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REGIONAL COUNCIL

Waikanae Floodplain Management Plan – 10 year Review

Summary Report for Consultation

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Executive Summary

Purpose of the Review

The purpose of the first 10 year review is to evaluate the performance of the Waikanae Floodplain Management Plan (WFMP) to date and assess whether there is any need to change the outcomes and implementation process.

The summary report will be used as the basis for consultation with Kapiti Coast District Council (KCDC) in the first instance. The report will then be distributed to Friends of the Waikanae River, community groups, organisations and interested and affected residents along with the wider public.

Following the consultation process and any further analysis required, the summary report and WFMP will be updated and implemented in accordance with recommendations approved by GW.

Background

The WFMP, completed in 1997, recommends non-structural and structural measures to manage flood risk. Greater Wellington (GW) adopted a 40 year time frame to fully implement the WFMP, with reviews proposed every 10 years.

The WFMP contains a set of 'outcomes' developed as a result of examining various options. The outcomes covered four main areas:

Non-Structural - These include land use measures such as providing information and advice, river corridor land procurement and providing advice to KCDC regarding planning controls on the Waikanae floodplain. The measures also include community preparedness such as providing up-to-date information, assisting KCDC in public education programmes and emergency management, operating flood warning systems and guiding disaster recovery.

Structural - Structural measures were selected to protect existing development from floods. Generally they are designed for a 100 year flood event, this being the level of protection selected by the community for urban areas. They include stopbanks, house raising, road raising and bridge lengthening.

River Management - These measures include the day-to-day activities and the programmed major works undertaken by GW to maintain the Waikanae River in its preferred alignment and to maintain existing flood mitigation structures.

Environmental Strategy - The objective of the environmental strategy was to provide a master plan for enhancing the landscape and environmental values of the river corridor below State Highway 1 to the river mouth.

Summary of Findings

Hydrology/Hydraulics

The hydrologic investigation completed by NIWA (Reference 1), included reviewing the 100 year flood design standard, using the additional river flow information available since 1992 and estimating the potential climate change impacts on the design standard. The investigation found that the estimate for the 1 in 100 year return period flood flow remains close to the 1992 result.

Flood levels along the river channel were estimated using an improved hydraulic model (Reference 2). Results show that river channel levels for the 1 in 100 year flood event have increased by up to 600mm above El Rancho and up to 900mm below El Rancho, when compared to the 1992 results. These increases are a result of updated survey information, recalibration based on the 2005 flood event (1 in 80 year return period), revised estimates for storm surge, use of a 100 year design sea level, adjustments to freeboard and assumption of a southerly mouth position.

The progressive nature of the development of the hydraulic model over the years means that the information used for the design of structural works is close to current estimates. Notably all new stopbanks meet the 1 in 100 year design standard. The exception is the Otaihanga flood wall where 1 in 100 year flood levels have increased by 470mm. The remodelled data indicates that currently the floodwall provides protection for a 1 in 20 year flood event.

Climate Change

The climate change impacts on the river flood flows are estimated to be an increase in the order of 10% and 20% in 1 in 50 and 1 in 100 year flood events respectively. This is a result of predicted increases in frequency and magnitude of high intensity rainfalls. In addition it has been recommended that allowances be made for a sea level rise of 200mm by the 2040s and a rise of 500mm by the 2090s (References 1 & 2).

The overall estimated effects of climate change would result in further increases in flood levels by up to 200mm by 2040 and up to 400mm by 2090. The upper limits apply mainly in the tidal areas at Otaihanga and Waikanae Beach.

In February 2010 GW's Flood Protection department adopted climate change criteria for future investigations and design work (Reference 3), as follows:

- *The increase in rainfall intensity to be used for calculation will be 16%*

- *The Sea Level Rise to be used for calculation is 0.5m by 2100*

These criteria are the same as was used to develop the finding for the 2090s climate change prediction in the hydrologic and hydraulic investigations of this review.

Future Remodelling

The investigations included only partial hydraulic modelling of the floodplain. This was undertaken for Jim Cooke Park and Otaihanga in 2010, because of a recognised need to

provide greater certainty in the model results at these locations. The model could be further improved with updated Lidar (ground level) data and improved two-dimensional (2-D) modelling tools. Detailed remodelling of the floodplain is not planned until 2015.

Non-Structural Measures

Good progress has been made in managing the flood risk through the District Plan. The Waikanae flood hazard was initially included in the District Plan in 1995 and later amended in 2002 to include revised flood hazard categories as a result of new stopbanks constructed. District Plan measures include controls on new development with regard to earthworks, the location of buildings in overflow paths and building levels in ponding areas. These measures, together with advice provided by GW has been reasonably successful in requiring development in flood hazard areas to either take into account the flood hazard and/or construct dwellings with a minimum floor level.

Between 1995 and 2009, the majority of building consents issued in the flood hazard areas included a minimum floor level condition to the 1 in 50 year level, rather than the 1 in 100 year level recommended by GW. These were mainly for infill development of existing lots. KCDC have estimated that a further 350 vacant sites could still be in filled within existing residential areas identified as being within the 1 in 100 year flood spread. These sites would only require building levels to the 1 in 50 year level.

The district plan has no rules regarding minimum floor levels in flood risk areas that would flood in a greater than 1 in 100 year event. These areas are shown on the KCDC website as residual overflow and residual ponding. Presently there are only controls in residual overflow paths regarding the location of buildings/structures and earthworks.

The total land area in public ownership in the river corridor has increased from 71% to 77%. Land purchase has taken place primarily as a result of implementing the capital works programme. Reserve contributions through subdivision have not been significant at this stage. Land purchase remains an important mechanism to avoid development in the river corridor and facilitate river corridor maintenance and improvement works.

GW has provided generic flood hazard information to the public, improved the flood warning system, responded to flood events and participated in joint exercises with KCDC. The WFMP needs updating to reflect current practice and links for Civil Defence and Emergency Management.

GW's Flood Protection, Environment and Land Management departments provide advice to land owners and other users in the river catchment on minimising erosion of land and river banks. There has been limited success in this area and GW recommends that this is discussed further with KCDC. Options to be discussed include incorporating the provision of advice to land owners as a primary objective in the proposed Open Space Strategy and further supporting the upper catchment vegetative framework which has been developed for Waikanae.

Structural and River Management Measures

Overall good progress has been made in implementing the WFMP structural and river management measures in the last 10 years and the plan is on track for completion by the target date of 2040. By June 2009, the measures were 44% complete providing 68%

benefits in terms of total damages saved (Reference 4). Full details of the progress, achievements and outcomes are shown in Appendix 1, Appendix 2 and Figures 1 to 3. A location plan of the Waikanae River is shown in Appendix 3.

Stopbanks that have been completed are Kauri/Puriri Road, Chillingworth and Otaihanga Domain. The Kauri/Puriri Road and Chillingworth stopbanks contained the 1998 (15 and 28 year flood events) and 2005 floods (1 in 80 year flood event), providing protection to over 450 houses. Previously the stopbank only provided protection for a 10 year flood event. The proposed Otaihanga Domain stopbank was replaced with a floodwall following public consultation. The floodwall overtopped during the 2005 flood. The revised 1 in 100 year flood design level estimate for this floodwall is 470mm higher than the top of the existing floodwall. Further structural measures completed include Otaihanga Road raising-Stage 1 and the raising or flood proofing of 7 buildings with GW assistance. The remaining structural measures in the WFMP all require further investigation and re-prioritising.

River realignment and bank edge protection works that have been completed are Otaihanga (part), El Rancho, Jim Cooke Park, River Glade, Kebbels, Edgewater Park and State Highway One. These works have performed well during subsequent floods, except for the Kebbels grade control weir and some rock groynes, which have eroded on a number of occasions and required topping up, as expected. River realignment and bank edge protection works that have not been carried out are the mouth, Otaihanga (except part) and Greenaway Road.

The agreed river training techniques have been relatively successful in maintaining the river channel within the preferred channel alignment, recognising that the implementation of additional programmed major river works have been required following major flood damage. With the completion of the programmed major river works, the balance of types of methods has changed to reflect the increase in permanent works in the river. As a result the amount of maintenance to rock edge protection has increased and the quantity of cross-blading has reduced. Approximately 80% of the river channel is maintained within the preferred channel alignment.

Gravel extraction has been carried out annually, as recommended following 5 yearly bed level surveys, in an attempt to maintain overall bed levels at the status quo (1991 surveyed levels) where possible, and hence maintaining the existing channel capacity of the river. Overall the results show a general trend of aggradation (gravel build-up) from the mouth to Jim Cooke Park (JCP) and degradation (gravel erosion) above this point.

During the last 5 years it has not been possible to extract the annual quota of gravel within the tidal reaches of the river owing to resource consent restrictions. Extraction has mainly occurred between El Rancho and JCP. Therefore it is likely that gravel is building up below this point. Whether or not this build up is significant and what options there are to address the issue should be clarified following completion of the next bed level survey and gravel analysis in 2010.

The river mouth has been inspected on a regular basis to ensure that the existing rock groyne at the mouth continues to operate effectively, the sand level between the groyne and the beach is generally below high water spring tide level and that mouth cuts are carried out when required. Minimal maintenance has been necessary since the mouth was last cut in December 2001.

Monitoring of River Processes

The monitoring activities as described in the WFMP (Section 3.3.5) have by in large been carried out and improved. Monitoring of the river has proven to be a useful tool in understanding the river processes, taking preventative measures and planning to mitigate potential flood hazards on the floodplain. Monitoring needs to be implemented in an ongoing manner as new research reveals improved ways of applying flood risk management.

Environmental Strategy

An Environmental Strategy was developed in 1999 by GW and KCDC with input from Iwi, DOC, landowners, environmental organisations and the community. The first 10 year review is currently underway and will be completed in 2010. This review acknowledges the intentions of GW and Kapakapanui Te Ati Awa ki Whakarongotai in ensuring the incorporation of the Ecological Strategy for the Waikanae River into the Environmental Strategy[1]. A reach has been added to the Strategy to acknowledge the importance of middle to upper catchment restoration work.

The Strategy identifies methods for protecting and enhancing the river corridor. Most of these have been agreed with the Waikanae community and Friends of the Waikanae River (FWR). Using the Strategy as a guide for best practice restoration, GW prepared a 5 year planting plan for FWR. Considerable progress has been made in the restoration of areas of the Waikanae River by the community groups with help from KCDC and GW. An improved link in policy has been identified through the environmental outcomes of the report based upon the Otaki Floodplain Management Plan. This ensures that the Environmental Strategy and Environmental Code of Practice are used to guide best practice in flood risk management.

Tangata Whenua

To date, our interaction with Iwi/Hapu has largely been issue driven or in response to resource consent applications and compliance. This approach does not provide opportunities to address wider issues or planning. Further opportunities through the Environmental Strategy and the proposed regional Natural Resource Plan should be advanced with local Tangata Whenua, with a focus on strategic responses to sites of significance and the possible implementation of cultural health monitoring.

Summary of Key Issues

- *Provision of design parameters in structural and non-structural measures to account for climate change*
- *Updating the hydraulic modelling of the floodplain and flood maps*
- *Building levels on existing lots presently not being built to 1 in 100 year flood levels*
- *Lack of control on building levels for development in areas that would flood in greater than 1 in 100 year event*

[1] Kapakapanui Te Ati Awa ki Whakarongotai & GW Flood Protection. (1999). Ecological Strategy - Waikanae River Operations and Maintenance Consultant's Brief, p.5.

- *Re-evaluate priorities for proposed flood mitigation measures (Section 6.2.5 on WFMP)*
- *Gravel aggradation in the lower reaches of the river*
- *Upper catchment erosion issues*
- *River mouth management*
- *River corridor land purchase*
- *Improving environmental outcomes*
- *Public awareness/community preparedness*

1. Purpose of the Review

The purpose of the first 10 year review is to evaluate the performance of the Waikanae Floodplain Management Plan (WFMP) to date and assess whether there is any need to change the outcomes and implementation process.

