Utuhina Stream Model Update

Report prepared for the Bay of Plenty Regional Council
by

Philip Wallace
River Edge Consulting Limited

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Contents

1 Introduction

Two flood events in January 2011 have provided an opportunity to check the calibration of the Utuhina Stream model. That model was last modified in 2006[1] but it remained "*largely uncalibrated to the current channel conditions*" (i.e. channel works carried out in 2002-03). "*Obtaining further calibration data must be a high priority.*"

Furthermore, there is a proposal by Rotorua District Council to replace the Lake Road bridge, and some modelling of the proposed bridge has been carried out over the past year, with some concerns expressed over the hydraulic capacity of the replacement bridge. A recalibration of the model is therefore timely.

Figure 1 shows the modelled reach and the cross-section locations.

Figure 1 Utuhina and Mangakakahi Streams and cross-section locations

[1] *Utuhina MIKE 11 Model,* Report to Environment Bay of Plenty by Philip Wallace, 31 August 2006

2 Hydrology of January Floods

The Bay of Plenty Regional Council (BOPRC) maintains a flood recorder at Depot St, near the site of the old railway line. This site is downstream of the Mangakakahi Stream and so includes all major tributaries of the Utuhina Stream.

Two storm events occurred: the first was on 23rd January, and the second on 29th January. The latter (Cyclone Wilma) resulted in higher flows but was of a shorter duration. The flood level record is given in Figure 2.

BOPRC staff gauged the first flood on two occasions: at 2.3m level and 1.4m, on the rising and falling limbs of the flood respectively. These compare to a peak level reached of 2.5m, so the first gauging at least was close to the peak. There had been no previous high flow gauging at this site, which has been in operation since 2006.

Results indicated that the previous rating curve needed adjusting at its upper end. Results also suggested that the newer ADP flow meter technology used gives higher flow estimates than conventional meters.[2]

The flow hydrograph over the period for the site is shown in Figure 3. The first flood reached a peak of 26 m^3/s , while the second reached a peak of 35 m^3/s. These flows correspond to a 5 year return period and a 10-20yr return period respectively, according to analysis of data to from 1968 to 1996[3]. (There was a flow recorder at Lake Road during this period. The recorder was removed in 1997.)

Robert Monk of Sigma Consultants carried out an analysis of the flow and rainfall data for RDC. Correspondence is reproduced in Appendix A. I have not provided any comment on his findings and conclusions.

However, I agree with his conclusion that the flow and rainfall, for the second flood event at least, suggest a time of concentration of about four hours. The four hour rainfall at Whakarewarewa for the first event was 58.5 mm and 90.5 mm for the second. According to the Whakarewarewa depth-duration-frequency plot he produced, these would correspond to around 4 year and 15 year return periods respectively. For HIRDS v3 data, these rainfall depths correspond to less than a 5 year event and around a 25 year event respectively.

Thus, the return periods of the flow peaks are similar to those of the recorded rainfall depths.

Lake levels during the period are shown in Figure 4.

[2] Craig Putt, BOPRC, pers. comm.

[3] *Environmental Data Summaries*, Environment Bay of Plenty. Environment Publication 2007/06

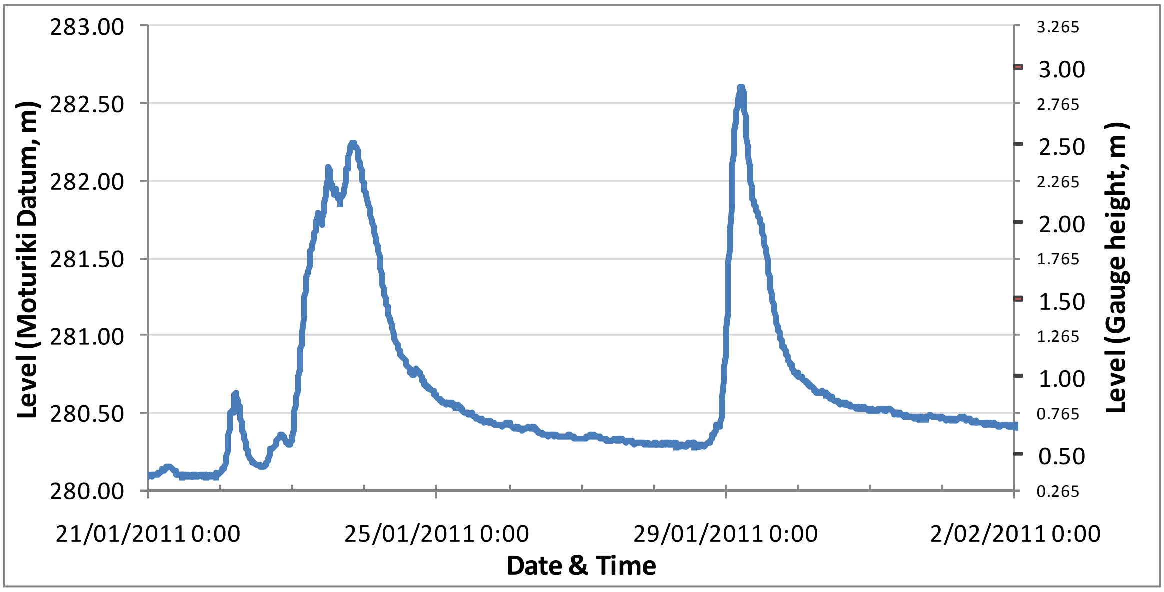


Figure 2 Flood level at Depot St, January 2011

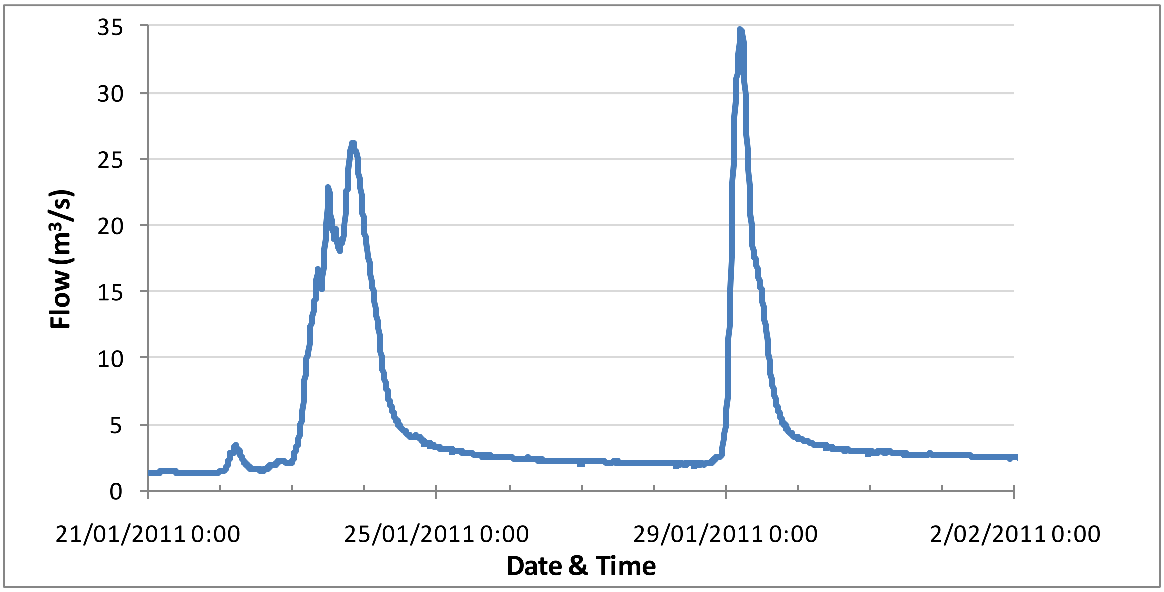


Figure 3 Flow at Depot St, January 2011

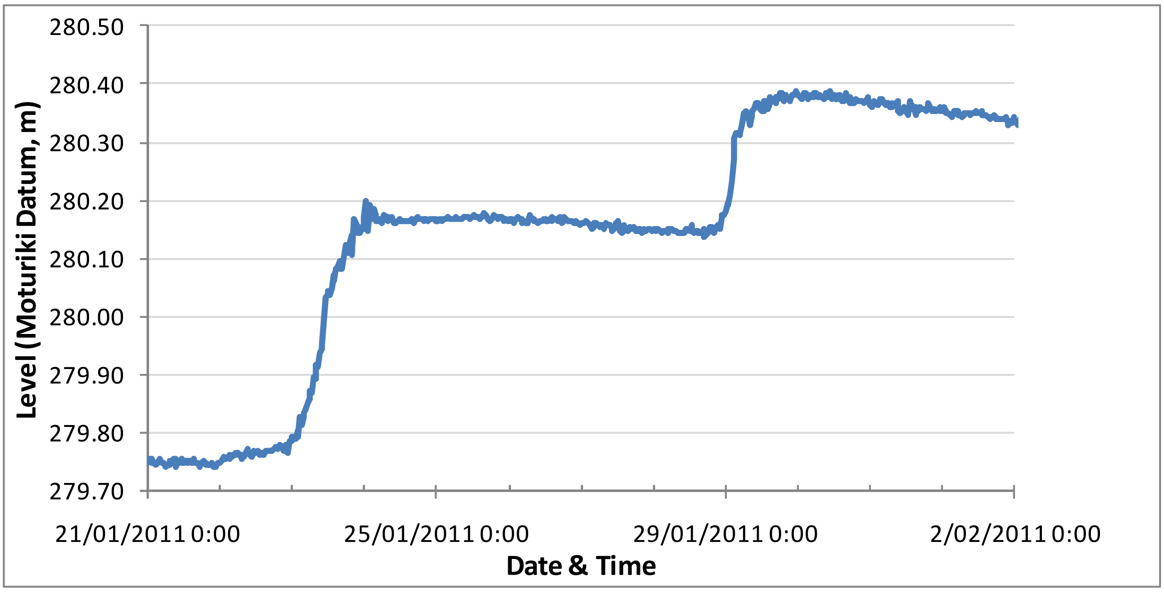


Figure 4 Lake level at Town Wharf, January 2011

3 Model Calibration

3.1 Simulation of January 2011 floods with the previous model

The January 2011 event was simulated with the model, as last modified in 2010. (Some cross-sections did not include the left bank top-up works of around 2008 downstream of Lake Road. However water levels did not reach the level of those works and results were unaffected.) The lake level time series was used for the downstream boundary, while the recorded flow hydrograph at Depot St was split between the Mangakakahi and Utuhina Streams.

