The Waiōhine I Rakahanga River Plan
The Waiōhine River Plan

Incorporating the Waiōhine Floodplain Management Plan

Published as Draft Version 2.6 March 2022 incorporating changes following hearings

Waiohine River Plan 12_2

A forward for the Waiōhine

Kei te mihi mahana ki nga whanau o Waiōhine, ki nga whanau o Kuratawhiti me ki nga whanau o Wairarapa. Warm greetings to the families of the Waiōhine, to the families of Greytown and to the families of Wairarapa. Two ways that New Zealand recognises the mana or the importance of water is through viewing water holistically and through its connections that makes our waters integrated. This is not a new concept for people who live in the Waiōhine Catchment. When this community decided they would like to be more involved in some of the characteristics associated with water, flooding, they brought a collective consciousness to this task. The Waiōhine Plan then is the combination of holistic and interconnected views of water in the Waiōhine space we share.

Living in a province named after glistening waters, not just from our waterways, but named after the attachment we have to the place we call home. As a community people who are our neighbours started a journey that considered costs and infrastructure amongst many things, but a community became WAG, the Waiōhine Action Group because our work became about the place we call home. The complexity that is about building a resilient pathway for a swollen river includes the complexity that builds a community.

Making a living in the Waiōhine catchment is more than economic well being, it can also be about environmental wellbeing, social wellbeing and cultural wellbeing. You know you're from the social catchment that is the Waiōhine catchment when you know the river. When you can match the feeling of how a person by themselves, or the feeling with your family, can go to a place on the river because it leads you to a better standard of living. It's the common unity in our community. It's the marker of home that Māori present in the pepeha. Ko Waiōhine toku awa or Waiōhine is my river.

The holistic view of our community and of the place we call home has been a unifying vision, but the whole is made up of different parts, including the Waiōhine. While a river in flood flows at a level and in pathways that are alarming, this is the product of multiple pathways. How all these water routes, from the sky through precipitation, to a surface above the soil and through the soil that might emerge through seeps or springs to connect with the Waiōhine in flood. These are connections we can understand so we can make better decisions in planning for the river that runs through us. The water contacts with different types of soils; a range of habitats for flora and fauna. Water is a foundation resource for people

From an essential element like drinking water, to a commercial opportunity in the agricultural industry and even a recreational place that entertains us. Water can connect with us negatively too as floods threaten to sweep away valuable items like homes, not just the brick and mortar of a house, but the space of heart felt memories of a family. As the Waiōhine Action Group confronted all of these concepts and more ideas, the contributors, from the consistent faces to those who shared the space intermittently, arrived at this, the Waiōhine Plan. Most will see this response as a plan for a joined up community, look just a little deeper, you'll see a catchment, you'll see a river. Ko Waiōhine tatou, we are the Waiōhine.

Rawiri (Ra) Smith, Kahungunu Ki Wairarapa Steering Group, Waiōhine River Living Plan

Detailed table of contents

A holistic, living river plan

This is the first plan produced for the Greater Wellington Region that views the river as a holistic, living, changing entity. It lays out a 30 and 70 year vision for better flood protection and the gradual improvement and restoration of a living corridor, pristine water, flora and fauna (including aquatic species) for better environmental, cultural, social and economic outcomes, for the river, from the gorge to the confluence with the Ruamahanga. It is prepared by the community, Tangata Whenua, all other stakeholders, and GWRC under the leadership of a Project Team reporting to the community and all stakeholders, statutory and otherwise.

We have tried to "walk a mile" in everyone's shoes and recognise the goals and statutory mandates of each group. Wherever we say "community" or "stakeholders'' in this plan, it is an inclusive term, recognizing these inputs and needs.

Significant professional expert inputs have also been made by Ian Heslop, Chartered Professional Engineer (Independent Peer Review), incorporating the findings of BECA (Independent Peer Review), also by Ra Smith of Hurunui o Rangi and Ngati Kahungunu ki Wairarapa, Horipo Rimene of Rangitane and Michael Roera of Kahukuraawhitia, Ngati Kahungunu ki Wairarapa and Rangitane, Report by Tonkin and Taylor (Geomorphic Trends Assessment), Professor Ian Fuller, Professor Russell Death and Will Conley of Massey University, Matthew Gardner of LandRiverSea Consulting, the late Doctor Brett Mullan and Doctor Trevor Carey-Smith of NIWA and many more.

