5 FUTURE MODEL APPLICATIONS

A possible further phase to this study is to develop a water quality model for the Kaituna River and Maketu Estuary system. EBoP have highlighted the following water quality parameters as of importance for the river and estuary:

- Bathing suitability;
- Bacteria;
- Metals;
- Nutrients;
- Algal growth – both blue and green blooms;
- Sediment load;
- Water temperature;
- Clarity; and
- Pesticide / herbicide residues.

Now that a calibrated model of the Kaituna River and Maketu Estuary has been set up, the model can be extended with water quality functionality using ECOLAB. The water quality model, ECOLAB, is an established add-on module to MIKE 3 FM and links dynamically to the core hydrodynamic model. ECOLAB can be developed to model the water quality processes you require using standard templates as a basis. These templates can be modified meaning no ecological problem is too small or too complicated to accurately predict its behaviour. Essentially, any advection/dispersal, growth/decay process can be simulated, but typical process groups are:

- Water Quality (BOD-DO relationship, nutrient transport and bacterial fate);
- Eutrophication (nutrient cycling and relationship with primary production); and
- Heavy Metals (fate of dissolved and suspended metal in water and sediment).

The key to developing a robust water quality model will be a comprehensive data set. EBoP currently have a monitoring programme and collect measurements at several locations within the river and estuary. This may need to be complimented with further data collection. The type of shellfish and their extent within the estuary will need to be quantified as the filtration process of the shellfish will have a large impact on the concentrations of water quality parameters. DHI also suggest undertaking a literature review to identify any other possible studies or data collection that has occurred for the area.

If EBoP decide to proceed with this phase, additional work will be required to resolve that with the current model the freshwater plume from the river and estuary does not disperse adequately and is drawn back into the estuary on the flood tide. Consequently water quality parameters will build up in the estuary, instead of dispersing out into the Bay of Plenty. It is possible to artificially induce a longshore current into the model to achieve the required behaviour. Such a current is likely to exist but is not currently represented in the model boundary definition.

Other issues that may require investigation include morphological changes to channels and likely erosion risks, i.e. to understand the required flows to maintain estuary depths or produce net sedimentation out of the estuary. The existing MIKE3 model could be used for these investigations or DHI could develop a fully morphological model which can dynamically update the bed bathymetry in response to local currents. A restriction in using this model is that can be computationally expensive.

6 CONCLUSIONS AND RECOMMENDATIONS

EBoP commissioned DHI to develop a three dimensional model of the lower Kaituna River and Maketu Estuary to investigate the effects of re-opening Papahikahawai Channel. A model was developed using MIKE3 FM, consisting of both hydrodynamic and advection/dispersion components.

The hydrodynamic model was calibrated for a six day period, with a good agreement achieved between observed and predicted levels within the river and estuary, achieved. The model appears to under predict current velocities in the estuary when compared with the data; however the model seems to sufficiently simulate the tidal exchange between the estuary and open ocean. It was also shown that during normal flow conditions the model will accurately predict the inflow through the Fords Cut culverts.

The advection/dispersion model was calibrated for two separate days when salinity measurements were taken within both the river and estuary. One of the periods was during a significant flood event in the Kaituna River. A good agreement was found between the observed and predicted salinities within the river when using a constant vertical eddy viscosity formulation. It was concluded that for this study the model was sufficiently calibrated to predict freshwater / saltwater inflows through Fords Cut and the re-opened Papahikahawai Channel.

The model was modified to include re-opening of the Papahikahawai Channel. The model was validated with a previous modelling study, with a good agreement found between the predicted inflows through the proposed culverts. Impacts for the proposed re-opening of the Papahikahawai Channel were investigated by assessing the ratio of freshwater inflows to the estuary with the existing layout and with the channel re-opened. The model indicates that the volume and freshwater/saltwater composition of water that is introduced into the estuary by the opening is strongly affected by the tidal conditions. Higher total volumes are introduced through the Papahikahawai Channel during spring tides (an additional 311,000 m^3) which are also more saline (75%) compared to neap tide conditions (93,000 m^3 additional inflow, 48% saline). Volumes and compositions of flows through Ford's Cut are largely unchanged compared to existing conditions.