Based on the relative catchment areas, the peak flow of the Mangakakahi could be about 30% of the total flow. However, in all likelihood the peak flows from each stream would not coincide. For comparison, the Riley model assumed that the Mangakakahi flow was about 25% of the total for the May 1999 flood event, while the 2010 RDC hydrological modelling ("Green & Ampt" method) produced 1% AEP hydrographs that showed the Mangakakahi Stream peaking much earlier than the Utuhina, so that at the time of the Utuhina peak, the Mangakakahi flow was about 15% of the total.

For the January 2011 simulations, the Mangakakahi flow was assumed to be 20% of the total at Depot St, with the same shape hydrograph as the Utuhina inflow. The assumption will only affect results upstream of the confluence however, and has no bearing on model results downstream.

Model results showed a significant underprediction of the peak flood levels for both flood events, as recorded by BOPRC staff (Figures 5 and 6).

3.2 Recalibration

The model was recalibrated in an attempt to reproduce the flood levels recorded by BOPRC survey staff. Firstly, the model was extended by around 30 m so that the downstream boundary was in the lake rather than at the last cross-section in the stream. Next the model was changed from using resistance radius to using a hydraulic radius formulation, in order that resistance values relate to more commonly accepted Mannings n values. Resistance values were then increased to reproduce the observed flood levels. The values adopted are shown in Figure 6.

The recalibration to that point in time was largely based on 2002 cross-sections, with some newer (2010) cross-sections around the Lake Road bridge. It was then decided to reconfigure the model by using the most recent pre-flood cross-sections, primarily 2007 cross-sections with 2010 cross-sections around the bridge. Results showed a slightly improved match with the 2011 flood levels downstream of cross-section 15 and a slightly worse upstream of that point.

The model does underpredict just downstream of Old Taupo Road in both events. Although further calibration effort may improve results, a site inspection should be carried out first. As this reach is not of immediate concern, this matter can be followed up at a later date.

Several of the data points of the 29th were noted as being of lower confidence by BOPRC staff, as shown in Figure 5. Nonetheless, most of these data appear reasonably consistent with those points regarded as being of higher confidence.

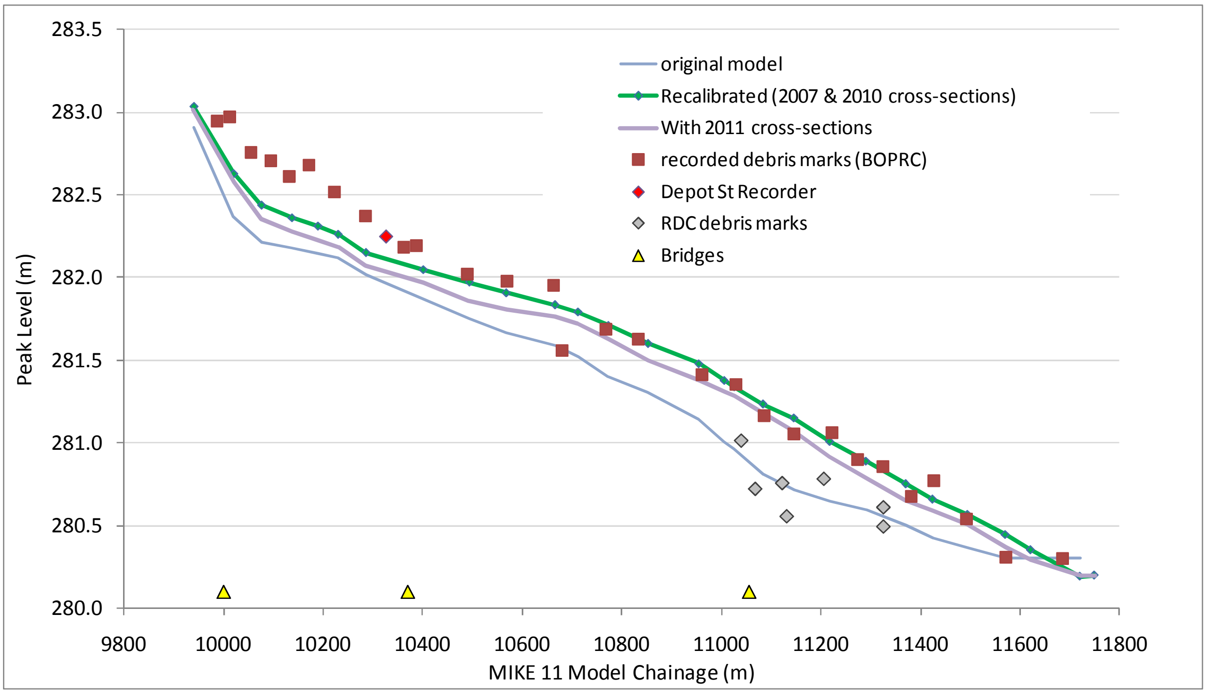


Figure 5 Model calibration, 23 January event

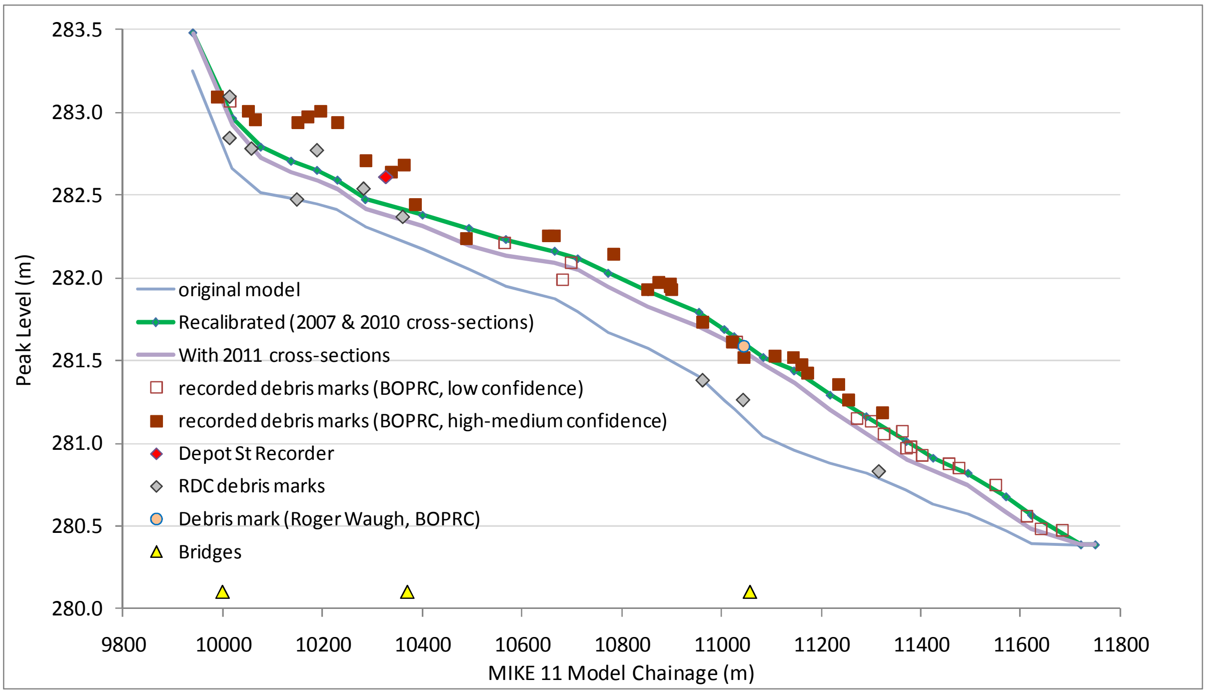


Figure 6 Model calibration, 29 January event

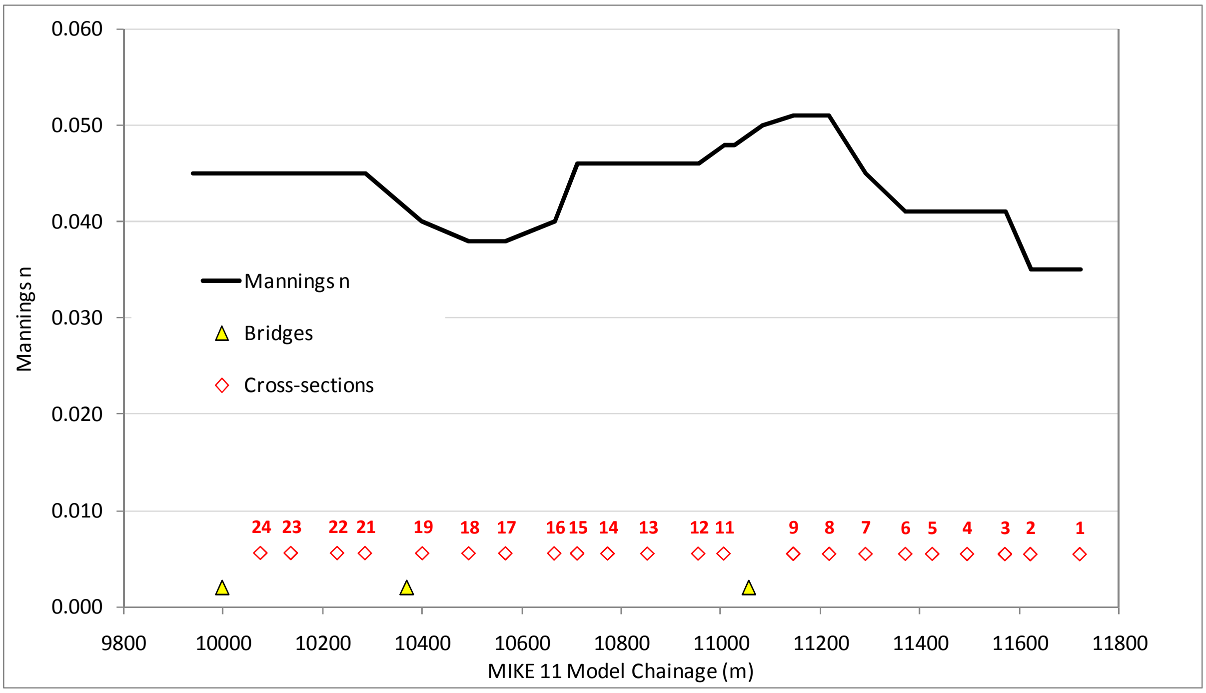


Figure 7 Model calibration - stream channel Mannings n values

3.3 Model rerun with 2011 cross-sections

Having considered the model results for the calibration and how much higher the recorded data points were than the previous model predicted, it was decided to resurvey the Utuhina

Stream channel. The survey was carried out in April 2011. The survey data show that the bed has lowered by around 0.5 m at cross-sections 5, 10A, 11 and 12 (Appendix B), possibly as a result of scour during the January events.