The following key elements of the WFMP were reviewed:

- Hydrology
- Hydraulics
- Processes monitored
- Work methodology
- Non-structural methods
- Effectiveness of all methods
- Capital and Operational expenditure budgets

This report includes the results of the hydrology and hydraulic remodelling reviews of the Waikanae River and an evaluation of the effectiveness of the completed non-structural, structural and river management measures contained in the WFMP.

This report will be used as the basis for consultation with Kapiti Coast District Council (KCDC) in the first instance following which it will be distributed to Friends of the Waikanae River, community groups, organisations and interested and affected residents along with the wider general public. A proposed consultation strategy has been prepared (Reference 5).

Following the consultation process and any further analysis required, the summary report will be updated and endorsed by Greater Wellington's Catchment Management Committee. Following this, sections of the WFMP will be updated and the agreed recommendations implemented.

2. Background

The WFMP was first published in October 1997 and was the result of five years of work by the Waikanae River communities, Te Ati Awa ki Whakarongotai, GW and KCDC. The WFMP provides a blueprint for management of the river and floodplain over the 40 years 1997-2037.

At the inception of the WFMP for the Waikanae River it was stated that the WFMP would be reviewed every ten years or when the flood hazard was significantly altered.

The WFMP states that:

"*As reviews of the WFMP are undertaken, aspects and details may change to reflect the changing needs and desires of the community. Any changes will be issued as addenda and inserted into the document when they are approved. Changes to the Plan will be by Council resolution and can be promoted in accordance with standard Council procedures. It is generally expected that changes to the Plan will be promoted through the Annual Plan process*" (p.81).

The WFMP anticipated that a new plan would be produced after 40 years or earlier, if required.

As part of the WFMP the community developed a set of 'outcomes' as a result of examining various options for managing flood risk and the river. The outcomes covered three main areas: non-structural, structural and river management. A fourth outcome was to prepare and implement an Environmental Strategy as part of the Floodplain Management Plan. A 'considerations' section covers environmental, economic, social and cultural issues and corresponding policies, objectives and methods.

These considerations outline the floodplain management approach. Based on this review and the current floodplain management approach, where existing methods or actions need refocusing, the considerations section provides the policy intent of the document and details what GW wanted to achieve.

2.1 Non-Structural Methods

Planning and Land Use Measures

Non-structural methods focus on keeping people away from floodwaters and helping the community cope when flooding occurs. They are the most cost-effective method of flood mitigation and their principles can be applied to both minor and major flooding.

Flood hazard categories have been identified on the Waikanae floodplain and have been included in District Plan since 1995. These flood hazard categories have been used for encouraging appropriate land use development on the

floodplain. Other measures include providing information and advice, river corridor management and land procurement.

Community Preparedness

These measures include providing up-to-date information, assisting KCDC in public education programmes and emergency management, flood warning and disaster recovery.

2.2 Structural Methods

Where flood-prone areas have already been intensively developed, planning controls alone maybe insufficient. The WFMP identified structural measures to provide an agreed level of protection to existing development on the Waikanae floodplain.

Based on the community's expectations and consultation through the WFMP, structural methods protecting urban areas have been designed for a 1 in 100 year flood event.

They include:

- Stopbanks
- House raising
- Road raising
- Bridge lengthening

2.3 River Management Methods

These measures include the day-to-day activities and the programmed major works undertaken by GW to maintain the Waikanae River in its preferred alignment and to protect and maintain existing flood mitigation structures.

Implementation of structural and river management methods were to be guided by WFMP's environmental guidelines.

Expenditure

Funding levels are kept at approximately the same level as in 1997 ($65,000 per year exclusive of overheads 1997$).

Channel alignment

The river will be maintained within the preferred channel alignment

River Training Methods

The current practices (1997) will continue to be used to maintain the river in its preferred channel alignment, recognising that additional programmed major works will be required over time. Additional policies for river mouth management and gravel extraction are also covered by the WFMP.

2.4 Environmental Strategy

The strategy provides a master plan for enhancing the landscape and environmental values of the River Corridor below State Highway 1 to the river mouth.

It was envisaged that all agencies and individuals involved in environmental management would use the strategy to link their work into a joint management approach for the Waikanae River Corridor.

3. Findings

3.1 Overall Findings

Good progress has been made in implementing the WFMP in the last 10 years and it is on track for completion by the target date of 2040. By June 2009, the structural measures of the WFMP were 44% complete providing 68% benefits in terms of total damages saved (Reference 4). Significant progress has also been made with the non-structural measures proposed in the WFMP. Flood hazard information has been included in the District Plan and updated as required. Advice on flood hazards is provided to the public on an ongoing basis.

Appendix 1 provides details of the WFMP review outcomes.

Appendix 2 is a summary of the progress of the structural works, river management works, non-structural methods and the environmental strategy. The structural and river management works are shown diagrammatically in Figures 1 to 3.

3.2 Technical Information

The initial part of the review focused on the hydrology and hydraulics of the Waikanae River. This primarily involved updating the 1991 "*Kapiti Coast Floodplain Management: Hydrology and Climatology*" report. The flood frequency analysis components of the report were updated using the additional flood data recorded to 2009 and the climate change impacts on the updated 100 year flood flows were assessed using the latest published climate change information. This data was used to update the existing hydraulic model in order to determine the current estimated river levels for a range of scenarios including:

- Short mouth or long mouth
- 100 year Waikanae flow + 20 year sea level + 20 year Muaupoko & Waimeha flows **or** 100 year sea level + 20 year Waikanae flow + 20 year Muaupoko & Waimeha flows
- Current climate, 2040 mid-range climate forecast, 2090 mid-range climate forecast or 2090 upper end of forecast range climate (referred to as "extreme").

Hydrology findings

The hydrologic investigation completed by NIWA (Reference 1), included reviewing the 1 in 100 year flood design standard, using the additional river flow information available since 1992 and estimating the potential climate change

impacts on the design standard. The overall conclusions and recommendations made by NIWA were as follows:

- Flow records for the Waikanae River were of a reasonable quality, given the mobile nature of the gravel river beds.

- The lengths of record now available (34 years) are sufficient to provide reasonable estimates of flood quantiles, without the need to resort to lower reliable regional methods.

- The flood quantiles for the Waikanae River have increased marginally over those in the 1991 report. They are however slightly lower that the design value adopted by GW in 1992.

- There have been no significant developments in probable maximum precipitation (PMP) estimation methods in New Zealand since the 1991 report; therefore the probable maximum flood (PMF) estimates in that report remain valid.

- The topographical catchment area for the Waimeha Stream is ill-defined, and it is recommended that urban drainage details for the Waikanae urban area be investigated to better define the drainage paths through the area, in particular considering contingencies such as the blockages of culverts.

- Global warming is expected to result in intensification of severe storms because a warmer atmosphere can contain more moisture. As a consequence, increases in flood peak flows of the order 10% and 20% are suggested in 50 and 100 years respectively.

Hydraulics findings

The hydraulic review was completed by Philip Wallace, River Edge Consulting Limited in August 2009 and further updated in May 2010. (Reference 2). Flood levels along the river channel were estimated using an improved hydraulic model which included a 600mm allowance for model uncertainties (known as freeboard).

The findings of the initial report completed in August 2009 were as follows:

- Results show that peak flood levels are lower than earlier results upstream of the state highway and rail bridges, but are higher downstream. The differences upstream of the bridges are largely due to the slightly lower design flow now used and a lower freeboard at the bridges. Downstream of the bridges peak flood levels have increased by up to 900mm, when compared to the 1992 and by up to 700mm, when compared to the 2004 results. These increases are a result of recalibration based on the 2005 flood (1 in 80 year return period),

updated survey information, revised estimates for storm surge, the use of a 100 year design sea level, a longer mouth and increasing the freeboard at the lower few cross-sections.

- The existing Kauri-Puriri stopbank as built levels are close to the 2090, 1 in 100 year flood levels. However the Chillingworth stopbank may need topping up in places to cope with the 2090's climate change prediction. More accurate survey information is required to confirm this.

- The existing Jim Cooke Park stopbank is up to 400mm lower than current 1 in 100 year flood levels in places. Further increases of approximately 300mm in height would be required to allow for the 2090's climate change prediction. The stopbank is due for reconstruction in 2013/14. Again more accurate survey information is required to confirm this.

- The floodwall in Otaihanga Domain was built to 4.15m RL. The current design level estimate is now 4.51m, rising to 4.63m by 2040 and 4.77m by 2090. The remodelled data indicate that currently the floodwall provides protection for a 1 in 20 year flood event.

- In the lower reach of the river, 1 in 100 year flood levels have increased by up to 700mm. The implications of increased river flows spilling along the Waimanu Lagoon at Waikanae Beach require further modelling and investigation.

- A programme of house-raising has begun in the Otaihanga area. The current modelling predicts that houses previously raised to 3.5m RL in Makora Rd should be above 3.6m RL now to provide 1% AEP (1 in 100 year) protection, including 600mm freeboard (Table 1). Results at other locations where house-raising has been undertaken or is planned are given in Table 1. Freeboard of 600mm has been included in these figures. These floodplain results are subject to the qualifications below.

Location	Existing Floor Levels	now	2040	2090	extreme
1-13 Makora Rd		3.57	3.71	3.89	4.20
17-19 Makora Rd	3.5	3.60	3.73	3.91	4.21
21 Makora Rd		4.05	4.17	4.31	4.60
73 Makora Rd	4.6	5.11	5.23	5.37	5.67
11-15 Toroa Rd	4.6	5.34	5.45	5.55	5.82
Otaihanga Floodwall[1]	4.15	4.51	4.63	4.77	5.07

Note (1) Top of wall

Table 1 Predicted 1% AEP design levels (m RL), including freeboard at houses in Otaihanga

- The model could be improved with available Lidar data and two-dimensional modelling tools (MIKE FLOOD), particularly along the river berms and adjacent flood storage areas. If that was to be done, the Lidar data and MIKE FLOOD could also be used to upgrade the floodplain model. It needs to be emphasised that the floodplain component of the model has not been upgraded as yet. Thus the effect of climate change on the flood hazard on the floodplain has also not been assessed or results are at best provisional. Such a model upgrade remains a future, but important, task.

- When the floodplain model is upgraded, it would make sense to integrate it with models of the Waimeha/Ngarara and Mazengarb catchments that have been commissioned by Kapiti Coast District Council. These catchments seamlessly connect to the Waikanae and Otaihanga floodplains.

Following on from the findings of the Waikanae River Hydraulic Model Update 2009 as described above, P. Wallace of River Edge Consulting was requested to further upgrade the model using two-dimensional (2-d) modelling tools (MIKE FLOOD) on the floodplains at Jim Cooke Park and Otaihanga to check the previous findings.

Changes were made to the model as follows:

- All river cross-sections were resurveyed in 2010, and these new cross-section data have been included in the updated model.

- The lower reaches of the Mazengarb Drain have been taken from a model currently being built for Kapiti Coast District Council and joined to the Waikanae model.

- KCDC is intending to upgrade the outlet from the Waikanae Lagoons and the proposed structure has been incorporated in the model.

- The floodplain topography has been obtained from a LiDAR survey of the floodplain undertaken in 2003. This data has an expected accuracy of ±0.15m on clear ground. However, comparisons with survey data suggest that there is a vertical discrepancy between surveys and the LiDAR data. The LiDAR data have accordingly been raised by 150mm to compensate. The topography has been further adjusted by incorporating recent ground survey data for Makora Road and the crest of Jim Cooke Park, and by cutting a channel along Muaupoko Stream to better define that watercourse.