In this plan GWRC have taken the progressive step of agreeing to place the responsibility for researching and creating the Waiōhine River Plan and the inherent ongoing Living Plan, as resting on the collective shoulders of the community, Iwi, all other stakeholders and statutory bodies and GWRC itself and that leadership for this has been taken by the community, on behalf of, and working with all parties, this respects the principles of Te Mana O Te Wai and how it can be practically applied. It is recognized that the legal responsibility for delivering the agreed level of flood protection, amongst other responsibilities, rests with GWRC within the aegis of this plan. The community also recognizes the innovation, foresight and genuine intent for partnership GWRC, Iwi and all that the participating stakeholders bring to this community led plan on an ongoing basis.

Our approach follows the MfE advice:

"All communities and levels of government are able to make sustainable long-term decisions based on the best available information to reduce flood risk."

and we have applied this with regard to the good health, mauri and management of the river; pragmatically, in the Critical Areas where critical infrastructure, assets or culturally sensitive locations are potentially at risk, we have applied the maxim of "a stitch in time saves nine".

The community of the Waiōhine

When this plan says "community", this is what the term embraces:

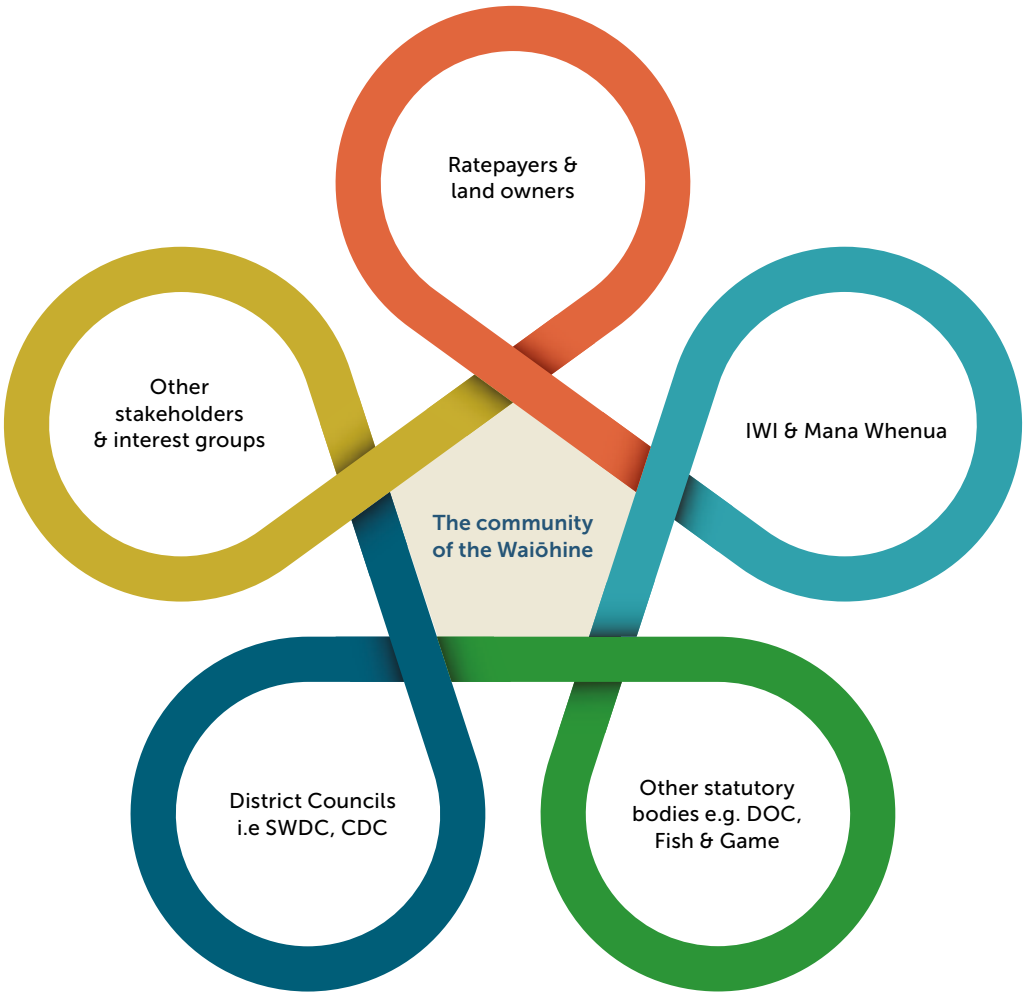


Figure 1: A Community of Stakeholders.