The model was run with these new cross-sections (with the exception of the section at the Old Taupo Lake Rd bridge – there being little difference there between the 2002 and 2011 bed levels), with the same Mannings n values as calibrated with the older cross-sections. The model then predicts water levels typically around 100 mm lower than with the 2007-2010 cross-sections, due to the lowered bed.

The model calibration has nonetheless been left as above, on the assumption that the bed changes occurred after the flood peak. Mannings n values, already high, would need to be raised further if the calibration was to be based on the 2011 cross-sections.

3.4 RDC data

Rotorua District Council also commissioned a survey of flood debris marks immediately after each of the two floods. Most of the marks surveyed were upstream of the model extent, but several marks were within the model reach. The resulting data points have been plotted in Figures 5 and 6.

The RDC points for the first flood event are around the Lake Road bridge (Figure 5). These points are significantly lower than the BOPRC points and show a large scatter, bringing their reliability into question.

For the second flood event, the RDC points are again lower than the BOPRC points, although there is generally less scatter in them.

It is worth noting that the peak flood level obtained from the Depot Street recorder in each event fits with the general trend of the BOPRC points. A further point recorded independently by Roger Waugh of BOPRC, on the upstream side of the Lake Rd bridge after the second flood event, fits well with the BOPRC data from that event.

Given these additional data points, and without further evidence (e.g. photos of debris marks), it is considered prudent to be conservative and use the BOPRC debris marks rather than the RDC marks for the calibration.

4 Design scenarios

4.1 Design Hydrology

The design standard for the Utuhina Stream is a 100 year return period event. Flood frequency analysis for the flow record up to 1996 indicates that the 100 year flow is about 68 m^3/s downstream of the Mangakakahi Stream.

At present, there is probably not enough additional data from the new flow recorder at Depot Street to update the flood frequency analysis. This could be done in a few years time however.

A further issue is that the newer ADP flow meter technology now used appears to give higher flow estimates than conventional meters. This implies that previous flow measurements may have been underestimated, and that design flows may be higher than previously estimated.

Without further analysis, the previous design flow estimates have been adopted in this study however.

A flow of 80 m^3/s has been modelled to allow for climate change – i.e. a 16.8% flow increase based on 2.1°C temperature increase to 2090. Note however that this is based on expected rainfall intensity increases for such a temperature rise, but the peak runoff increases resulting from that are likely to be higher still.

The shapes of the Mangakakahi and Utuhina Stream hydrographs have been derived by hydrological modelling carried out by RDC in 2010.

4.2 Design Lake Level

The design lake level assumed is the 20 year return period lake level of 280.544 m RL[4]. Note that this is higher than the previously used level of 280.3 m RL (the 20 year return period level reported by Riley Consultants[5]). The higher lake level has only a limited impact however, raising flood levels by less than 1 cm upstream of cross-section 7.

To determine design levels for the lower reaches of the stream, the model should also be run with a 100 year return period lake level (280.787m RL) in conjunction with a 20 year flow. This has not been done at this stage.

No allowance has been made for possible increases in lake levels due to climate change. Lake level flood frequency analysis is complicated by artificial lake level control via the Ohau Channel control structure. However the likelihood of more intense rain storms may lead to higher lake levels.

4.3 Existing Situation

The model has been run with the existing bridge. The bridge section is based on the 2010 survey section immediately upstream of the bridge, and hence shows some constriction from the stream banks (Figure 8). (See also Appendix C).

[4] *Environmental Data Summaries*, Environment Bay of Plenty. Environment Publication 2007/06
[5] Riley Consultants Ltd. *Utuhina Stream Modelling*. 28 January 2003

Although the 2006 modelling assumed a substantial debris blockage of the bridge, following calibration to the 1999 flood, in this current study no debris has been assumed. However, the constricted section shown in Figure 8 has a similar effect.

As in the 2006 modelling, the mouth at cross-section 1 has been assumed to scour (Appendix B).

Results are provided in Appendix D.

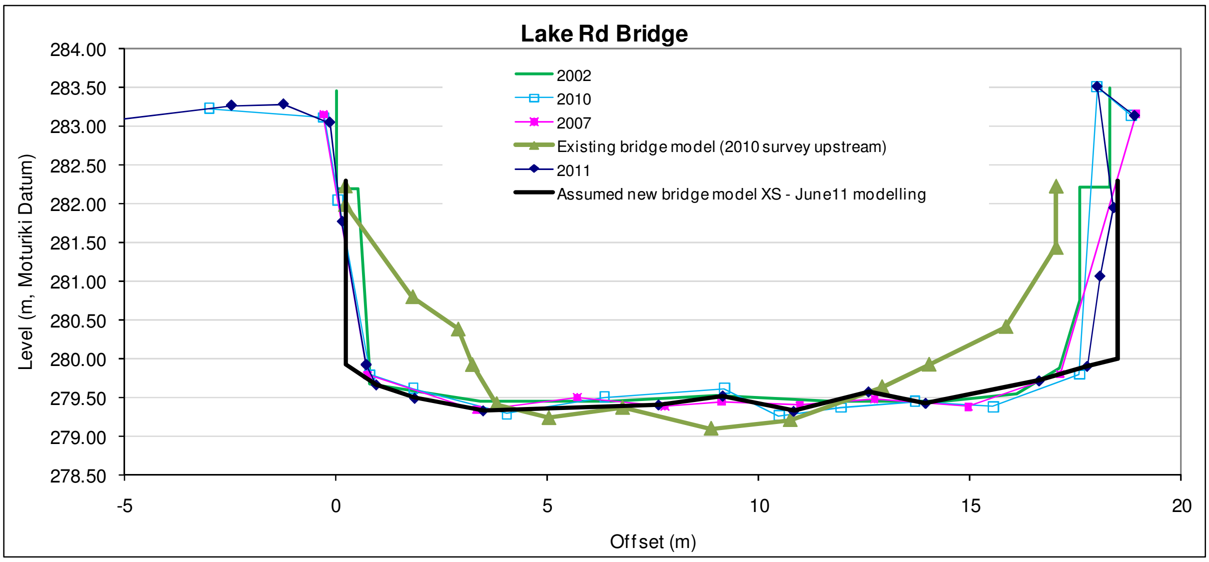


Figure 8 Lake Road bridge waterway - surveyed and modelled cross-sections

4.4 Proposed Bridge

The proposed Lake Road bridge replacement is a single span bridge (i.e. no piers) with a soffit level of 282.3m RL.

The design also allows for excavating the waterway on the upstream face of the bridge, which is currently constricted by the stream banks (Figure 8). (See also Appendix C).

Again, no debris has been assumed on the bridge.

Results are provided in Appendix D. These show a 13 cm reduction in flood level upstream of the Lake Road bridge. Figure 9 illustrates the reduction and its extent.

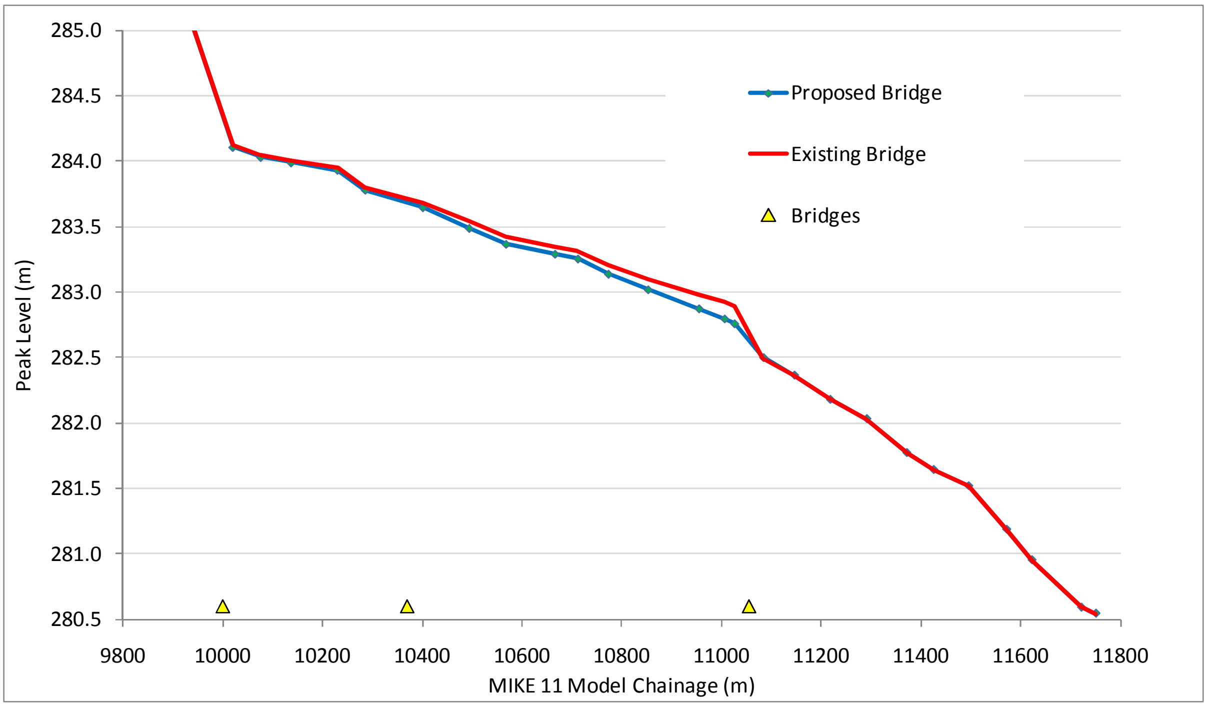


Figure 9 100 year flood levels, existing and proposed bridge cases (no freeboard)

4.5 Sensitivity Tests

Sensitivity tests have been modelled for the proposed bridge case to test the effect of several assumptions. Results are presented in Appendix D. The particular sensitivity tests are as follows:

- Bridge modelling method. The base model uses the FHWA WSPRO method of bridge analysis. Calibration with this method for the existing case was satisfactory, and hence it was also used for the proposed bridge case. Nonetheless, a simulation was carried out using the simpler energy equation option within the MIKE 11 software. Results showed a 7 cm reduction in water level upstream of the bridge.