- Further adjusted roughness parameters to obtain a better calibrated result for the 2005 flood event. Results showed the average error is 70mm (a net under prediction), while the average absolute error is 210mm.

- Greater Wellington now incorporates climate change in its flood risk assessments (Reference 3), assuming a 2ºC temperature rise, 16% increase in rainfall intensity and 0.5m sea level rise. This is equivalent to the 2090 mid-range scenario presented.

The August 2009 hydraulic model report was updated in May 2010 with the following findings:

- The results in the river channel at key locations are shown in Table 2. Overall these show similar trends to the 2009 results but with the notable changes highlighted below.

Location	Previous Designs		Updated Design	
	1992	2004	Current	2090
Waikanae Treatment Plant	31.40	31.63	31.59	32.02
SH1 bridge	25.00	24.28	23.00	23.28
Edgewater Park	18.30	18.81	18.85	19.11
Leybourne Ave	14.70	14.62	14.35	14.57
Jim Cooke Park (at entrance)	11.80	11.70	12.23	12.39
Greenaway Road	6.40	6.59	6.64	6.77
El Rancho	4.80	5.03	5.16	5.38
Otaihanga Domain	3.60	4.22	4.61	4.84
Otaihanga Boating Club	3.00	3.33	3.55	3.85
Tutere Street	2.60	2.35	3.11	3.51

Table 2: Predicted 1% AEP design levels (m RL), including freeboard in Waikanae River channel

- The existing Kauri-Puriri stopbanks as built levels are above the current 1 in 100 year flood levels, including 2090 climate change. The Chillingworth stopbank as built levels are close to the current 1 in 100 year flood levels. Additional topping up, by up to 200mm, would be required to meet the 2090's climate change prediction. More accurate site survey information is required to confirm this.

- Results along the Jim Cooke Park stopbank alignment are lower than expected, being 200 – 400 mm lower than the existing stopbank levels (for the current climate). Calibration modelling under predicts the January 2005 event by 250 mm at section 310 (upstream of the stopbank) and by 360 mm midway along the stopbank crests. To make allowance for the under prediction, the recommended stopbank levels are 360 mm higher than the model outputs, with 600 mm freeboard. The net result is that the existing stopbank needs to be raised by up to 500mm, allowing for 2090's climate change.

- The floodwall in Otaihanga Domain was built to 4.15m RL. The current design level estimate is now 4.62m, rising to 4.85m by 2090. (Table 3)

Crest according to design drawings	January 2005 flood		Design level (100 year return period)	
	Recorded	2010 model	Current	Climate Change (2090)
4.15	3.792	3.830	4.62	4.85

Table 3 Predicted 1% AEP design levels (m RL), including freeboard at Otaihanga Domain flood wall

- A programme of house-raising is well underway in the Otaihanga area. Results at locations where house-raising has been undertaken or is planned are given in Table 5. Freeboard for houses 1 to 61 Makora Road in Table 5 has been set at 600 mm, as these houses are adjacent to the river or are in the path of direct overflow from the river. Houses at 73 Makora Road and 11-15 Toroa Road are further from the river and flow would take a longer path to reach them, and a relaxing of freeboard to 300 mm is proposed. The design levels in Table 5 include a freeboard allowance. The results show that houses previously raised Makora Road and Toroa Road with GW assistance are close to the current 1 in 100 year flood design standard.

- The 2090 climate change scenario shows minor flooding into Weggery Drive which requires further investigation and analysis.

- Floodwaters are also predicted to spill into the right bank Waikanae Lagoons. Levels reaches in the lagoon are shown in Table 4. Low-lying properties adjacent to the lagoons might be affected by floodwaters. This requires further modelling and site survey.

	2010 Design	
	Current	2090
South-west lagoon	2.504	2.861
North-east lagoon	2.505	2.867

Table 4 Peak flood levels, Waikanae Lagoons (no freeboard)

- It needs to be emphasised that bulk of floodplain component of the model has not been fully upgraded as yet (the Waikanae left bank upstream of cross-section 270 and the right bank). Thus the effect of climate change on the flood hazard on the floodplain has also not been assessed or results are at best provisional. Nor have overdesign events been remodelled for the Waikanae floodplain. Greater Wellington is therefore not in a position yet to update previous flood maps of the Waikanae floodplain. Such a model upgrade remains a future, but important, task. The 2-d component of the 2010 model would be extended to cover the remaining areas of the Waikanae floodplain. The model has been integrated with the model of the Mazengarb catchments commissioned by Kapiti Coast District Council and could also be integrated with the model of the Waimeha/Ngarara that KCDC has commissioned.

Houses identified for raising	Year Raised	Floor Level given by GWRC (u/s floor joist)	Estim. Existing Floor Level of Living Areas (u/s floor joist)	January 2005 flood		Design level (100 year return period)	
				Recorded	2010 model	Current	Climate Change (2090)
11 Toroa Road	2000	4.6m	4.63	4.325	4.3	4.74	4.95
13 Toroa Road	2000	4.6m	4.67			4.74	4.95
15 Toroa Road	2006	4.6m	5.04			4.74	4.95
1 Makora Road			2.44	2.203	2.430	3.47	3.8
3 Makora Road			2.12			3.47	3.8
5 Makora Road (Front)			2.21			3.48	3.81
5 Makora Road (Rear)			2.77			3.47	3.8
7 Makora Road			4.61			3.48	3.81
9 Makora Road			2.92			3.5	3.82
11 Makora Road			2.00			3.49	3.81
13 Makora Road			4.32			3.5	3.82
15 Makora Road			3.99			3.52	3.84
17 Makora Road	2009	3.5m	4.21	2.559	2.600	3.56	3.85
19 Makora Road (Boat Club)	2009	3.5m	3.49			3.6	3.9
21 Makora Road	2006		4.77	3.124	3.360	4.25	4.51
61 Makora Road			3.47		3.840	4.62	4.85
73 Makora Road	2006	4.6m	5.33	4.586	4.300	4.74	4.95

Table 5 Existing floor levels and recommended 100 year design levels (m RL), including freeboard for houses in Otaihanga area

Climate Change

The climate change impacts on the river flood flows are estimated to be an increase in the order of 10% and 20% in 1 in 50 and 1 in 100 year events respectively (Reference 1). This is a result of predicted increases in frequency and magnitude of high intensity rainfalls. NIWA also recommend that allowances be made for sea level rise of 200mm by the 2040s and a rise of 500mm by the 2090s. These estimates are consistent with the Ministry for the Environment guidelines, from which can be derived an increase in rainfall for a 100 year rainstorm of 7% and 16% by 2040 and 2090 respectively, for mid-range temperature increase estimates. The Ministry guidelines also note that the likely upper end of the range of temperature increase by 2090 is 5.2ºC, which is predicted to increase 100 year rainfall depths by 41.6%. The guidelines also suggest that the effects of an 800mm sea level rise be considered. Therefore the following climate scenarios were modelled:

- Current climate
- 2040 mid-range: sea level rise of 0.2m, flows increased by 10%
- 2090 mid-range: sea level rise of 0.5m, flows increased by 20%
- 2090 extreme: sea level rise of 0.8m, flows increased by 41.6%

The overall effects of the 2090 mid-range climate change would result in further increases in flood levels by up to 400mm by 2090 (Reference 2). The largest increases apply mainly in the tidal areas at Otaihanga and Waikanae Beach. The results of the river channel flood levels for the 2090 climate change scenario at various locations along the river are shown in Table 2.

Reviews of current knowledge on climate change have been undertaken every 5 years following reviews undertaken by the Intergovernmental Panel on Climate Change (IPCC). The lack of certainty and no GW policy in the past has meant that climate change figures have not been used for flood mitigation methods and flood level advice for proposed developments. However, in February 2010, GW's Flood Protection department developed design criteria for climate change (Reference 3) in line with the most recent Ministry for the Environment recommendations (Reference 20 of Appendix 1). This criterion is the same as was used to develop the finding for the 2090s climate change prediction in the hydrologic and hydraulic investigations of this review.

Future Remodelling

The investigations included only partial 2-d hydraulic modelling of the floodplain; along the lower reach the river berms and adjacent flood storage areas, as shown in the figure below. The available flood storage is now better represented in the model than previously.

Full hydraulic modelling of the floodplain was last completed in 2002 when the flood hazard information was updated for KCDC District Plan Change 50.

Ongoing improvements to the model should be undertaken to improve calibration of the model to actual events. Continued data collection in flood

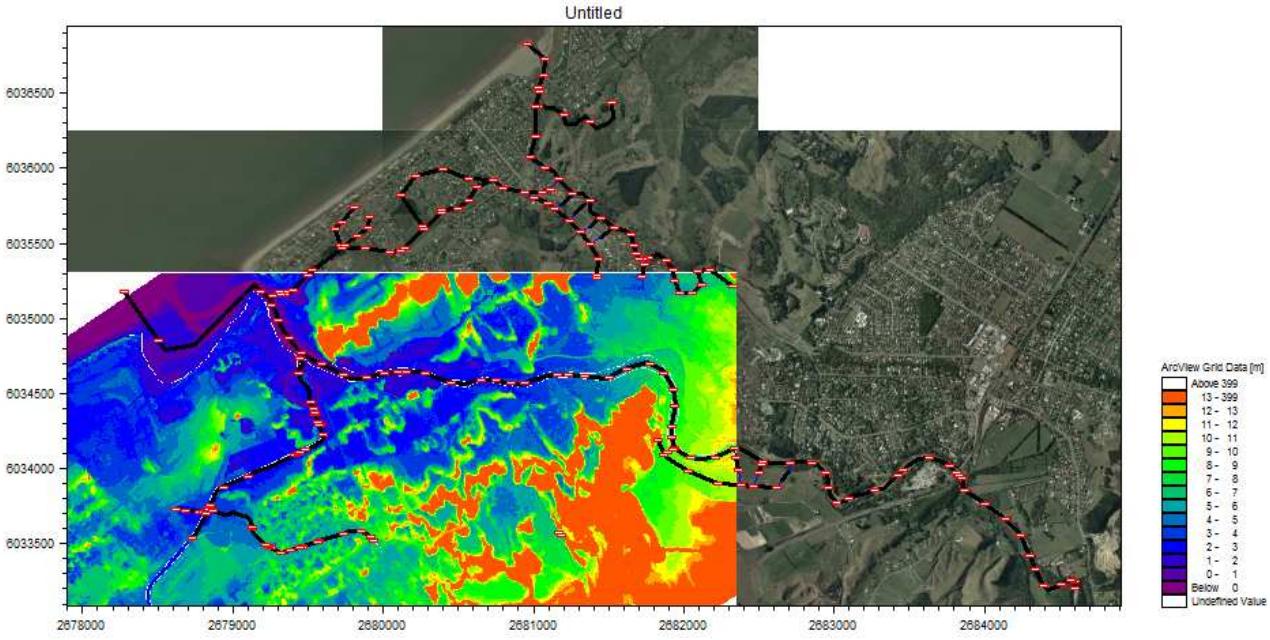
events (gauging flow to give more certainty at the higher end of the rating curve, and recording flood level information) is recommended.

The implication of the discrepancies in calibration results is that design results should not be taken direct from model results before finalising design features. Some consideration should be taken of the calibration results first. For example, the recommended Jim Cooke Park stopbank levels incorporate an adjustment to allow for calibration under prediction. House raising levels should also take into account the possibility that the marginal cost of raising floor levels higher above the design predictions is less than the implications of under prediction.