A flood impact assessment was carried out for two different Papahikahawai Channel geometries. Based on a channel geometry including minimal enlargement of the existing cross section, the peak levels within the river and estuary were found to increase by a small amount. The maximum water levels during a spring tide with a normal river flow are predicted to increase by up to15 cm within the main estuary. The simulations suggest that peak levels will increase more in the eastern part of Papahikahawai Channel. During a spring tide with a storm surge (peak tidal level of 1.62 m, Moturiki datum) and a 20% AEP river flow, the maximum water levels are predicted to increase by 10 cm.

With the Papahikahawai Channel re-opened new areas of land will be exposed to elevated flood levels. Peak velocities in the channel during the a 20% flood event reach a maximum of 1.5 m/s locally near the Kaituna river end of Papahikahawai Channel and 0.2 to 1.8 m/s elsewhere in the channel. Higher velocities will assist to scour and maintain a larger channel cross section. Additional investigations are required to refine the final channel design and assess the flood impacts.

The developed model can be expanded in future with water quality functionality using ECOLAB, which is an add-on module that links dynamically to the hydrodynamic model. For this phase, additional work will be required to determine how to adequately disperse the freshwater plume from the study area to ensure that there is not a build up of the water quality parameters within the estuary.

7 REFERENCES

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Fords Cut Tidal Gauging

MEMORANDUM

To: Glenn Ellery
Manager Data Services

From: Mark Lumsden
Environmental Data Officer

Date: 9 January 2008

File Ref:

Subject: **Fords Cut Tidal Gauging 12th December 2007**

INTRODUCTION

Late 2007, Environmental Data Services (EDS) were asked to provide an accurate estimate of the flow over a rise/fall tidal cycle through a man made channel connecting the Kaituna River with the Maketu estuary. This channel is commonly known as Fords Cut but is sometimes referred to as Brains Cut or Brains Drain.

Several site inspections were carried out in the following months to ascertain the most practical, replicable and accurate method of completing the task. There is a series of 4 large culverts under the road with self closing tidal gates operating on the Maketu side of the culverts. These gates stop almost all of the reverse flow down the drain back into the Kaituna (Figure1).

Figure 0-1 Fords Cut Tidal Gates

On the river side, there is a short abutment coupled with a concrete platform, approximately 11 meters wide, over which the water flowed, before it entered the culverts (Figure 2). At high tide the water level was approximately 2 metres deep. A gauging slack line was installed on the abutment 2 metres up from the culverts to allow safe measurement of flows.

Figure 0-2 Fords Cut Culverts

It was decided to conduct the gauging in a continuous series of gaugings with as small a gap as possible between each, over a complete tidal cycle (approximately 13 hours). Two teams of two staff from EDS were used in two shifts to break the time spent gauging to a more manageable length to reduce error and fatigue. These teams were Mark Lumsden and Adam Vankempen, Craig Putt and Krystie Knowles.

The day chosen to complete the gauging was the12th of December, due to the tide compatibility as well as getting the task completed before summer break.

METHODOLOGY

On the morning of the 12th of December at approx. 0545 (ST) the gauging run started. This coincided with the turn of the incoming tide, and continued over the high tide, through the low tide and back to the turn of the incoming tide again. In all, 16 individual gaugings took place over 13 hours, with the teams swapping over at around 12:00 midday.

During the gauging run, when the flow reversed (water flowed from the drain out into the river), the gaugings were recorded as negative, to differentiate between inward and outward flow.

The start and finish times from the gaugings were then used to ascertain the corresponding stage heights from the EDS monitoring site, Kaituna at Fords Cut, situated upstream approximately 100m from the gates.

The gaugings undertaken appear as the squares on the stage hydrograph (Figure 3). The flows measured were then used to derive a rating for both the rising and falling limbs of the tidal cycle (Figure 4).