- Bridge waterway. Modelling in late 2010 by BOPRC assumed a different bed for the bridge waterway, with a build-up of sediment on the right bank but a lower general bed level. This bed profile (Figure 10) has been run with the model. Results showed a 3 cm reduction in water level upstream of the bridge.

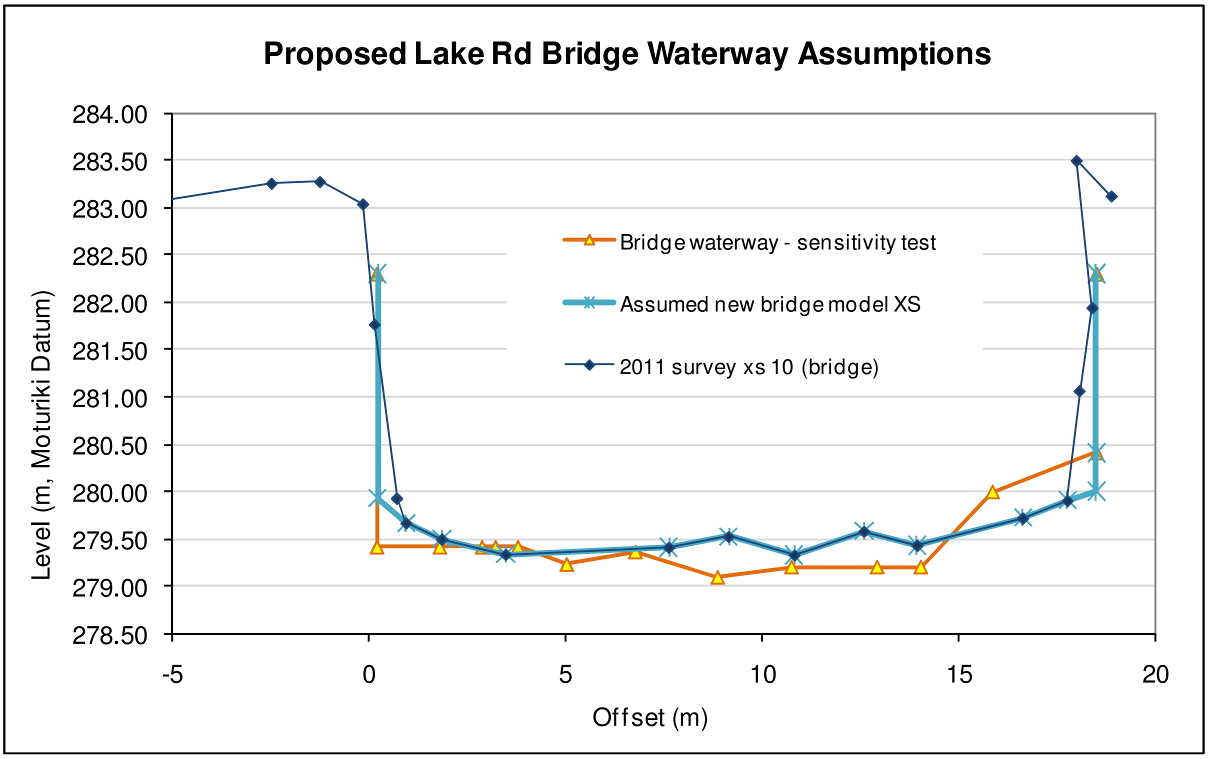


Figure 10 Lake Road Bridge (proposed) waterway assumptions

- Bridge Debris. As the proposed soffit is lower than the design flood level, it is conceivable that debris will become trapped on the soffit. (Indeed, it is good design practice to assume so.) A simulation has been made with the bridge soffit lowered by 0.5m to represent debris build-up. The model predicts a 14 cm rise in flood level upstream of the bridge.

- Higher soffit level. A simulation has been made with the soffit raised to be clear of the flood waters, and to be clear of any debris. Flood levels are predicted to fall by about 10 cm.

4.6 Design Flood Levels and Flood Implications

A freeboard of 500 mm is appropriate for design levels along most of the stream, with 800 mm freeboard at the lake margins to allow for wind waves.

Design levels for the proposed bridge case are in Table 1. Note that design levels for the lower reaches of the stream may be determined by a 100 year return period lake level in conjunction with a 20 year flow, which has not yet been modelled.

A floor level survey of buildings adjacent to the stream was carried out in February 2007[6]. Table 1 also summarises the floor levels near each cross-section. It is clear that several

[6] Robbin Britton. *Utuhina Stream Flood Protection Investigations – Progress Report 31 October 2008*

buildings are at risk of inundation in a 1% AEP flood event. Even if climate change is not included, on the basis that the design should provide a 100 year standard of protection now, the risk to these buildings is still high (Figure 11).

Figure 12 provides a general indication of the floodable area in a 100 year event, without freeboard. (This map has been prepared manually as flow over the floodplain has not been modelled.)

Cross-section	Chainage	Freeboard	Design Levels	Design Levels (no CC)	Bank levels		Floor levels	
					Left	Right	Left	Right
50 m u/s of OTR	9940	0.5	285.52	285.28			285.04	285.22
25A	10020	0.5	284.61	284.39	284.637	283.754		
24	10076	0.5	284.53	284.27	284.070	283.535		
23	10137	0.5	284.49	284.21	284.044	283.162		284.00
22	10230	0.5	284.43	284.13	283.480	283.496		
21	10286	0.5	284.28	283.99	283.670	284.017	283.51	
19	10401	0.5	284.15	283.88	284.084	283.609		
18	10494	0.5	283.99	283.75	283.534	283.470		283.70
17	10568	0.5	283.87	283.67	283.676	283.430		284.20
16	10666	0.5	283.79	283.61	283.312	281.828	282.90	283.40
15	10712	0.5	283.76	283.56	282.751	282.847	282.86	283.11
14	10773	0.5	283.64	283.45	282.084	282.462	282.80	283.00
13	10853	0.5	283.52	283.32	282.582	282.654	282.88	283.14
12	10955	0.5	283.37	283.17	282.288	282.790	282.79	282.66
11	11006	0.5	283.30	283.08	282.276	282.310	282.54	282.77
10A	11026	0.5	283.26	283.04	282.398	282.260		
9A	11084	0.5	283.00	282.83	282.367	282.117		
9	11146	0.5	282.87	282.70	282.096	282.086		
8	11218	0.5	282.68	282.52	282.019	282.006		281.44
7	11291	0.5	282.53	282.36	282.007	282.430		281.80
6	11371	0.5	282.27	282.12	281.776	281.655		
5	11425	0.5	282.14	282.01	281.722	281.568		
4	11495	0.5	282.02	281.89	281.622	281.320		282.17
3	11571	0.5	281.69	281.58	281.391	281.384		
2	11622	0.5	281.45	281.37	280.615	280.977	280.85	281.15
1	11721	0.8	281.39	281.37	280.374	280.504		

Table 1 Utuhina design flood levels (proposed bridge case, with freeboard), bank levels and adjacent floor levels

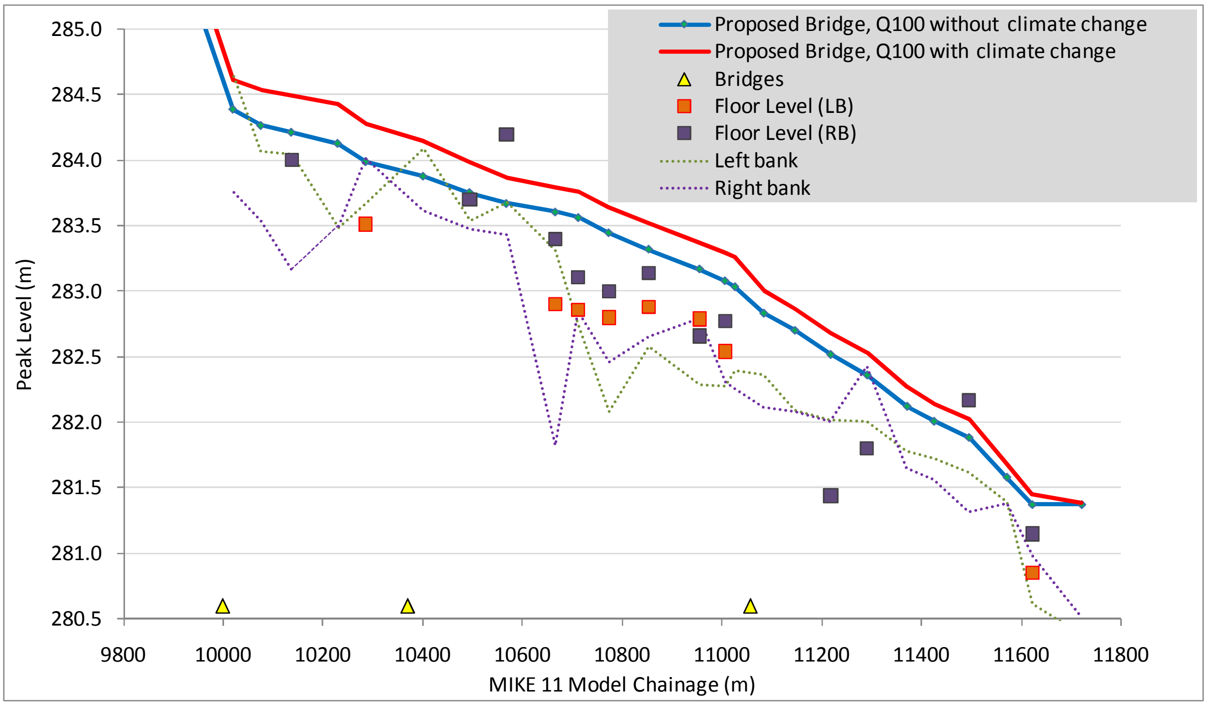


Figure 11 Utuhina design flood levels (proposed bridge case, with freeboard), bank levels and adjacent floor levels