It needs to be emphasised that bulk of floodplain component of the model has not been upgraded as yet (the Waikanae left bank upstream of cross-section 270 and the right bank). Thus the effect of climate change on the flood hazard on the floodplain has also not been assessed or results are at best provisional. Nor have overdesign events been remodelled for the Waikanae floodplain. Greater Wellington is therefore not in a position yet to update previous flood maps of the Waikanae floodplain.

Such a model upgrade remains a future, but important, task. The 2-d component of the 2010 model would be extended to cover the remaining areas of the Waikanae floodplain. The model has been integrated with the model of the Mazengarb catchments commissioned by Kapiti Coast District Council and could also be integrated with the model of the Waimeha/Ngarara that KCDC has commissioned.

In order to incorporate GW's policy on climate change it is recommended that the floodplain be fully remodelled in order to provide up to date flood level advice to the public.



MIKE 21 model extent

3.3 Non-structural measures

Land Use

WFMP policies seek to:

- Encourage open space provision, riparian management, reserve contributions or esplanade strips, discourage clearance of the upper catchment, and encourage reforestation of the upper and middle catchment through district and regional plans.

- Utilise structural methods to protect existing development.

- Ensure uses of flood-prone land are appropriate to the risk and costs associated with flooding.

- Implement long-term means of land use planning to reduce the flood hazard and limit future growth in potential flood damages.

- Prevent inappropriate development of the river corridor and overflow paths and ensure that development does not adversely affect flood mitigation structures.

- GW has achieved progress with these policies largely through resource consents. Some progress has been made in riparian management and restoration through the Environmental Strategy and Ecological Strategy.

District Plan

Good progress has been made in managing flood risk through the District Plan. The Waikanae flood hazard was included in the District Plan in 1995 and later amended in 2002 to include revised flood hazard categories as a result of new stopbanks being constructed. The revised flood hazard categories now include river corridor, overflow path, ponding, residual overflow path, residual ponding and erosion hazard. The revised categories are included in Plan Change 50 of the District Plan which became operative in March 2010.

The District Plan also includes objectives, policies and rules that control how land and buildings can be developed within the 100 year flood extent. Flood hazard information is also provided to the public by KCDC through their building consent process and Land Information Memorandums (LIMS).

During the last 10 years GW has responded to hundreds of queries on flood hazard information from KCDC, developers and residents. This includes responses to all resource consent applications in floodable areas. This advice, together with the District Plan measures, has been successful in requiring development in flood hazard areas to either take into account the flood hazard and/or construct dwellings with a minimum floor level.

GW has reviewed 104 building consents issued by KCDC for residential development in a flood hazard area between 1995 and 2009 and found that 83% of these included a minimum floor level condition. 62% were specified to the 1 in 50 year flood level and 8% were specified to the 1 in 100 year level (Reference 2 of Appendix 1). GW has always recommended that new buildings be constructed to the 1 in 100 year flood level.

KCDC have estimated that a further 350 vacant sites could still be in filled within existing residential areas identified as being within the 1 in 100 year flood spread. At these sites KCDC would only require building levels to the 1 in 50 year level in accordance with the Building Code 2000.

The district plan has no rules regarding minimum floor levels in flood risk areas that would flood as a result of breaching and overtopping of flood protection structures (such as stopbanks or flood works) built to the 1 in 100 year flood event. These areas are shown on the KCDC website as residual overflow and residual ponding. Presently there are only controls in residual overflow paths regarding the location of buildings/structures and earthworks.

From the review the main issues in this area identified are:

- A significant percentage of new development (houses on existing lots) is being built at the 1 in 50 year flood level.

- The residual ponding areas have no accompanying rules in the District Plan regarding building levels, which makes the lack of controls difficult to prevent development in these areas.

GW would support KCDC changing the 1 in 50 year building requirement to a 1 in 100 year standard through changes to the district plan and developing rules for residual .ponding areas.

Policies in the WFMP need to be updated to reflect current thinking in particular the ‘avoidance approach’ in the proposed Regional Policy Statement (Reference 4 of Appendix 1). This issue is raised in the assessment of the considerations section below.

Education/Community Preparedness/Civil Defence and Emergency Management

GW has provided generic flood hazard information to the public, improved the flood warning system and responded to flood events.

KCDC has a community education programme and Civil Defence Emergency Management has an active role in providing emergency response. Regular meetings are held with Civil Defence Emergency Management staff to ensure continued cooperation and dissemination of information. GW also improves community preparedness through planning exercises in the community. Two joint exercises with GW have occurred in Kapiti between 1995 and 2009. These exercises brought together all the relevant emergency services which have proved to be useful to all parties concerned.

In terms of the Civil Defence/Emergency Management links the WFMP needs updating to reflect current practice. Notably, post disaster recovery[2] is not currently identified in the existing WFMP in any great detail. Disaster recovery is a vital component of achieving the implementation of:

- appropriate non-structural methods;
- community resilience;
- managed retreat concepts; and
- managing flood risk long term, particularly in light of climate change issues.

A real-time flood forecasting model has been developed and maintained by GW. Two alarm levels have been set at both Kapakapanui and Warwick's rainfall gauges. i.e. 15mm/2hours and 20mm/2hours. The river gauge at the treatment plant has been rebuilt with 2 river level recorders, each with separate recorders and communications systems. Specific warnings and levels have been changed and made to automatically alarm for KCDC emergency management staff.

The Otaihanga flood warning system was improved following the 2005 flood. Following this, GW's Flood Procedures Manual was reviewed and updated in 2007.

Upper Catchment Erosion Control

GW Flood Protection, Environment Division and Land Management provide advice to land owners and other users in the upper catchment on minimising erosion of river banks and flood related issues.

GW Environment Division and MFE have engaged PA Handford & Associates to work with landowners in the headwaters of the Waikanae River to develop a catchment level vision for planting and vegetation management that provides wide catchment and community benefits, such as improved water quality and soil protection. Details are given in the Waikanae Headwaters Vegetative Framework (Reference 3 of Appendix 1).

It is recommended that this issue is discussed further with KCDC in order that it is incorporated as primary objective in the proposed Open Space Strategy. Upper catchment restoration (reforestation) has numerous benefits in reducing the impacts of erosion, sediment transport and gravel water quality.

A plan of action could be agreed between KCDC and GW based on the Waikanae Headwaters Vegetative Framework.

Presently the Waikanae Catchment is not part of the GW funded 'Streams Alive' programme for private landowners in implementing riparian management.

It is recommended that the WFMP policy be changed to:

[2] Post Disaster Recovery - the measures in place to address medium to long term recovery of the community after a large flood event.

- Encourage KCDC to protect upper and middle catchment remnant bush through the Kapiti Coast District Plan;

- GW and KCDC coordinate restoration work in middle and upper catchments with landowners - based on the Waikanae Headwaters Vegetative Framework, particularly on slopes steeper than 30º'.

3.4 Structural Measures

Stopbanks

Stopbanks that have been completed are Kauri/Puriri Road (1997), Chillingworth (1997) and Otaihanga Domain (2003).

The Kauri/Puriri Road and Chillingworth stopbanks contained the 1998 (15 and 28 year flood events) and 2005 floods (1 in 80 year flood event), providing protection to over 450 houses. Previously the stopbanks only provided protection for a 10 year flood event. The updated model predicts that these stopbanks will require topping up in places to cope with climate change predictions to maintain protection from a 1 in 100 year flood. A long section survey of existing stopbanks would provide a clearer indication of the required top-ups.

The proposed Otaihanga Domain stopbank was replaced with a floodwall following public consultation. The floodwall has contained flooding from the river since it was constructed in 2003, except in the 2005 flood when it was overtopped by floodwater getting behind the flood wall through the local stormwater network and from the river. The 2005 flood showed that with certain combinations of mouth position, spring tides and storm surge, flood levels can be higher than have been designed. The previous design levels at Otaihanga were based on a 1 in 100 year flood with a 20 yr storm surge and the mouth exiting directly to the sea. Modelling work has now allowed for a worse combination of events for the setting of design heights for stopbanks than in the past. The existing floodwall is estimated to provide protection for a 1 in 20 year event. The revised 1 in 100 year flood design level estimate for this floodwall is 470mm higher than the top of the existing floodwall. An allowance for climate change (2090) would increase the design level estimate a further 230mm.

Stopbanks that have not yet been constructed are Jim Cooke Park, Waimeha Golf Course, Lion Park (121 Otaihanga Road) and 61 Makora Road. The Jim Cooke Park stopbank, which includes a retaining wall at the upstream end, is programmed to commence in 2013/14. The Waimeha Golf Course stopbank should be reconsidered following a detailed review of the hydrology and hydraulics of the Waimeha and Ngarara catchments. The Lion Park stopbank is not programmed for construction within the next 10 years. However, options including house raising or relocation need to be considered (as compared to ring banking), as site conditions have changed. The house at 61 Makora Road was flooded in the January 2005 flood; however the owners have not requested

any assistance from GW until recently. Options for flood proofing are currently being investigated.

Summary of overall achievement:

Length of stopbank in WFMP	Length of stopbank completed	% complete
2180m	710m	33

Bridge Lengthening

The WFMP recommends that the Fieldway Bridge be lengthened to 18m, the channel widened, debris arrestors put in place, and further channel realignment be carried out at the Waimeha mouth. This has not proceeded because of uncertainty about flood discharges from the Waimeha and Ngarara Streams and a lack of catchment information, rainfall data and historical flooding in the area.

A detailed review of the hydrology and hydraulic model for the Ngarara/Waimeha catchment areas is presently being undertaken by KCDC. This information will be used to confirm or otherwise the need for bridge lengthening.

House Raising

Houses at 11 Toroa Road and 13 Toroa Road were raised in 2000 following the 1998 floods. These houses were not flooded in the 2005 flood event.

The other houses that have been raised or flood proofed since the 2005 flood are 15 Toroa Road, 17 Makora Road, 19 Makora Road, 21 Makora Rd and 73 Makora Road. 15 Toroa Road, 19 Makora Road and 21 Makora Rd were not specified in the WFMF but were subsequently approved for house raising assistance by GW.

Summary of overall achievement:

Number of houses to be raised in WFMP	Number of houses in WFMP raised or flood proofed to date (with GW assistance)	% complete in WFMP (with GW assistance)	Number of houses in WFMP raised to date without GW assistance	% complete in WFMP (with and without GW assistance)
12	4	33%	4	67%

In 2007, GW confirmed that house and road raising in Makora Road remains the preferred flood mitigation measure in Otaihanga. (Reference 10 of Appendix 1). The other option was stopbanking around the properties at 1-19 Makora Road, but this proposal was abandoned because of cost and the environmental impacts.

GW has budgeted in the LTCCP for three houses to be raised or flood proofed over the next 3 years. The remaining houses specified in the WFMP have already been rebuilt to the 1 in 100 year event flood level or do not use the downstairs area as living space. Details are given in Table 6.

Houses Identified for Raising	Year Raised	Floor level given by GWRC (u/s joists)	Existing liveable floor level (u/s joists)	Comments
11 Toroa Road	2000	4.6m	4.63	Raised with GW assistance
13 Toroa Road	2000	4.6m	4.67	Raised with GW assistance
15 Toroa Road	2006	4.6m	5.04	Raised with GW assistance
1 Makora Road*			2.44	Single story
3 Makora Road*			2.12	2 Story-living both stories
5 Makora Road* (Front)			2.21	Single story
5 Makora Road (Rear)			2.77	Built to after WFMP
7 Makora Road			4.61	2 Story-living top story
9 Makora Road			2.92	Re-built after WFMP
11 Makora Road*			2.00	2 story-living both stories
13 Makora Road			4.32	2 story-living top story
15 Makora Road			3.99	2 story-living top story
17 Makora Road	2009	3.5m	4.21	Raised with GW assistance
19 Makora Road (Boating Club)	2009	3.5m	3.49	Raised with GW assistance
21 Makora Road	2006		4.77	Flood proofed with GW assistance
73 Makora Road	2006	4.6m	5.33	Flood proofed with GW assistance

* Potentially qualify for GW assistance for raising/flood proofing

Table 6: House Raising Details

The hydraulic model undertaken in 2010, using the more advanced 2-d modelling tools, showed that houses raised in Makora Road and Toroa Road with GW assistance are close to the current 1 in 100 year flood design standard. Details are shown in Table 5.

