths between 0.5 and 2.5 m, and speeds up to 2 m/s.

The resulting hazard categorisation ranges between H3 and H4, with small areas of H5. This means that most of Mataura will be unsafe for children, the elderly and vehicles, and in some parts all other people and even buildings.
The stopbank on the true left just upstream of the township also overtops, resulting in inundation of several residential blocks with depths up to 0.5 m and speeds up to 1 m/s.

Breach results

Nine breach scenarios have been simulated which demonstrate the significant consequences should a section of bank fail. All breach scenarios have been carried out in a 2% AEP event when the stopbanks would not overwise be overtopping.

Results show extensive flooding for all of the scenarios except for breach scenario 3 between the Gore Road and Railway bridges where the road embankment is acting as a secondary bank and is preventing further inundation through the town.

Depths and velocities are very significant in most of the locations modelled such that there would be high risk for loss of life should a breach occur. This emphasises the importance of ongoing asset inspections and maintenance, as well as the need to maintain workable, reliable and up to date evacuation procedures that are understood by the entire population.

Impact of raising the Boundary Creek stopbank

Raising Boundary Creek has decreased flood extents and depths in the Mataura Township on the true right bank, however the following negative impacts can be seen;

- The true left stopbanks now overtop causing inundation to a large number of properties on the true left bank which didn't previously flood. This will also increase the likelihood of catastrophic failure of this bank which would lead to flooding even more severe with high likelihood of loss of life, if people were not evacuated.
- Residential properties upstream of the Boundary Creek have increased flood depth in the order of 0.3 to 0.5m
- Water levels through the Gorge increase with flood levels at the Mataura Road Bridge increasing to sufficient levels to hit the road deck, preventing use of the bridge and potentially causing permanent damage to the road infrastructure.

Impact of deepening and widening the channel under the Gore bridges

Deeping and widening the channel under the Gore bridges has not shown any benefits to the water levels at the railway bridge as was originally shown in the 1D hydraulic modelling. Decreases in water

level are experienced upstream of the road bridge, but this benefit does not extend to the railway bridge where it is most needed.

This is most likely due to the limited channel capacity downstream from this location. Consideration could be given to widening a greater length of river, and removing all constrictions in channel width downstream of the bridges.

RECOMMENDATIONS

The following recommendations can be made:

- The model is fit for the purposes outlined in this report.
- If the model is to be used for designing stopbank levels, setting floor levels, and district planning purposes then a range of sensitivity scenarios should be run through the model including increasing channel roughness, bridge blockage and changes in inflows.
- Considering the very significant consequences demonstrated in the model results, urgent priority must be given to ensuring that all evacuation planning procedures etc are up to date and well understood.
- Further investigations into options for reducing flood risk now that the model has been developed are recommended.
- Deepening and widening the river through the Gore bridges is not sufficient on its own, and in order to increase the capacity through the bridges, additional widening may be necessary downstream from the bridges.
- Now that the consequences of raising the Boundary Creek stopbank are better understood, consideration will need to be given to remediating the negative effects.
- Considering the severity of flood risk in some locations such as on the true left of the Mataura River, consideration may need to be given to managed retreat to allow the river to have more room.
- Before carrying out any river engineering works on the Mataura River, the effects of these works need to be carefully considered and assessed. This model is likely a useful tool for these purposes.