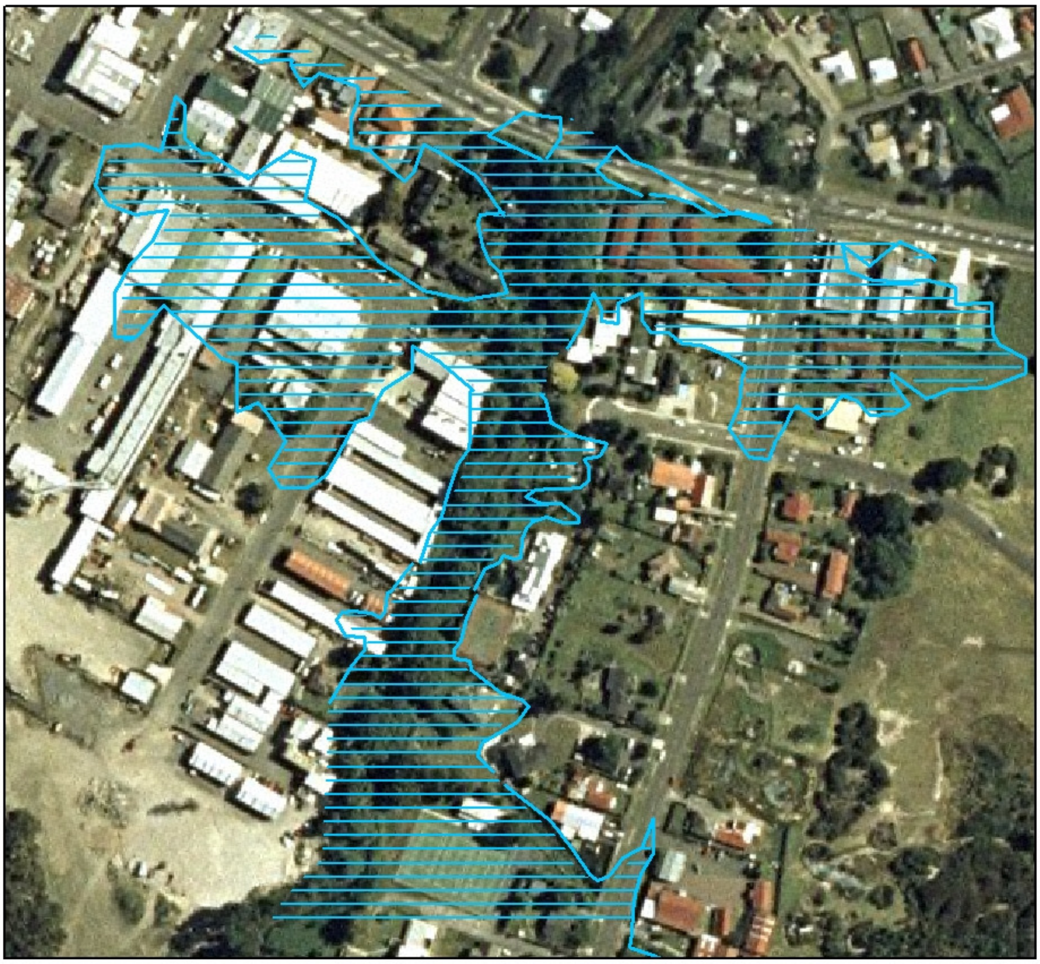


Figure 12 Indicative flood extent, 100 year flood (no freeboard applied)

5 Conclusions

Previous modelling highlighted the fact that the floodplain adjacent to the Utuhina Stream did not have protection from flooding in a 100 year event as required by the Kaituna Asset Management Plan.

Attempts in 2007-08 to address shortcomings in the level of protection to the surrounding floodplain had limited success. Banks on the left bank downstream of Lake Road were raised in 2008. "C*onsiderable effort too was put into finding options to protect properties on the true right bank between Lake Road and the lake and upstream of Lake Road to the railway bridge but due to space constraints, poor ground conditions and owners' preferences, no physical work was undertaken.*"[7]

With recalibration of the model now leading to an increase in design flood level estimates, it has become even more difficult to provide the required standard of flood protection. Yet at

[7] Robbin Britton, Environment Bay of Plenty, Utuhina Stream Flood Protection Investigations – Progress Report 31st October 2008.

the same time the recalibration shows that the level of risk is higher than realised before, so there is more urgency to address the issue.

It also needs to be appreciated that the modelled flood levels, and the effects of the proposed bridge, are based on the 2011 cross-sections. This is a favourable situation, and if cross-sections were at 2002 – 2007 levels, the flood levels would be higher.

The proposed bridge clearly does not meet usual design standards for bridge waterways, even without allowing for possible debris blockage under the soffit. While the model predicts that a higher bridge might only lower flood levels by 10 cm in the design flood, with the current stream and bank dimensions, future improvement works to the stream and banks might be compromised by the proposed bridge. Given that the proposed bridge will be a long term asset, and will be difficult to modify, ideally it should be future-proofed to allow it to meet the 100 year design standards once the remainder of the stream meets those standards.

There is a 25 m corridor along the stream upstream of the bridge that may be in public ownership, which may provide an opportunity to build floodwalls to compensate for the bridge effects, although floodwalls are less desirable than other forms of protection for a number of reasons.

With the difficulties faced in providing the required standard of flood protection, it becomes more important to develop emergency management procedures, awareness campaigns, and development controls. Flood hazard maps in particular are required – none have been developed to date. Flood proofing options might also be considered. Flood warning options are likely to be limited given the short catchment.

Future investigations should focus on developing flood hazard maps, with floodplain modelling a necessary task. This will also allow refinement of flood levels given in this report – it may be that flood levels could be lower but the flood extent larger once the floodplain storage is accounted for. That work could also refine the model upstream of the Mangakakahi confluence. At the same time, BOPRC should be ready to collect data (flood level records, high flow gauging in the event of further floods), and consider reanalysis of design flow estimates in light of new flow measurement techniques.

Appendix A Model Files

Jan2011(HR)v4.sim11
January 2011 flood (using 2007-2010 cross-sections)

Jan2011(HR)-2011xsmodel.sim11
January 2011 flood (using 2011 cross-sections)

Q100_existing_bridge_Apr11xs-model2_Lake280544.sim11
100 year return period flood, including climate change, existing Lake Rd bridge

Q100_New_bridge_Apr11xs-model2_280544Lake.sim11
100 year return period flood, including climate change, proposed Lake Rd bridge

Q100_New_bridge_Apr11xs-model2_280544Lake-noCC.sim11
100 year return period flood, no climate change allowance, proposed Lake Rd bridge

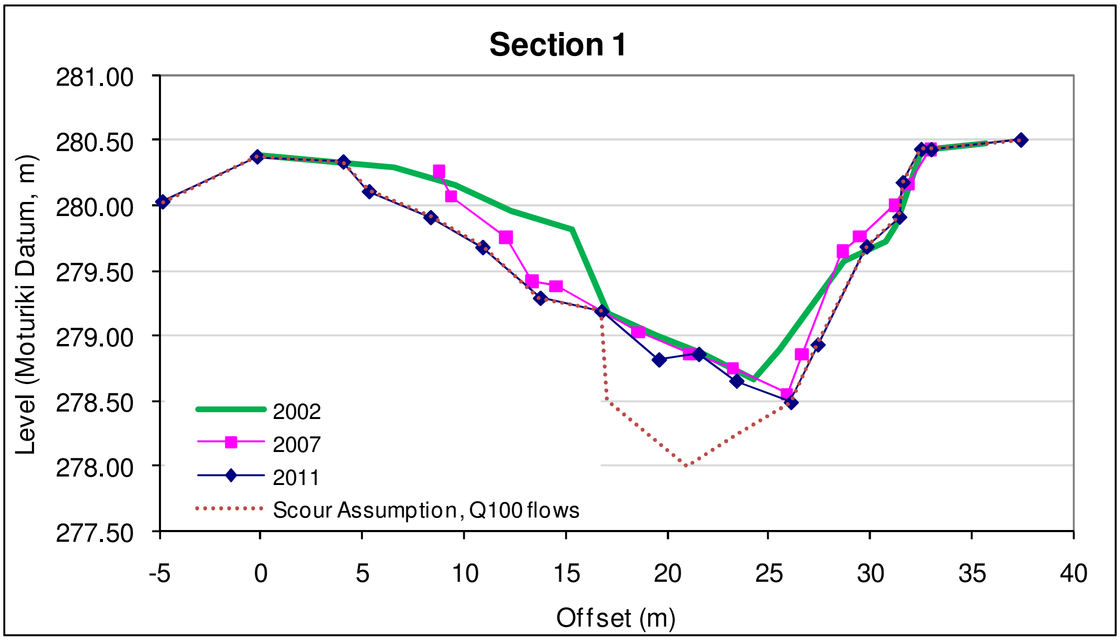
Q100_New_bridge_Apr11xs-model2_Debris_Lake280544.sim11
100 year return period flood, including climate change, proposed Lake Rd bridge with some debris blockage

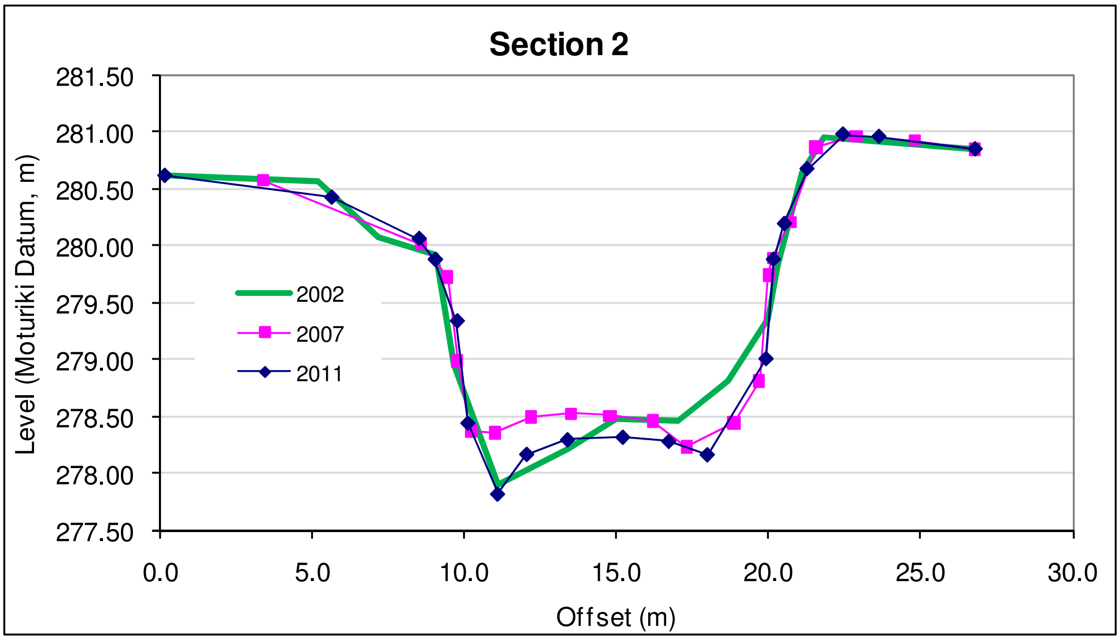
Q100_New_bridge_Apr11xs-model2_sens1_Lake280544.sim11
100 year return period flood, including climate change, proposed Lake Rd bridge, sensitivity test with alternate bridge waterway (as modelled by BOPRC in 2010)