Road Raising

Greenaway Road - This was completed in 1997 and withstood the 1998 and 2005 floods.

Otaihanga Road west - This was completed in 2000 and withstood the 2005 flood.

Makora Road west - Works did not proceed at the request of residents because of their concerns regarding traffic safety and access issues. KCDC have no plans to upgrade this section of road. Flooding occurred at numbers 2-8

Makora Road during the 2005 flood. At this stage GW has no intention to pursue road raising, unless agreement can be reached with the affected residents and KCDC. The alternative is house raising or District Plan measures. Stopbanking was ruled out by GW in 2007 (Reference 10 of Appendix 1). It is recommended that GW review the options to protect houses in Makora Road west (numbers 2 to 22) from the 1 in 100 year flood event, including an agreed allowance for climate change.

Summary of overall achievement:

Length of road to be raised in WFMP	Length of road in WFMP raised to date	% complete
630	430	68

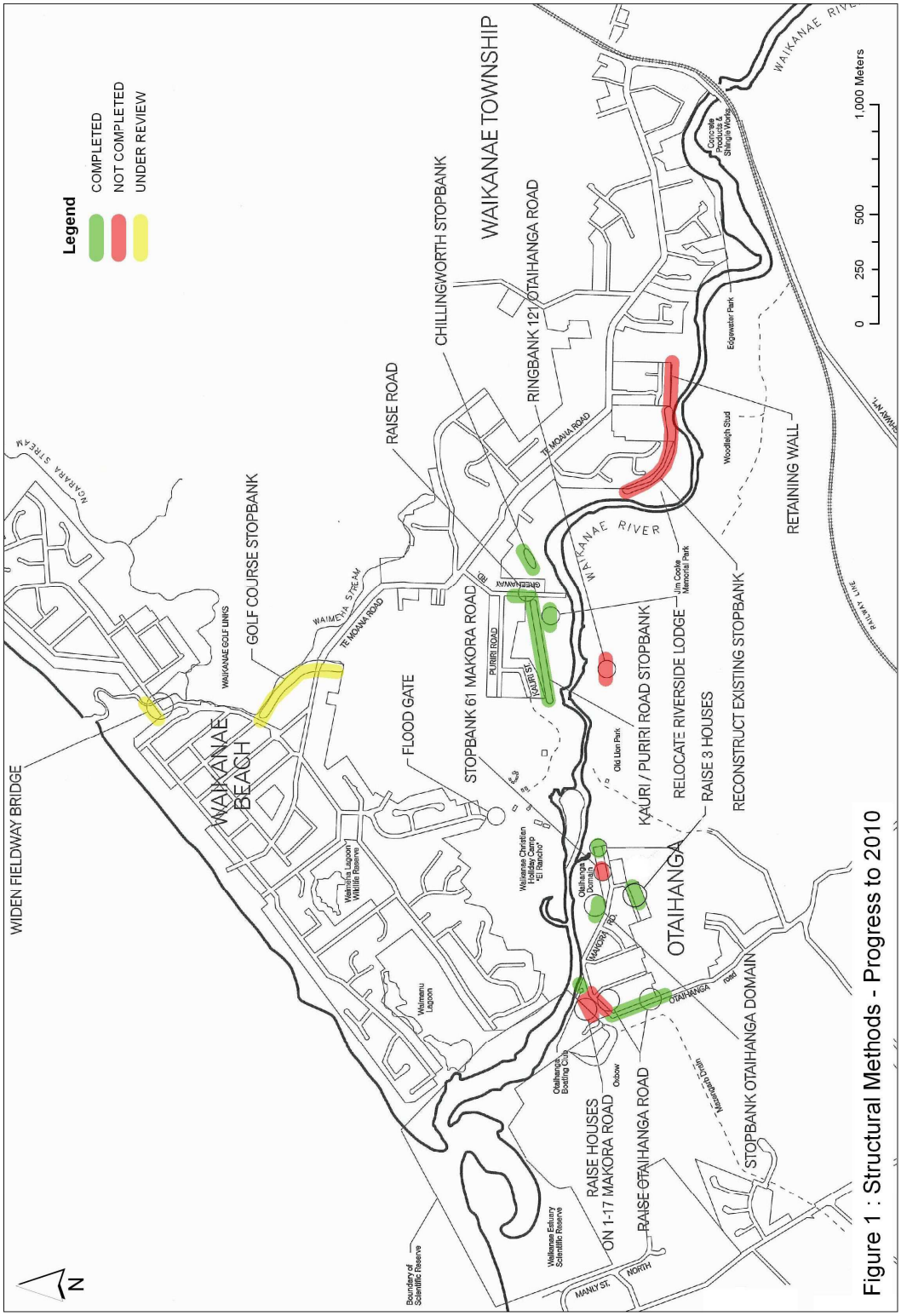


Figure 1: Structural Methods – Progress to 2010

Fig 2. - Location of Otaihanga Structural Measures - Progress to 2010

3.5 River Management

Overall river management works have performed well overall, without any significant major damage, notably during the 1 in 80 year flood that occurred in January 2005. The exception was the section between SH1 and Leybourne Avenue during the 1998 floods. Major river realignment and bank edge protection work over this section were completed in 2000. In addition major river realignment has been completed at Jim Cooke Park to mitigate potential flood damage to the stopbank.

Routine River Maintenance

River management methods undertaken in the Waikanae River are the day-to-day activities undertaken by the Council to maintain the river channel to a preferred alignment and to protect and maintain existing flood mitigation measures. The overall outcome has been improved with the completion of a number of programmed major river works.

The agreed river training techniques as outlined in Section 3.3 of the WFMP have been partly successful in maintaining the river channel within the preferred channel alignment. Major damage occurred to these low cost edge protection structures particularly between the State Highway 1 Bridge and Leybourne Avenue during the 1998 floods.

With the completion of a number of programmed major river works the balance of types of methods has changed to reflect the increase in permanent works in the river. As a result the amount of maintenance to rock edge protection has increased and the quantity of cross-blading has reduced. The main location where cross-blading is presently required on a regular basis is between Jim Cooke Park and Greenaway Road. This location was identified for hard edge protection in the WFMP (Greenaway Road), but this work has not yet been programmed.

The annual operations expenditure has been maintained at $65,000 (1997 dollars) or $103,000 (2009/10 dollars). Routine maintenance has been able to be carried out within this budget. Additional budgets are available from the Major Flood Protection Recovery Fund account for major repair work required following greater than a 1 in 25 year flood events.

Approximately 80% of the river channel has been maintained within the preferred channel alignment. Only small lengths of cross blading have been required in recent years (average of 130 metres p.a. over the last 3 years).

Despite the increase in rock edge protection, vegetation remains a key method of river channel management, accounting for 49% of the bank edge protection provided along the Waikanae River. On average, between 1995 and 2009, 400 willows have been planted each year.

Tree clearing, willow layering and willow planting are undertaken each winter after the asset inspection and/or after significant flood damage. Tree clearing has been routinely carried out to replace old and dangerous trees to ensure river channel and flow paths are maintained and provide areas for native vegetation restoration.

The invasive Booth Willow species are being systematically replaced with single stem hybrid willow varieties. The replacement tree willow species provide similar benefits in terms of root stability and are more easily managed. The WFMP (section 4.5.6) ecological guidelines for willow planting have been followed.

Willow planting, pruning and layering have been carried out each winter to ensure stability of the river edge. Generally where no other edge protection exists, willows have been planted within the 20m buffer either side of the design channel alignment, where necessary.

Depending on the flood risk in particular areas, the full 20m buffer widths are not always needed for bank edge protection in all areas of the river. Opportunities exist to interplant with natives or replace willows outright. This has been implemented in places along the river.

It is recommended that the guidelines in the WFMP are updated to consider and implement native interplanting and reduced buffer widths where appropriate in the river corridor.

Planting of Native Trees and Shrubs

The WFMP states that 10% of the GW willow planting budget be used for planting and maintaining native species. This has evolved somewhat with the Friends of the Waikanae River taking over this role with establishment of a nursery for the propagation and planting of eco-sourced native plants. GW provides financial and managerial assistance to the Friends of the Waikanae River (FWR) with site preparation and maintenance of native species planting by the FWR. The FWR plant approximately 3500 native plants annually. The group also has an advisory role in floodplain management on behalf of the Waikanae community.

The WFMP requires changes to reflect the current approach to achieve native planting. This requires updating sections 3.3.2.3 and section 4.5.6 ‘Guidelines’ in WFMP to reflect progression with FWR.

Programmed Major River Works

River realignment and bank edge protection works, as recommended in the WFMP, that have been completed are Otaihanga (part), El Rancho, Jim Cooke Park, River Glade, Kebbels, Edgewater Park and SH1. The major works in place during the 1998 and 2005 floods performed well. The exception was the Kebbels grade control weir and some rock groynes between Jim Cooke Park and SH1, which have experienced erosion on a number of occasions and have required topping up, as expected.

River realignment and bank edge protection works identified in the WFMP that have not yet been carried out are at the mouth, Otaihanga and Greenaway Road.

- At the mouth there is minor erosion of the south bank and the main river channel has moved southward outside the design channel alignment. This is possibly caused by sand build up on the northern side of the channel opposite the Waimanu Lagoon. The area requires monitoring and should be assessed in detail during the proposed 5 yearly gravel analysis to be undertaken in late 2010. Options to be considered include doing nothing (other than ongoing monitoring), gravel/sand removal and bank edge protection works. Major works in this area will need to be consistent with the management practices in the scientific reserve and coastal marine area. A memorandum of understanding enabling the integration of the management of the mouth for flood mitigation with the management practices in the scientific reserve needs to be developed with DoC.

- At Otaihanga, further bank edge protection works may be necessary in the future. The area will need to be closely monitored.

- At Greenaway Road the river channel is on a long left turning bend and the willow and block line edge protection works are regularly eroded on both sides of the river. Cross blading, gravel extraction and edge protection maintenance has been necessary over the years to prevent serious erosion of the existing edge protection and access ways on the north and south banks. The programmed major works to provide a permanent solution are channel realignment and rock lining and/or rock groynes.

At this stage there are no proposals to carry out any of the above major river works.