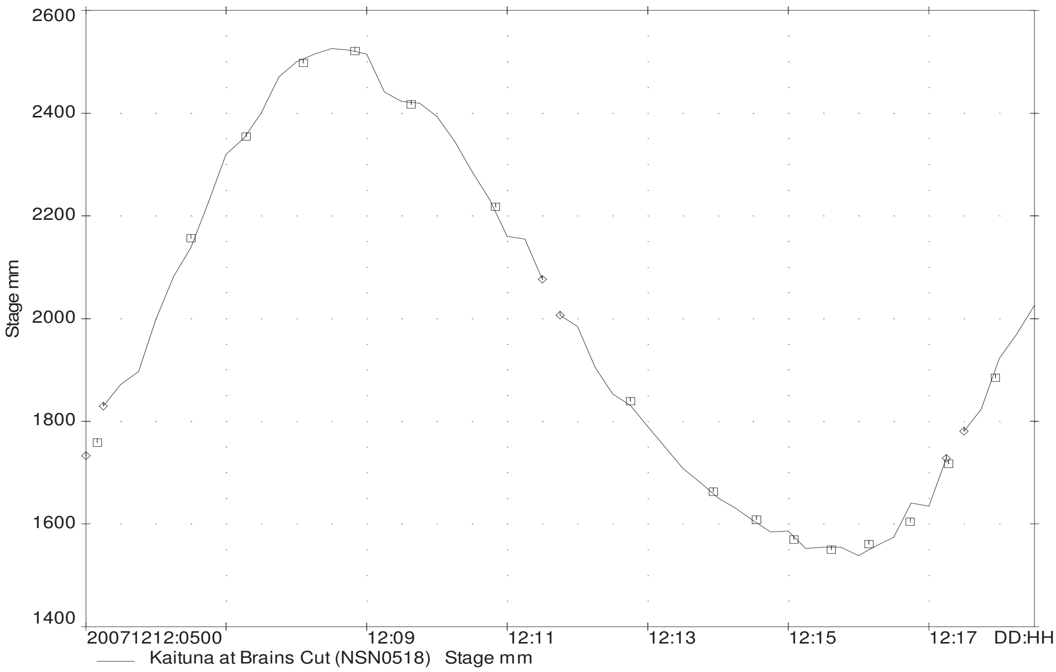
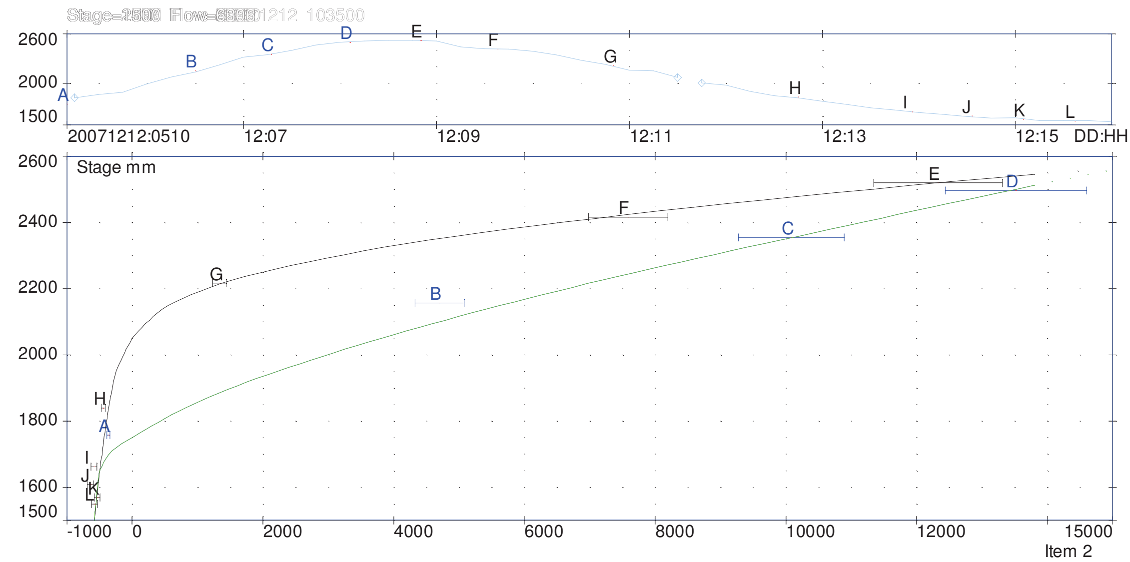


Figure 2 tage Graph and Plotted Gaugings



Site: 518 Start Time: 20071212 051000 Finish Time: 20071212 160000

Figure 3 atings Curves of Rising and Falling Tide

Using these ratings, a flow hydrograph was derived (Figure 5).