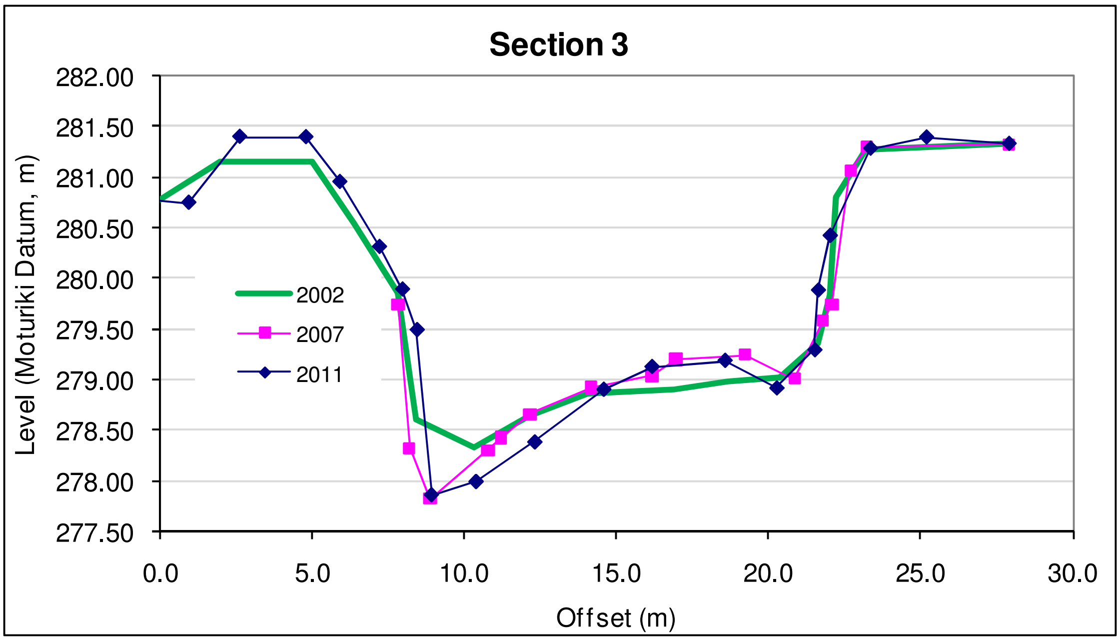
Q100_New_bridge_Apr11xs-model2_EnergyOption_Lake280544.sim11
100 year return period flood, including climate change, proposed Lake Rd bridge, sensitivity test with alternate bridge modelling method

Q100_New_bridge_Apr11xs-model2_HighBridge_Lake280544.sim11
100 year return period flood, including climate change, proposed Lake Rd bridge, sensitivity test with raised bridge