Summary of overall achievement:

Length of river realignment in WFMP	Length of river realignment completed	% complete
4060m	2400m	59

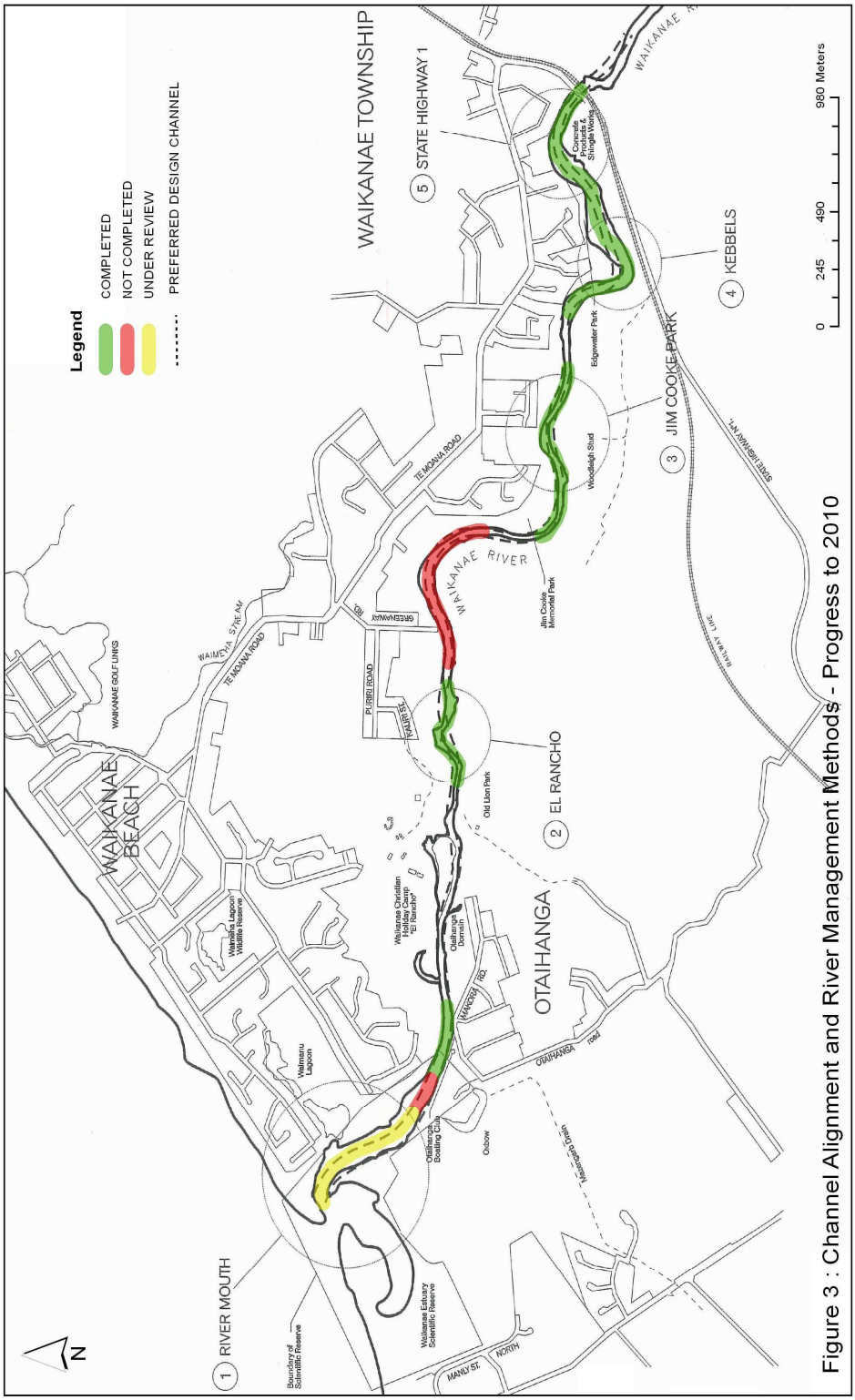


Figure 3: Channel Alignment and River Management Methods – Progress to 2010

Gravel Extraction

Gravel extraction has been carried out annually to maintain overall bed levels at the status quo (1991 surveyed levels) where possible, and hence maintain the agreed channel capacity of the river.

Cross sections were initially surveyed in 1991 and subsequently in 1995, 1999 2004 and 2010. Bed levels from these surveys were analysed and recommendations made for locations and amounts of gravel to be extracted. Overall the results show a general trend of aggradation (gravel build-up) from the mouth to Jim Cooke Park (JCP) and degradation (gravel erosion) above JCP. The change from aggradation to degradation coincides with a change in grade in the river.

The 1995 gravel analysis resulted in a recommendation to continue extracting 3000m³ of gravel annually, in locations where the build-up of gravel had been identified.

Following the 1999 bed level survey it was recommended that work be initiated to determine optimum bed levels for the lower reaches of the river. This resulted in a resource consent (WGN 020106) being obtained to extract a further 35,000m³ (through wet extraction behind bunds), over 5 years 2002-2007, from the lower Waikanae River to remove the gravel build-up that occurred following the 1998 floods. Wet extraction of gravel within the Coastal Marine Area (below Queens Road) was excluded because of objections received to the notified resource consent application.

The amount that could be physically extracted during the 5 year period under the consent conditions amounted to 30,815m³. This occurred mainly in the Pukekawa reach (above the east end of Makora Road). It was not possible to extract within the tidal reach (Queens Road to the east end of Makora Road) because of consent conditions, water levels and site constraints.

Analysis of the 2004 survey results (Reference 17 of Appendix 1) showed that aggradation below JCP had increased by 33,000m³ since 1999 and 83,000m³ since 1991. This resulted in the annual extraction volume being increased from 3000m³ to 9000m³. The survey states that the objective was to extract within the reach between Sections 70-220 and hence minimise the requirement to work in the DOC scientific reserve and coastal marine area.

Over the 3 years 2007/8 to 2009/10, an average of 1,770m³ of gravel was able to be extracted per annum under the current resource consent conditions. This occurred in the Pukekawa and JCP reaches, between El Rancho and JCP. The wet extraction consent expired in September 2007 and present resource consent conditions only allow extraction on the dry beaches (dry extraction), 100mm above water level (Reference 24 of Appendix 1).

The 2004 gravel analysis report recommended that:

- Flood Protection applies for an amendment to their resource consent to enable extraction from below water level.

- Supply the results of the survey to DoC and discuss the implications. If appropriate, seek their approval to proceed with extraction in the tidal reach. This approval should be sought as part of an overall agreement to undertake river management works in the Scientific Reserve.

The above tasks have not yet been implemented. Further recommendations in the report included:

- A study of the impacts of the erosion in the upper catchment following the 2005 flood to determine what benefits would be gained from greater controls on vegetation cover in the upper catchment.

- Reconsider the river training approach above JCP to determine whether more bed control structures may be required to minimise bed level degradation.

It is recommended that these be revaluated in the proposed 2010 gravel analysis.

A limited cross section survey was carried out in 2008 which showed that:

1. About 10,000m³ of fine gravel had accumulated in the Otaihanga Reach, at the upstream end of the scientific reserve (Sections 50-80); and
2. A further 10,000m³ of sand had accumulated further downstream within the River Mouth Reach and scientific reserve (Sections 20-50).

This has had the effect of raising the 1 in 100 year flood level at the Makora Road by less than 50mm (Reference 18 of Appendix 1).

It is recommended that the aggradation/degradation issue be considered as part of the proposed 2010 gravel analysis. This analysis should include:

- The existing WFMP management measures for the river mouth (section 3.3.3),
- Issues highlighting adverse effects of river management activities (section 4.5.2),
- Ecological guidelines (section 4.6.6);
- Providing a variety of alternatives to address gravel build up sedimentation issues long term (section 4.6.5, 4.5.5); and
- That these matters be included in a Memorandum of Understanding (MOU) with DoC, based on section 4.2.3.2 of the WFMP.

River Mouth Management

The river mouth has been inspected on a regular basis to ensure that the existing rock groyne at the mouth continues to operate effectively, the sand level between the groyne and the beach is generally below high water spring

tide level and that mouth cuts are carried out when required. Minimal maintenance has been necessary since the mouth was last cut in December 2001. It was expected that a mouth cut would be required every 5 years but only one has been required in the 12 years since the WFMP was adopted.

An agreement (MOU) with DoC to integrate the management of the mouth for flood mitigation with the management practices in the scientific reserve is recommended. Flood mitigation works potentially include routine maintenance, mouth cutting, gravel/sand removal and possible future edge protection works within the Scientific Reserve. These works together with non-structural measures and monitoring may become more crucial with future climate change.

Further studies on river mouth migration and coastal processes are suggested to determine the most appropriate form of mouth management into the future.

Monitoring of River Processes

The monitoring activities as described in the WFMP (Section 3.3.5) have by in large been carried out and improved as described below:

- Advances in technology have resulted in improved aerial photography of the river. Since 2001 high level aerial digital colour photographs have been produced at 2 yearly intervals or after a 20 year flood or greater. These are integrated with GIS to provide multiple layers of information such as assets and contours. This information has proved invaluable for monitoring the changes to the river particularly following floods and the construction of river management works.

- Bed level surveys have been undertaken every 5 years as well as after the 2005 flood. The bed levels from these surveys were analysed and recommendations for annual extraction volumes were reported to GW and actioned, where possible.

- The location of the mouth and the level of sand build-up at the mouth are visually checked several times each year.

- Annual reports recording work done, including dates, location and type of work, etc have been completed as a consent requirement. Costs are not included in these reports but are recorded elsewhere. Work done and records of the assets performance have not been linked to the aerial photography and this work remains outstanding.

- Flood damage reports have been produced following all major floods.

- Asset management records are updated annually and a report on the condition of assets has been produced annually. A SAP asset management system has been recently implemented (2009) which will be capable of linking and analysing all the information gathered.

- In the most recent Flood Protection Annual Asset Management report to GW (Reference 19 of Appendix 1) it was reported that the Waikanae River flood protection assets are in good condition. Waikanae River assets are currently valued at $6.7M. The only asset that requires major improvement is the JCP stopbank, which is due for a capital upgrade in 2013/14.

- Significant implications for the flood hazard on the Waikanae floodplain as a result of monitoring have been reported to GW through 6 weekly manager's reports, annual asset management, operations and WFMP progress reports and other reports as required.

- The effectiveness of flood mitigation works has been monitored regularly by routine site inspections and recorded in quarterly/annual operations reports, flood damage reports, asset management registers and GIS records.

- Monitoring of the river has proven to be a useful tool in understanding the river processes, taking preventative measures and planning to manage potential flood risk on the floodplain.

A continual improvement approach to flood mitigation methods is necessary in order to update the mechanisms for implementing improved practices. This includes applying new methods in between major reviews. A regional research programme is being established in 2010 which will look at ways of improving current techniques in flood risk management and applying best practice to these techniques.

River management techniques undertaken as part of routine maintenance are subject to outcomes of ongoing monitoring and research. These outcomes may result in alternative methods to reduce potentially adverse effects.

The WFMP states that major reviews of river management practices be undertaken at 15 year intervals. It is recommended that further reviews be undertaken in an ongoing manner (based on a continual improvement approach), as and when new data/research becomes available".

3.6 Prepare and implement an Environmental Strategy

The Waikanae River Environmental Strategy was produced in 1999 (Reference 22 of Appendix 1) and is currently being reviewed and this review is due to be completed in 2010. The Waikanae River Ecological Strategy report (Reference 23 of Appendix 1) was produced shortly after the environmental strategy (as a condition of consent) and provides the overall framework for ecological restoration in the river corridor long term. An additional reach has been added to the environmental strategy to put effect to environmental enhancement above the SH1 Bridge (Reikorangi Reach).

Discussion is needed around strengthening the link between best practice for flood risk management in the WFMP and methods to implement this. One alternative could be to change from the existing design guidelines in the

WFMP to environmental principles (as reflected in the OFMP). The WFMP could follow the same approach, with delegation of updated design guidelines to both the Waikanae Environmental Strategy and the Environmental Code of Practice or, they could be reflected in the WFMP and environmental strategy.

Proposed changes to update existing WFMP or other recommendation

- Update the methods section to reflect progress on the Environmental Strategy (rename environmental outcomes).

3.7 Environmental Outcomes

The linkages between planning and implementing flood mitigation methods and guidelines to direct how effects can be minimised (through sections 4.5.6 and 4.6.6 and the Considerations section of the WFMP), are unclear. There is a need to develop policy that outlines the relationship between structural methods/river management and minimising effects on ecological, heritage and landscape values through improved practices (see Environmental Code of Practice/Environmental Strategy).