Our approach anticipated Te Mana O Te Wai and honours it's tenets, as depicted by the Ministry of the Environment. The plan embraces:

- Te Mana O Te Wai is understood to be a concept for the wider community, not just Tangata Whenua. It suggests an integrated approach from it's foundations upwards, but with a deep recognition of the special role of mana whenua and Iwi respecting the foundational values of Te Tiriti O Waitangi.
- It embraces the concept of Kaitiakitanga,
- It's building blocks are to be guided by independent subject matter experts and to respect matauranga Māori, the Mauri of water, it's conservation and restoration to a naturalistic state wherever this is practicable.
- It engages the community and tangata whenua, not just in the writing of the River Plan but positive and respectful partnership in the ongoing conduct of the Living Plan – for the next seventy years or more,
- It applies the hierarchy of obligations under the National Policy Statement for Freshwater Management 2020, including the National Objectives Framework For Water (NOFFW),
- It creates a process and framework at the local level for how all stakeholders, including statutory bodies can, without impinging on their existing rights and obligations, work together for the best future of our river for all.
- It is a value led process, reflecting the need to rethink values based upon an holistic accounting for the integral values of the water. For instance swimmability is not just a question of pollutants but also of sediment in suspension. Rivers should be seen from an interdisciplinary, whole perspective, rather than the past "siloed" approach.
- It respects natural indicators of the health and mauri of the water – such as the presence of Kaakahi.
- A whole of river (or catchment) living plan is the logical way to think about Te Mana O Te Wai. If we do this well, we will benefit all and pass the benefit down the river to other communities, other rivers, lakes, the sea and the oceans.
- We need to think in future about the whole transpiration cycle and include groundwater and precipitation in our planning and management. The principal of poutiriao – of rebalancing the earth in the environment – needs joined up thinking.

Figure 2: Essential Water Fact Sheet – MOE.

A whole-of-river plan

As a whole-of-river plan, we must recognize the cultural significance of the Waiōhine. Nowadays, the flood plains of the Waiōhine exist on a very different level than they did traditionally. What we must all hope for and all work for is that important principles might transcend the changed landscape so that a sense of cultural landscape remains. We have sought and will always seek leadership from Māori in understanding the cultural landscape of the Waiōhine, and where opportunities lie to restore its cultural elements, naturalistic elements and beauty. For the whole community, the work of building this River Plan, incorporating Floodplain Management Plan, has been inclusive, and a recognition of the need for a practical, natural, ongoing co-governance model for our river, between iwi, other statutory bodies, community and local government.

Developing a whole-of-river plan that embraces all the hopes and needs of the community, will take time. So this is not a one-time, fixed plan. It includes a Living Plan Process through which topics such as the gradual improvement of the ecological values and amenity of the river can be fleshed out and evolved to take advantage of advances in cultural understanding, science and our societal values.