Appendix B Utuhina Stream Cross-Sections



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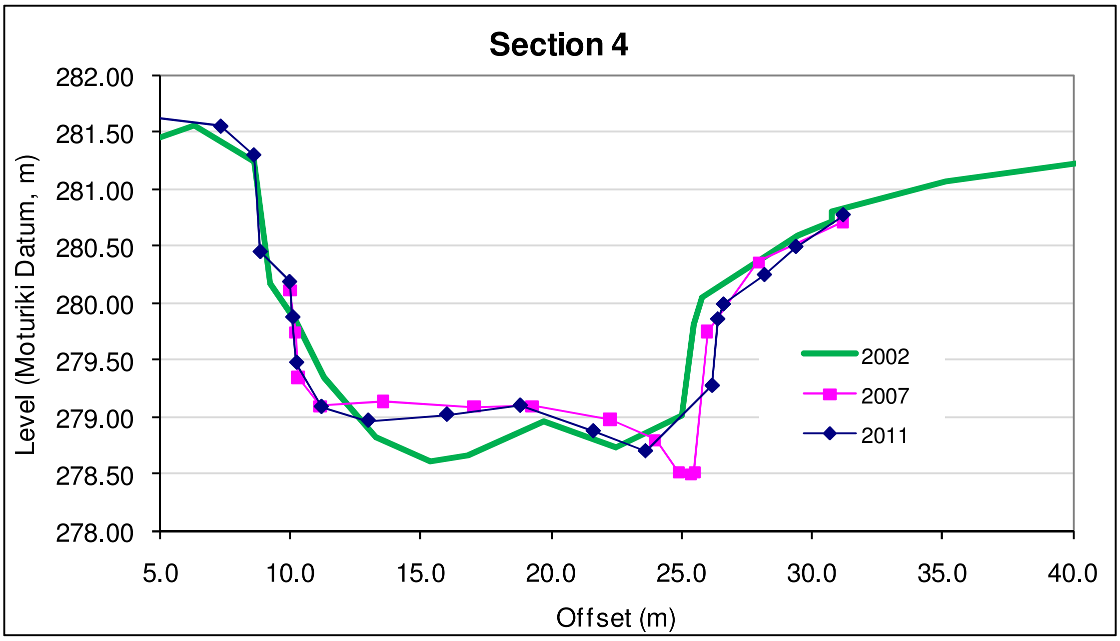
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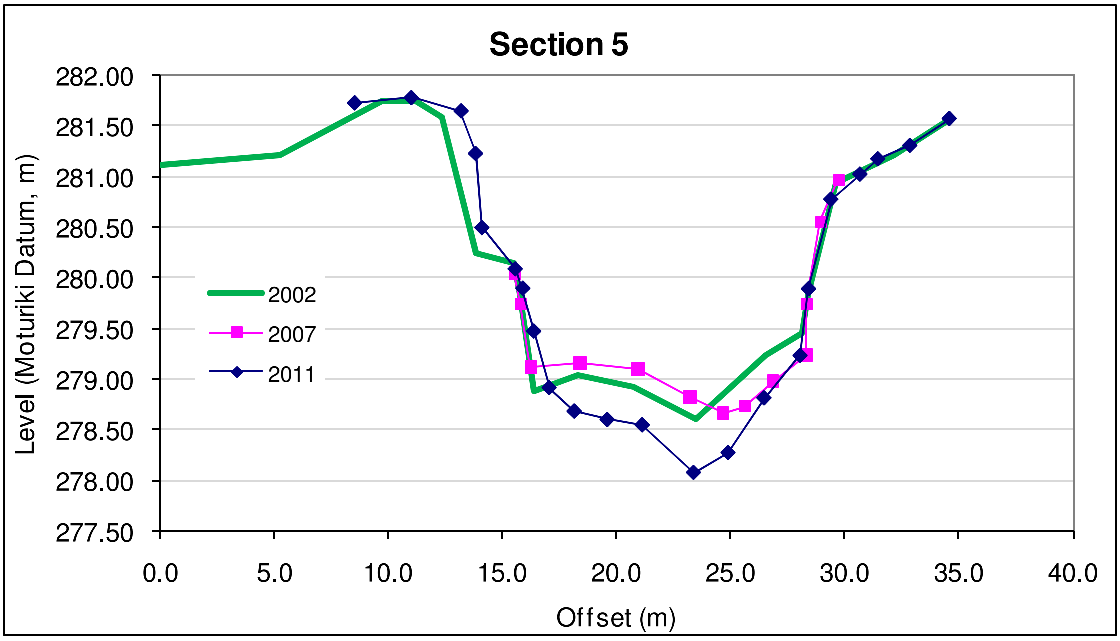
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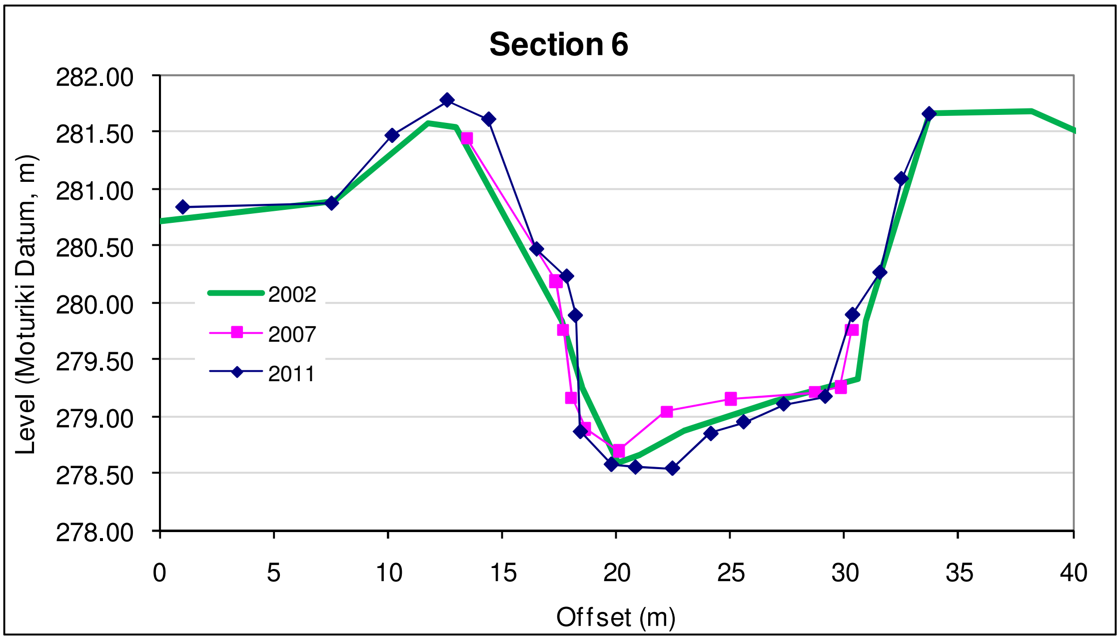
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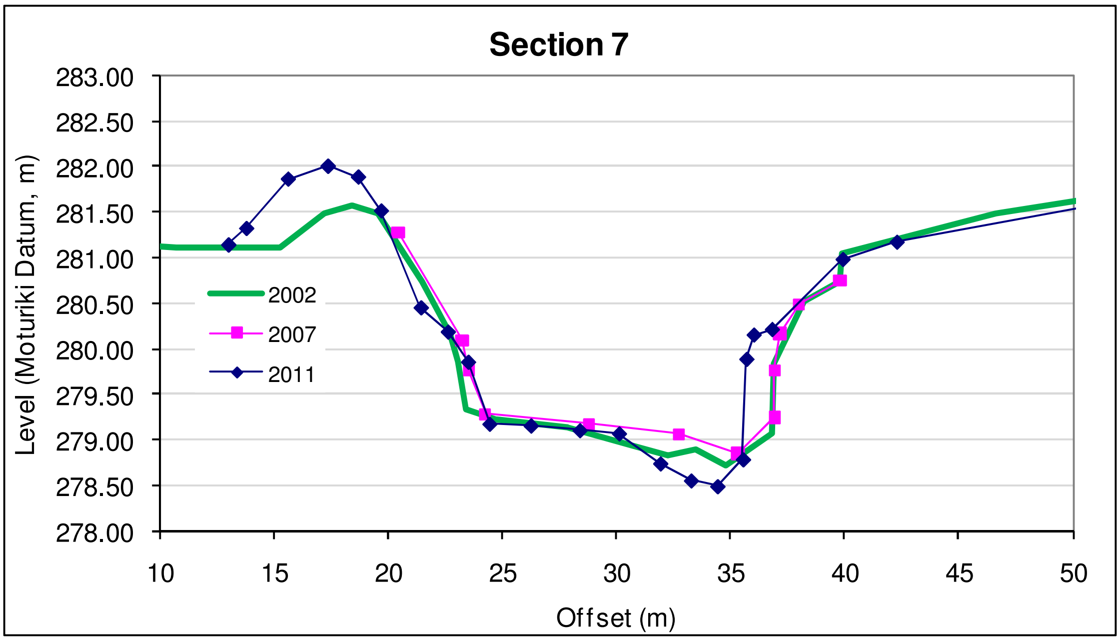
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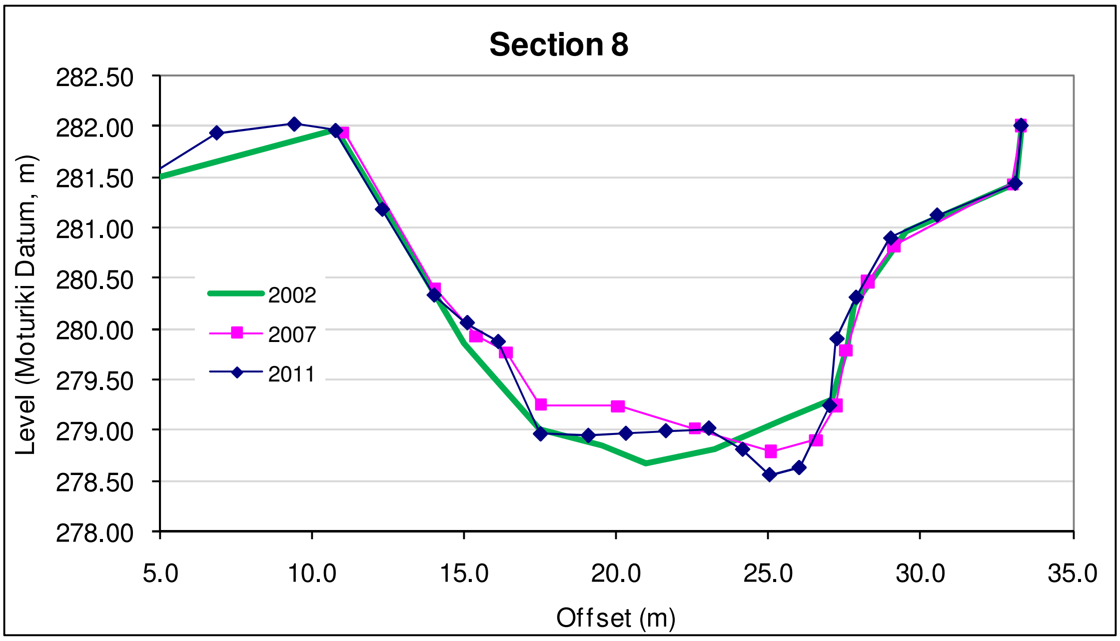
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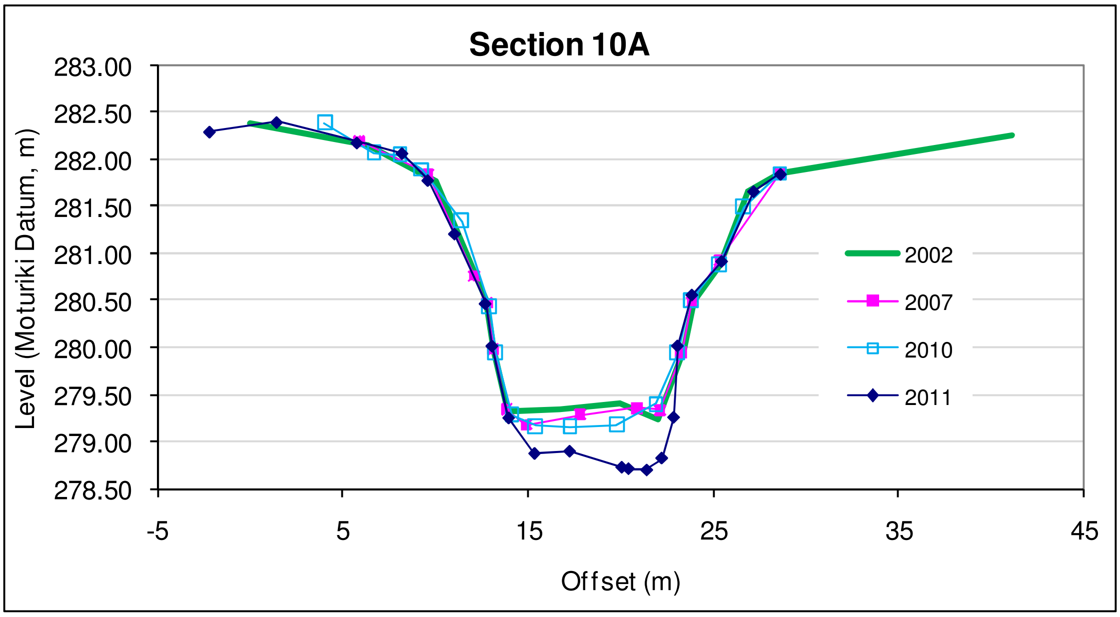
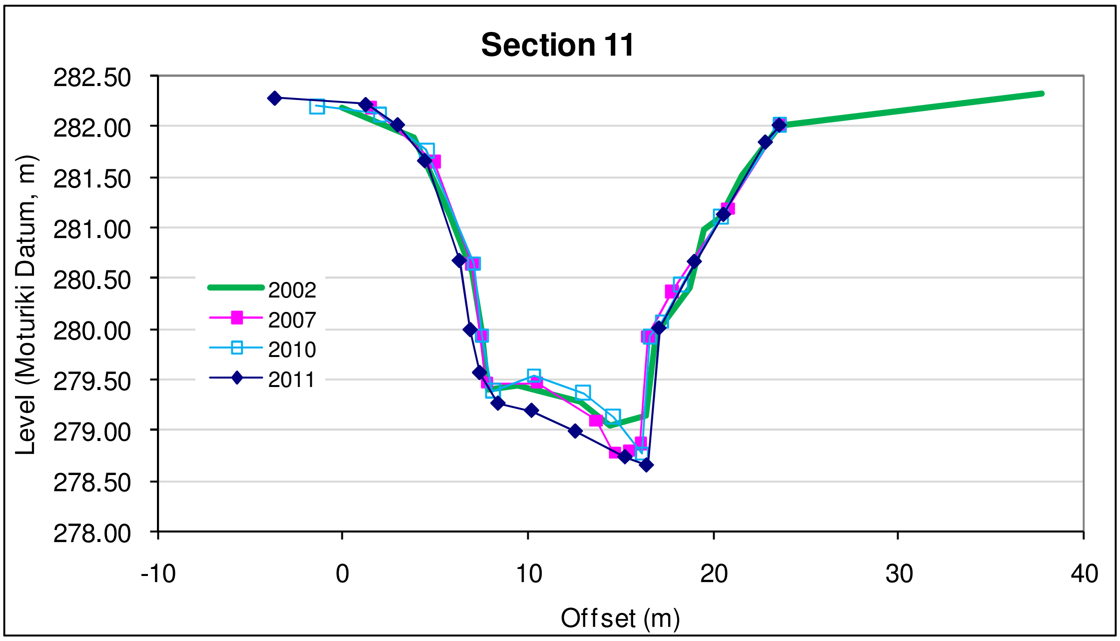
35.0
Offset (m)


Section 10A
Level (Moturiki Datum, m)
283.00
282.50
282.00
281.50
281.00
280.50
280.00
279.50
279.00
278.50
-5
5
15
25
35
45
Offset (m)
2002
2007
2010
2011