Emphasis needs to be placed on best practice guidance and the Environmental Strategy for implementation of the above policies. It is noted that the Otaki Floodplain Management Plan (OFMP) outcomes section provides a direct link between its flood risk management methods and the impacts on the environment. The OFMP states:

"*Environmental principles have been devised for situations where flood mitigation methods have potentially adverse effects; especially on ecology, landscape, recreation and heritage issues…The Environmental Strategy will identify opportunities for environmental enhancement within the Otaki River environment (see section 3.6).*

The Environmental Principles and Strategy will work in conjunction with a Code of Practice, providing environmental standards for river works carried out anywhere in the Wellington Region" (p.22); and

"The Strategy will provide a structure and framework for enhancing the environmental values of the River Corridor from the gorge to the river mouth. It will guide Council's structural and river maintenance works, non-structural methods, and the management activities of other parties involved in the River Corridor (see Figure 12). It will identify areas where particular management or action is needed, and provide an overall framework for individual actions. It is intended for use by agencies and individuals involved in environmental management. They will use it to link their core functions and management plans into a joint management approach for the Otaki River Corridor and its environs (p.41).

Appropriate management of the river directed by the Strategy, should result in enhanced environmental values.

The Council will implement its responsibilities contained in the Environmental Strategy after discussions with other agencies involved in the management of the River Corridor. This will help to ensure that other agencies 'buy into' the Strategy and use the document when they undertake their own work.

The Code of Practice will set out the Council's environmental standards for all river maintenance and structural works. Because good work practices are generally the same for all rivers, the Code of Practice will be applied regionally (p.41)".

Proposed changes to update existing WFMP or other recommendation

- It is recommended that the WFMP refocuses its outcomes and methods section to incorporate the same approach as the OFMP.

3.8 Capital and Operational Budgets

Capital expenditure details are shown in Section 3.2, Table 3 and Section 3.3.2.4, Table 4 of Attachment 1.

Capital expenditure to date for stopbanks, road raising and house raising was $1,250,000 ($1997). The budget for these works was $1,745,000 ($1997). The overall budget to complete all the works was $3,640,000 ($1997).

Capital expenditure to date for river realignment and bank edge protection works was $2,130,000 ($1997). The overall budget to complete all the works was $2,850,000 ($1997).

Operational expenditure has been maintained at approximately $65,000 pa ($1997)

3.9 Considerations

This section of the WFMP is based on environmental, economic, social and cultural issues and corresponding policies, objectives and methods. The considerations section guides the floodplain management approach of WFMP. Based on this review and the current floodplain management approach, where existing methods or actions need refocusing, the considerations section has provided the policy intent of the document and details what we want to achieve and whether we have done so. The considerations include:

- The Physical Environment (river processes, gravel management, river mouth and coastal environment, climate)
- The Human Environment (the community, industrial/commercial, infrastructures/services, economics)
- Maori
- Ecology
- Recreation/Landscape/Heritage
- Planning and Land Use

The majority of considerations in the WFMP remain valid. Some changes are recommended as detailed in Section 3 and the Outcomes Document (Appendix 1). The most significant of these are:

- Updating the policies to reflect the current flood risk management thinking
- Use of the avoidance approach
- Moving the considerations section in front of the outcomes section of the WFMP

4. Issues and recommendations highlighted by review

4.1 Climate Change

Provision of design parameters in structural and non-structural measures to account for climate change

Explanation

The objective in the WFMP is "To plan for the effects of climate change" (Section 4.2.4.3). Recent guidelines from the Ministry for the Environment (MfE) made recommendations for how local government should assess and plan for the likely effects of projected climate change during the 21st century.

Recommendations for climate change in accordance with current MFE recommendations have been included in the hydrology report (Reference 1) and hydraulics reports (Reference 2).

The overall effects from MFE mid-range climate change predictions would result in an increase of flood levels along the Waikanae River below SH1 by up to 200mm by 2040 and up to 400mm by 2090. The upper limits apply to the tidal areas at Otaihanga and Waikanae Beach. To account for this level of predicted climate change, existing and proposed flood mitigation measures would need to be upgraded and updated flood level advice for proposed developments would be required.

In February 2010 GW's Flood Protection department adopted a climate change criteria for future investigations and design work as follows:

- The increase in rainfall intensity to be used for calculation will be 16%
- The Sea Level Rise to be used for calculation is 0.5m by 2100.

Any selected climate change design criteria will likely change over time.

Proposed changes to update existing WFMP or other recommendation

- Discuss climate change implications with KCDC.
- Update WFMP policy to include agreed climate change policy in accordance with MFE recommendations.
- Confirm 1 in 100 year flood levels to account for climate change and how to deal with this.
- Update flood maps to account for climate change in accordance with GW policy.

- Determine policy for dealing with completed and proposed structural and house raising works to account for climate change in accordance with GW policy.

- Carry out a long section survey of existing stopbanks to confirm the extent and locations for the required top-ups to account for climate change. Update WFMP with agreed position on heights of stopbanks.

- Check actual raised house levels and compare with the updated 1 in 100 year flood levels including climate change.

- Update Figure 8 in the WFMP to include climate change.

- Investigate climate change implications for houses in Otaihanga and Waikanae Beach and agree GW policy for managing this.

4.2 Hydraulic modelling of the floodplain

Updating the hydraulic modelling of the floodplain

Explanation

The hydraulic review (Reference 2) updated the hydraulic model along the river channel, stopbanks and Otaihanga. Results show that the existing GW stopbanks, except at JCP, have been constructed close to the updated 1 in 100 year flood levels. However in the lower reach of the river, 1 in 100 year flood levels (including climate change) have increased significantly.

The investigations did not include full hydraulic modelling of the floodplain. This was last undertaken in 2002 when the flood hazard information was updated in KCDC's Plan Change 50.

The model could be further improved with updated LiDAR (ground level) data and the improved two-dimensional modelling tools along the entire floodplain. This would have particular benefit along the river berms and adjacent flood ponding areas. The model could then be combined with the KCDC hydraulic model to provide more accurate flood areas and depths to the general public.

Proposed changes to update existing WFMP or other recommendations

- Remodel the floodplain with climate change and updated LiDAR data and the improved two-dimensional modelling tools. Cost estimates are to be prepared for this work and included in the LTCCP.
- Combine the GW and KCDC hydraulic models and provide updated flood maps to the general public.

4.3 Non-Structural Methods - District Plan Provisions

Building levels on existing lots presently not being built to 1 in 100 year flood levels

Explanation

The WFMP states that "*With new subdivisions, every lot should have a building site above the 1 in 100 year flood level"* (Section 3.1.1.3). However existing lots only require building levels to the 1 in 50 year flood level, in accordance with the Building Act 2004. KCDC advise that approximately 350 vacant sites could still be in filled within existing residential areas identified as being within the 1 in 100 year flood spread. These sites would only require building levels to the 1 in 50 year level as there is no rule in the District Plan to require infill development to be built at the 1 in 100 year flood level recommended by GW.

Proposed changes to update existing WFMP or other recommendation

- Outcome of review of building permits and resource consents to be raised with KCDC.
- Discuss 1 in 50 year building level vs. 1 in 100 year building levels with KCDC in relation to changing the District Plan.
- Update flood maps to account for climate change in accordance with GW policy.
- Update WFMP to reflect proposed RPS policies 28, 50 and 51. (Reference 4 of Attachment 1).

Lack of control on building levels for development in areas that would flood in greater than I in 100 year event.

Explanation

The district plan has no rules regarding minimum floor levels in flood risk areas that would flood as a result of breaching and overtopping of flood protection structures (such as stopbanks or flood works) built to the 1 in 100 year flood event.

The information is available to the public through GW/KCDC advice and the KCDC website. These areas are described as residual overflow and residual ponding.

The WFMP presently deals with these areas under the community preparedness methods. (Section 3.1.2)

Proposed changes to update existing WFMP or other recommendation:

- Discuss controls (e.g. minimum floor levels) for buildings in residual ponding areas with KCDC.
- Discuss extreme event implications with KCDC.
- Delete references to fringe and extreme categories and add Residual Overflow Path, Residual Ponding and Erosion Hazard.
- Update conditions to reflect WFMP section 3.1.1.3 (iii) – page 29.

4.4 Work Priorities

Re-evaluate priorities for proposed flood mitigation measures (Section 6.2.5)

Explanation

The priority of works in the WFMP (Table 6) has changed as follows:

- Priority 1 - Fieldway Bridge lengthening, and Priority 5 - Waimeha Golf Club stopbank, have not occurred because of uncertainty about flood discharges from the Waimeha and Ngarara Streams and a lack of catchment information, rainfall data and historical flooding in the area.
- Priority 2 – JCP realignment has been completed.
- Priority 3 - Otaihanga road raising was completed, except Makora Road west, because of objections received from local residents.
- Priority 4 - River Corridor land purchase has increased by 5% mainly in conjunction with capital works upgrades.
- Priority 6 - Otaihanga house raising is programmed for completion over the next 4 years.
- Priority 7 - JCP stopbank is programmed for reconstruction during 2013-2015.
- Priority 8 - Otaihanga to Mouth bank protection was partly completed in early 2009. No further works are presently proposed.
- Priority 9 - Kebbels realignment, together with realignments at River Glade, Edgewater Park and SH1 were completed following damage caused by the 2008 floods.
- Priority 10 – Lion Park Ring bank is not currently programmed.

The Otaihanga floodwall has also been completed. However recalibration of the hydraulic model, as a result of the 2005 flood, means that the revised 1 in 100 year flood design level estimate is 470mm higher than the top of the floodwall. Climate change would add a further 230mm to the 1 in 100 year flood design level. There are also issues with local stormwater building up behind the floodwall that needs to be addressed.

Full detail of the present status of works is given in Appendix 1, Sections 3.2 and 3.3 and Appendix 2.

Proposed changes to update existing WFMP or other recommendation:

- Detailed analysis of KCDC review of the Waimeha/Ngarara hydraulic analysis is required to ascertain whether the Fieldway Bridge lengthening is required.

- Update WFMP to remove the Fieldway bridge lengthening and Golf Course stopbank if required.

- Carry out further investigations regarding the performance of the Otaihanga floodwall: Confirm flood levels, liaise with KCDC concerning local stormwater system and check stormwater easement stopbank height - top up if required to contain flood waters from the overflow path.

- Investigate options to protect houses in Makora Road west (numbers 2 to 22) from the 1 in 100 year flood event, including an agreed allowance for climate change.

- Check current status of flood proofing 61 Makora Road and if required possible options for flood mitigation.

- Reprioritise all proposals based upon the above investigations.

- Consult with KCDC at an early date regarding the proposed JCP stopbank encroaching onto the existing playing fields.

- Consult with property owners regarding the proposed JCP floodwall and environmental effects.

- Analysis/research needs to be completed to ascertain if the incremental change in current state of the 'mouth' (now wholly contained in the scientific reserve) is significant enough to bring any programmed major river works forward.

- Based on the regional research programme looking at the effects of flood mitigation works, undertake a review of river management practices in 2012/13 and ensure methods are reviewed and changed in an ongoing manner, based on new data/information that becomes available.

4.5 Gravel aggradation in the lower reaches

Confirm current policy to extract gravel at a rate approximately equal to the rate at which it is entering the river. (Section 4.2.2.4)

Explanation

Past surveys have shown that gravel is building up in the tidal reach between Queens Drive and the east end of Makora Road. However the current resource consent does not permit extraction below water level, hence full extraction of built up gravel in the tidal reach is presently not possible. In addition surveys carried out in 2009 have shown that there is an increase in gravel/sand build up within the coastal marine reach (below Queens Drive).

Proposed changes to update existing WFMP or other recommendation:

- The proposed Waikanae River Gravel Analysis 2010 will re-evaluate the recommendations in the Waikanae River Gravel Analysis 1999-2004 (Reference 17 of Attachment 1). This review will consider gravel extraction through the tidal reach and sand aggradation upstream of the mouth.