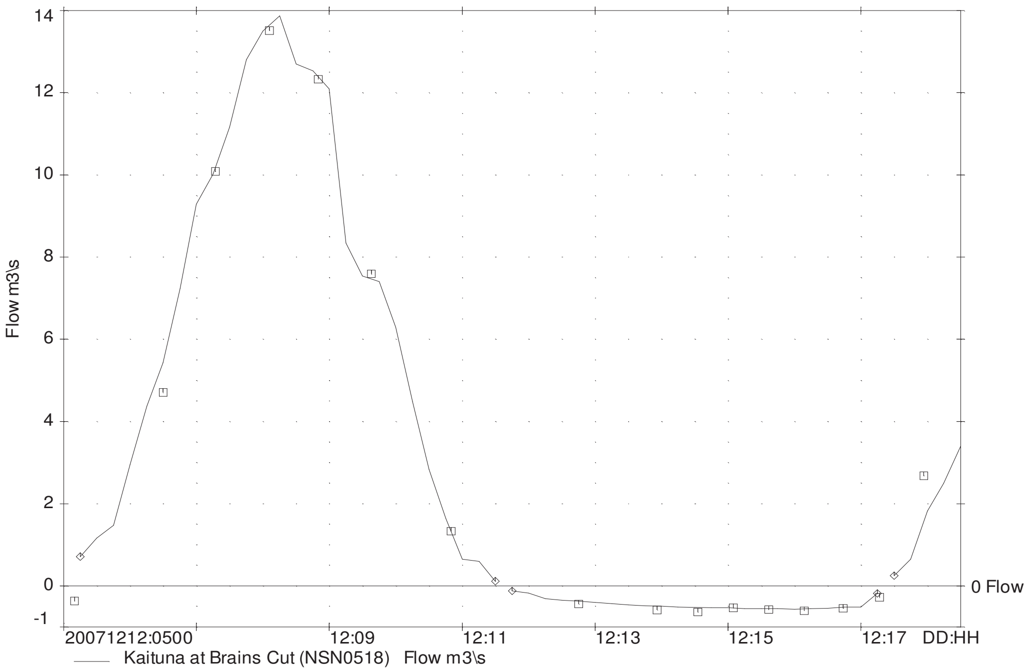


Figure 4 Flow Hydrograph and Plotted Gaugings

Once again using a program with in Tideda, the area under this curve was calculated, giving the total flow of water in cubic meters that passed through the culverts over the full tidal cycle. This curve was broken into two parts, positive and negative flow and their respective discharges calculated separately.

RESULTS

Of the 16 gaugings that were completed, half were negative flow, i.e. flow was moving from the Maketu Estuary into the Kaituna River. These gaugings all occurred during the low tide period when water was flowing back past the tidal gates. Although the gates look to be designed to stop the flow back into the river there was still considerable water getting past them and into the river. In total, over the time between no flow recorded through negative and back to no flow recorded, an estimated ***9,053 cubic metres*** of water flowed back into the Kaituna River from Fords Cut.

The rest of the gaugings that were completed were positive flow, i.e. that is the water was flowing from the Kaituna River through the culverts and into Fords Cut. There was a rapid transition from no flow through to positive flow, with the water level rising quickly. In total, from no flow through positive flow back to no flow, an estimated ***153,555 cubic metres*** of water flowed into Fords Cut.

It is also worth mentioning that it was noticed that at times during gauging, more so at lower flows, there was considerable surge, where the water level rose and fell approx. 50 – 75 centimetres, and the water increased in velocity. The surge seemed to be due to the large sea swell that was occurring at the time.

Mark Lumsden
Environmental Data Officer