Section 11
Level (Moturiki Datum, m)
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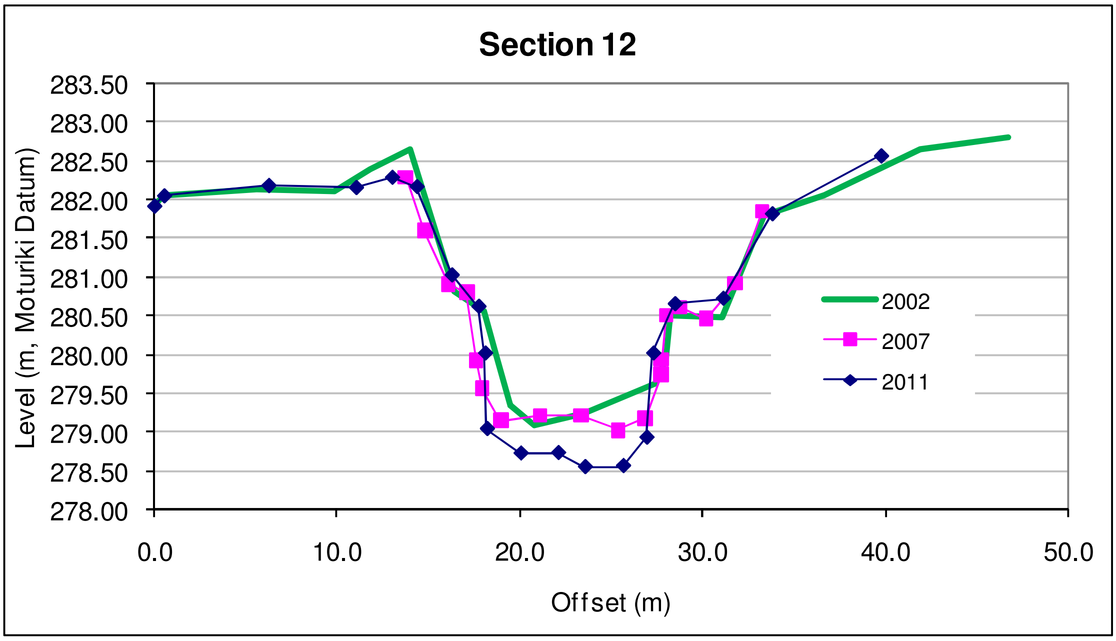
282.00
281.50
281.00
280.50
280.00
279.50
279.00
278.50
278.00
-10
0
10
20
30
40
Offset (m)
2002
2007
2010
2011


Section 12
283.50
283.00
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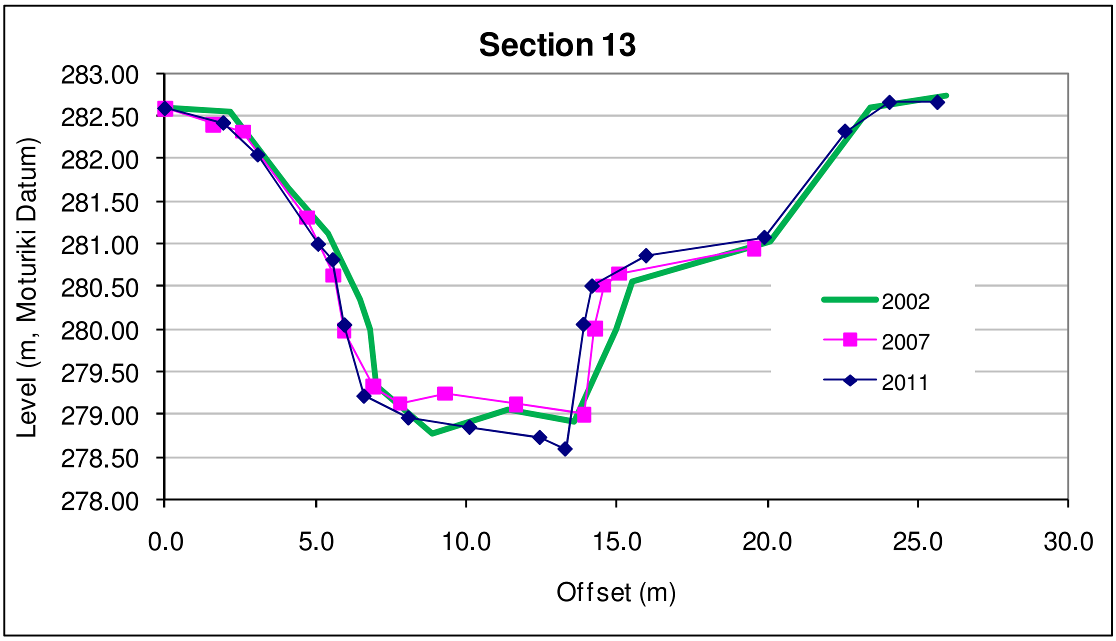
282.00
281.50
281.00
280.50
280.00
279.50
279.00
278.50
278.00
Level (m, Moturiki Datum)
0.0
10.0
20.0
30.0
40.0
50.0
Offset (m)
2002
2007
2011


Section 13
283.00
282.50
282.00
281.50
281.00
280.50
280.00
279.50
279.00
278.50
278.00
Level (m, Moturiki Datum)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
Offset (m)
2002
2007
2011

Appendix C Lake Rd Bridge

From: Ludovic Sprauer [Ludovic.Sprauer@rdc.govt.nz]
Sent: Wednesday, 5 May 2010 1:30 p.m.
To: Roger Waugh
Cc: Philip Wallace; Peter Dine; Colin Meadowcroft
Subject: Utuhina Lake Road Bridge Model
Attachments: EBOPbridge10.pdf; Utuhina-2010model.xns11; Aug06.HD11; Green&Ampt_100yr.dfs0; model_2010.nwk11; Q100-2010.sim11; Q100L20-2010model.bnd11

Importance: High

Hi Roger,

Thank you for sending us your upgraded cross-sections around Lake Road Bridge. I modified as suggested the following cross-sections: Xs 10A, 10, 11, 9, and 9A in our latest version including all Phil's recommendations.

We note that the upstream bridge cross-section areas are significantly different between RDC model input and EBOP one, respectively 48.38m2 and 41.00 m2. The reason is: RDC surveyed stricly the existing bridge with straight abutments. Whereas EBOP surveyed 1m upstream of the bridge (including the grassed left and right banks reducing therefore the bridge area by 15%).

I reran our MIKE 11 model using your surveyed data. The simulated maximum water level during the 100yr flood is now just at the beam stage. Therefore the bridge capacity is conveying the 100yr flood efficiently according to our upgraded and peer reviewed model.

<<EBOPbridge10.pdf>>
However, we are suggesting undertaking improvement works on the bridge inlet cross-section: the left and right banks would be reshaped and trimmed in order to ensure full bridge capacity (as modelled by RDC in April 2010).

Please let me know if that suits you.

Kind regards,
Ludovic

<<Utuhina-2010model.xns11>> <<Aug06.HD11>> <<Green&Ampt_100yr.dfs0>> <<model_2010.nwk11>> <<Q100-2010.sim11>> <<Q100L20-2010model.bnd11>>

Ludovic Sprauer
Hydraulic Modeller
Rotorua District Council

P: 07 350 0209 ext. 8232
C: 0274 954 290
E: ludovic.sprauer@rdc.govt.nz
W: www.rdc.govt.nz

Appendix D Model Results – Design Flood (100 year flow, with climate change)

Cross-section	Stream	Chainage	Existing	Proposed	Sensitivity Tests				
					Bridge Waterway	Soffit clear of flood	0.5m debris below soffit	Energy option	Lake 280.3m
	UTUHINA	9930	285.03	285.02	285.02	285.02	285.03	285.02	285.02
50 m u/s of OTR	UTUHINA	9940	285.02	285.02	285.02	285.01	285.03	285.01	285.02
25A	UTUHINA	10020	284.12	284.11	284.10	284.09	284.13	284.10	284.11
24	UTUHINA	10076	284.04	284.03	284.03	284.01	284.05	284.02	284.03
23	UTUHINA	10137	284.00	283.99	283.98	283.97	284.01	283.97	283.99
22	UTUHINA	10230	283.95	283.93	283.93	283.91	283.96	283.92	283.93
21	UTUHINA	10286	283.80	283.78	283.77	283.75	283.82	283.76	283.78
19	UTUHINA	10401	283.68	283.65	283.64	283.62	283.68	283.63	283.65
18	UTUHINA	10494	283.54	283.49	283.48	283.46	283.54	283.47	283.49
17	UTUHINA	10568	283.43	283.37	283.36	283.34	283.43	283.34	283.37
16	UTUHINA	10666	283.35	283.29	283.28	283.26	283.35	283.27	283.29
15	UTUHINA	10712	283.31	283.26	283.24	283.22	283.32	283.23	283.25
14	UTUHINA	10773	283.21	283.14	283.12	283.10	283.21	283.11	283.14
13	UTUHINA	10853	283.10	283.02	283.00	282.97	283.11	282.98	283.02
12	UTUHINA	10955	282.98	282.87	282.85	282.80	282.99	282.82	282.87
11	UTUHINA	11006	282.92	282.80	282.77	282.71	282.93	282.73	282.79
10A	UTUHINA	11026	282.89	282.76	282.73	282.67	282.90	282.69	282.76
9A	UTUHINA	11084	282.50	282.50	282.50	282.50	282.50	282.50	282.50
9	UTUHINA	11146	282.37	282.37	282.37	282.37	282.36	282.37	282.36
8	UTUHINA	11218	282.18	282.18	282.18	282.18	282.18	282.18	282.18
7	UTUHINA	11291	282.03	282.03	282.03	282.04	282.03	282.03	282.02
6	UTUHINA	11371	281.77	281.77	281.77	281.78	281.77	281.77	281.76
5	UTUHINA	11425	281.64	281.64	281.64	281.65	281.64	281.64	281.63
4	UTUHINA	11495	281.52	281.52	281.52	281.52	281.52	281.52	281.50
3	UTUHINA	11571	281.19	281.19	281.19	281.19	281.19	281.19	281.16
2	UTUHINA	11622	280.95	280.95	280.95	280.95	280.95	280.95	280.90
1	UTUHINA	11721	280.59	280.59	280.59	280.59	280.59	280.59	280.39
Lake	UTUHINA	11750	280.54	280.54	280.54	280.54	280.54	280.54	280.30
	MANGAKAKAHI	9964	285.81	285.81	285.81	285.81	285.81	285.81	285.81
	MANGAKAKAHI	9984	285.77	285.77	285.77	285.77	285.77	285.77	285.77
	MANGAKAKAHI	10016	284.11	284.09	284.09	284.08	284.11	284.08	284.09
2	MANGAKAKAHI	10058	284.10	284.09	284.08	284.07	284.11	284.07	284.09
3	MANGAKAKAHI	10148	284.05	284.04	284.03	284.02	284.06	284.02	284.04
4	MANGAKAKAHI	10222	283.99	283.97	283.97	283.95	284.00	283.96	283.97