- That in conjunction with KCDC, the Waikanae Headwater Vegetative Framework is investigated further in terms of developing and implementing a works programme for landowners to restore upper catchment vegetation.

- Evaluate the results of the 2010 gravel analysis based on existing WFMP management measures for the river mouth (section 3.3.3), issues highlighting adverse effects of river management activities (section 4.5.2), ecological guidelines (section 4.6.6) and methods (section 4.6.5, 4.5.5, in terms of providing a variety of alternatives to addressing gravel build up/ sedimentation issues long term.

- Develop MOU with DoC - based on section 4.2.3.2 of WFMP.

4.6 Upper catchment erosion issues

Confirm policies:

- *To encourage conservation forestry in erosion-prone areas in the Waikanae catchment through the Kapiti Coast District Plan (Section 4.2.1.4)*

- *To encourage land owners and other users to minimise lateral erosion of river banks above the water treatment plant(Section 4.2.1.4)*

- *To encourage riparian management: (Section 4.7.4)*

- *To discourage subdivision involving further clearances of the upper catchment, and that may destabilise the area*

- *To encourage reforestation of the upper and middle catchment through district and regional plans*

Explanation

Overall there has been limited success in controlling upper catchment erosion.

Between 1999 and 2004 it was estimated that 7,600m³/year of gravel has been eroded from the upper Waikanae River catchment, much of which is deposited in the lower reaches of the river channel. This is greater than the previous calculated inflow rates of 3000 to 5000m³/year. (Reference 17 of Appendix 1)

In recognition of the desire to improve soil protection and water quality, GW Environment Division and MFE engaged PA Handford & Associates to work with landowners in the headwaters of the Waikanae River to develop a catchment level vision for planting and vegetation management that provides wide catchment and community benefits.

The Boffa Miskell report in 1993 (Reference 6) concluded that although afforestation on a mass scale would not reduce peak flood flows significantly, it would be advantageous to not allow any further development of the upper catchment that is, clearing of native bush. Over time it was recommended that the steeper grazing slopes be planted to help stabilise them and reduce erosion. The research also found that afforestation was seen to improve the water quality and reduce sediment transport in the river channel. The downside was a reduced summer water yield in the river.

It is recommended that this issue is discussed further with KCDC in order that it is incorporated as primary objective in the proposed Open Space Strategy.

It is also suggested that the WFMP policy be changed to:

- Encourage KCDC to protect upper and middle catchment remnant bush
- GW and KCDC coordinate restoration work in middle and upper catchments with landowners - based on the Waikanae Headwaters Vegetative Framework, particularly on slopes steeper than 30º'

This should include a study to determine what benefits would be gained from greater controls on vegetation cover in the upper catchment.

Proposed changes to update existing WFMP or other recommendation:

- Raise with KCDC – with view to incorporating as a primary objective in proposed Open Space Strategy.
- Recommend that policy is changed as follows:
- 'Encourage KCDC to protect upper and middle catchment remnant bush' (and)
- 'That GW and KCDC coordinate restoration work in middle and upper catchments with landowners - based on the Waikanae Headwaters Vegetative Framework, particularly on slopes steeper than 30º'.
- Request that the Waikanae Catchment be included GW funded 'Streams Alive' programme for private landowners and riparian management
- A plan of action is agreed upon between KCDC and GW based on the Waikanae Headwaters Vegetative Framework.

4.7 River mouth management

Confirm objectives and policies:

- *To integrate the management of the mouth area for flood mitigation with the management practices for the scientific reserve (Section 4.2.3.3)*

- *To continue managing the mouth area in the same way that it has been managed in the last 10 years. (Section 4.2.3.4)*

- *To gain better understanding of the river mouth migration, to enable more informed decision-making. (Section 4.2.3.4)*

Explanation

Gravel and sand is building up upstream of the mouth adjacent to the Waimanu Lagoon and Queens Road (see "Gravel aggradation in the lower reaches" above).

Further analysis/research needs to be completed to ascertain if the incremental change at the mouth and lower part of the Otaihanga Reach (now wholly contained in the scientific reserve) is significant. Recent research by Dr Jeremy Gibb noted that recognition should be given by GW to "allow for the migration cycle of the river mouth to continue as a natural process …as it rejuvenates the Waikanae Estuary, and not attempt to constrain such migration by constructing training works at the mouth" (p.20) (see Reference 15 of Attachment 1).

An MOU is required with DOC in order to integrate the management of the mouth for flood mitigation with the management practices in the scientific reserve.

Further studies on river mouth migration and coastal processes are suggested to determine the most appropriate approach to flood risk management at the mouth into the future.

Proposed changes to update existing WFMP or other recommendation

- Evaluate the results of the 2009/10 gravel analysis based on existing WFMP management measures for the river mouth (section 3.3.3), issues highlighting adverse effects of river management activities (section 4.5.2), ecological guidelines (section 4.6.6) and methods (section 4.6.5, 4.5.5, in terms of providing a variety of alternatives to managing gravel build up/sedimentation issues long term.

- Develop a MOU with DoC - based on section 4.2.3.2 of the WFMP.

- Determine the trigger point at Otaihanga or carry out further investigations to determine the necessity of retaining this requirement.

- Surveys are carried out to determine the level of sand build-up at the foredune.

4.8 River corridor land purchase

Confirm priorities for land purchase within the river corridor

Explanation

The objective in the WFMP in the long term is that the remaining 56 hectares of privately owned land in the River Corridor be brought into public ownership (section 3.1.1.4).

The total land area in public ownership in the river corridor has increased from 71% to 77% since 1997. Land purchase has taken place primarily as a result of implementing the capital works programme. Reserve contributions through subdivision have not been significant at this stage.

There are a number of locations where the design river channel and buffer zones are located on private land. It would be advantageous for these areas be brought into public ownership to enable better control for river management purposes and access for the general public.

Proposed changes to update existing WFMP or other recommendation

- Discuss current strategy and timing for river corridor land purchase with KCDC.
- Investigate options for purchasing privately owned land within the river corridor (including the design channel and buffer zones).

4.9 Environmental Outcomes

Confirm priorities:

- *To minimise the disturbance and damage to habitats and species during river management activities, the construction of flood mitigation methods, and other developments (section 4.5.4)*

Explanation

Discussion is needed around strengthening the link between best practice for flood risk management in the WFMP and methods to implement this. Existing guidelines (section 4.4.6, 4.5.6 & 4.6.6) are not currently linked to the environmental strategy. They also need to be updated based on improved flood risk management practices.

The OFMP has developed overarching environmental principles and directed the implementation of these principles through the Otaki Environmental Strategy and the region-wide Environmental Code of Practice.

Proposed changes to update existing WFMP or other recommendation

- Consider the adoption of the OFMP link between best practice and methods to implement this (refer to Section 3.6 of the OFMP).

- Consider the integration and development of environmental principles and/or guidelines in WRMP.

- Change to Objective section 4.5.3 as follows: “To avoid, remedy or mitigate any potential adverse effects upon the ecology of the river and its floodplain and associated restoration works”.

- Consider a new Policy based on the following: 'To ensure cultural health monitoring is implemented, to ascertain where there are potential adverse effects and other information to better inform planning and design of flood mitigation works and mitigation measure'.

- Insert a new Objective: 'To incorporate restoration opportunities wherever possible, whilst implementing flood risk management methods'.

- Add new policy: 'Where exotic species are used for bank edge protection, implement native interplanting in the river corridor and consider reducing buffer widths (where this may be possible) to encourage restoration (p.63).

- Update Policy: 'Use native plants that are eco-sourced in all restoration sites'.

- Ensure existing guidelines in WFMP are implemented, update guidelines based to 'consider interplanting and reduced buffer widths where appropriate in river corridor' (p.65).

- Develop a policy to ensure that best practice restoration components are provided for effectively in flood mitigation methods.

4.10 Environmental Strategy

Confirm priorities:

- *To protect habitats and species of high conservation value (Section 4.5.4)*

- *To enhance the riparian environment wherever possible*

Explanation

Weed infestation has become a serious issue in the river corridor. As the proportion of land being restored is becoming cumulatively greater, the overall issue of weeds threatens to undermine this work. At present there is limited dedicated funding to prevent and eradicate noxious and other pest weeds. Weed seeds originate from the upper, middle and lower catchments of the river. It is recommended that preventative and eradication measures be investigated.

Proposed changes to update existing WFMP or other recommendation:

- Continue to implement the environmental strategy in terms of enhancing the landscape and environmental values of the river corridor. Incorporate and implement the ecological strategy in terms of a best practice approach to restoration work.

- Continue to revise the environmental strategy document to reflect improved floodplain management approach, completed restoration work and new opportunities in specific reaches.

- Focus on implementing specific actions within each reach, from Reikorangi to Kenakena. Continue to work with stakeholders to achieve

recommendations in the environmental and ecological strategies (DoC, KCDC, private landowners and the Friends of the Waikanae River) in the river corridor and wider catchment.

- Develop a policy to ensure that best practice management for planting and maintenance is undertaken along the river corridor.

4.11 Public awareness/Community preparedness

Confirm objectives and policies to:

- *To maintain awareness of the flood hazard throughout all sectors of the community, to enable people to better cope in a flood. (Section 4.3.1.4)*

- *To reduce social disruption and damage caused by flood events by improving and maintaining community preparedness. (Section 4.3.1.4)*

Explanation

Many people are not aware that they live in a floodable area or how to deal with the consequences of flooding. Those people who are prepared will respond more effectively to floods. It may be appropriate that a review be undertaken to check that GW and KCDC are presently doing enough in the following areas:

- Providing information.

- Public education.

- Flood warning and emergency management

- Disaster recovery planning

Proposed changes to update existing WFMP or other recommendation

- Continue to hold regular joint Civil Defence exercises with KCDC and emergency services.

- Insert section on Post Disaster Recovery: (under 3.1.2 Community Preparedness)

- Implement policy for GW involvement in public education programmes on community involvement or change to reflect what actual practice is. Discuss this further with KCDC.

- Change WFMP to reflect that advice will be given to insurance companies rather than individuals.

- Discuss with Niwa/MetService ways in which forecasting can be improved.

- Update sections of the WFMP – Section 3.1.2.2, Appendix C: Regional Civil Defence Operations, Appendix D – Kapiti Coast Disaster Response procedures, Appendix E – National Recovery Plan and Appendix F – Flood Warning System.

- Discuss with KCDC whether there is any uncertainty with the responsibilities of KCDC and the GW with regard to flood preparedness and response.

- Ensure planning processes for post disaster recovery are in place, including information relevant to communities' long term sustainability, in areas adversely affected by flooding.

5. References:

1. McKerchar, A. (2009). NIWA Client Report : CHC2008-158 - Review the Flood Hydrology of the Waikanae & Otaki Rivers (WGN DOCS #605875)

2. Wallace, P. (2009 & 2010). River Edge Consulting - Waikanae River Hydraulic Model Update (WGN DOCS #692316 and #805312)

3. Flanagan, J. (2010), Climate Change (WGN DOCS #741469)

4. Atapattu, D. (2009). Greater Wellington Regional Council, Floodplain Management Plan Implementation: Annual progress report to June 2009 (WGN DOCS #704163)

5. Berghan, T (2010) Waikanae FMP 10 Year Review – Consultation Strategy (WGN DOCS #707777)

6. Boffa, D. (1993). Waikanae River Floodplain Management Plan - Phase 2 investigations: Option assessment - Impacts of afforestation on catchment run-off. Wellington Regional Council.

6. Appendices:

1. Outcomes document of the WFMP 10 Year Review (WGN DOCS #654449)
2. Achievements of the WFMP 10 Year Review (WGN DOCS #705656)
3. Location plan of the Waikanae River