The Big Picture

Flood protection

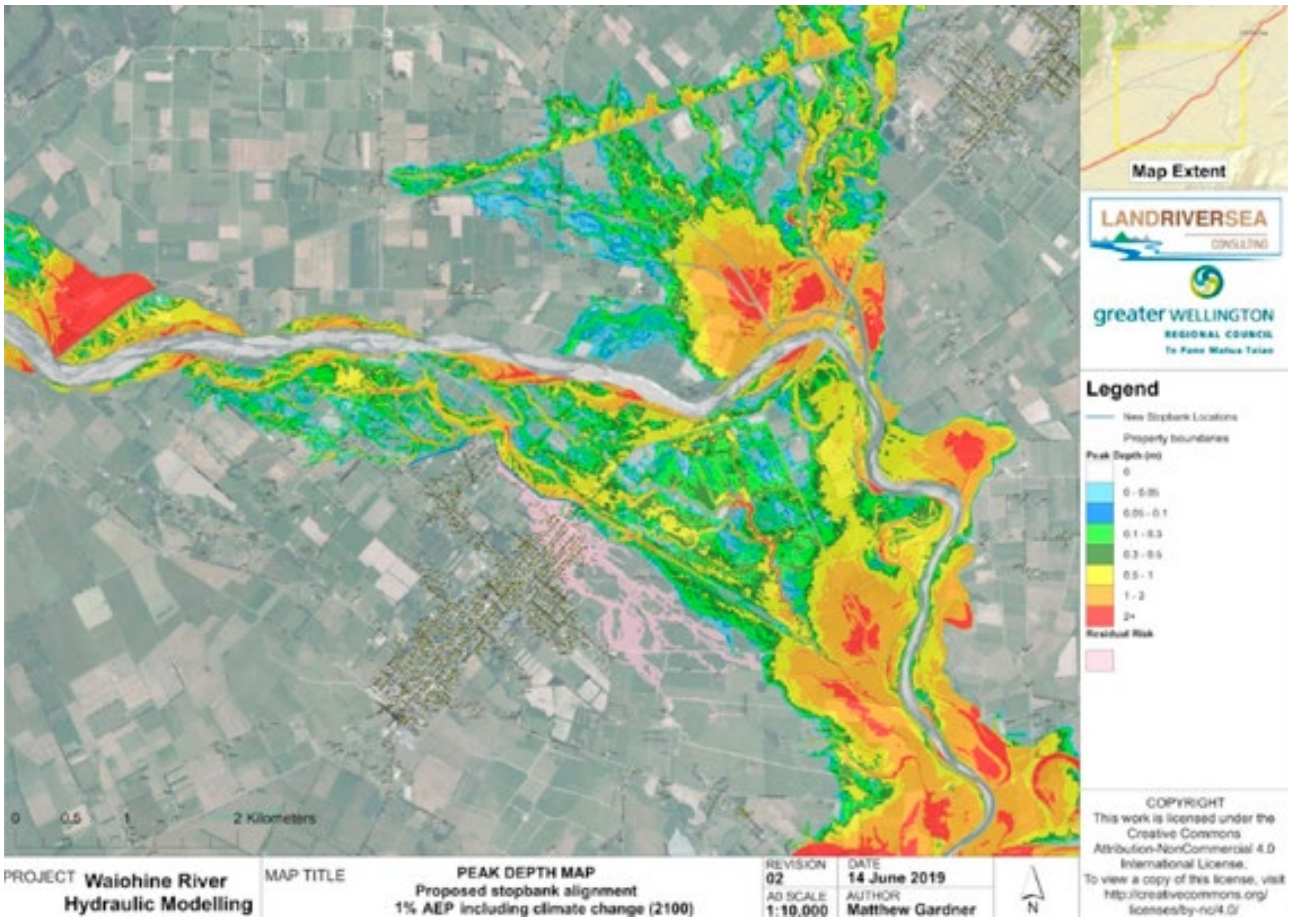


Figure 3: Flood map showing proposed stopbanks as blue lines.

Flood protection is intended to withstand a once-in-a-hundred-year flood for Greytown and a once-in-twenty-year flood for dwellings in the rural area of the floodplain. Allowance has been made for climate change estimates, derived from IPCC scenario RCP6.0, allowance for margin of error of LIDAR surveying and as appropriate freeboard (where wind or velocity might push water higher up the side of an upright structure) or flood sensitivity (where there are reasons why the flood might spread slightly further in some places in some circumstances).

There is, of course, no such thing as a flood that is precisely the shape, duration and behaviour of a modelled one-in-one-hundred year flood (1% chance of occurring in any year) that occurs only once, if at all, in a hundred years. There is nevertheless, a high degree of confidence in the underlying data and accuracy of models and maps used to develop this plan, based upon careful cross-checking against aerial photography of actual floods, multiple flood events and a range of other tools for correlating evidence. Over time this will keep on improving, as more events yield more data and new technology (e.g. more sophisticated LIDAR using drones) are available. We have made provision in the living plan models and processes within this plan, to revise and improve the plan. We have also set an intermediate planning horizon that ensures the plan will be reviewed and updated before 2050, including climate change data.

A living plan

A pragmatic, cost effective and workable compromise has been reached between the need to protect important assets (railway, roads, towns, existing river defences, water supplies, Urupa and homes) and the need to step flood defences back from the river to allow it to assume more of a natural character.

This plan adopts the principles of shared responsibility embraced in te Mana O Te Wai, between the community and GWRC. This Living Plan will continually grow, change, manage and improve the River Plan. Whilst adopting new science and trialling new techniques it will remain faithful to the vision for the river, owned by the community. The vision, targets and requirements of the Whaitua programme and Te Mana O Te Wai are also incorporated here.

A series of "triggers" have been identified and built into the Living Plan section, to identify situations for the Project Team to urgently review this plan and modify it. Also, in its ongoing capacity as an advisory sub-committee to the Wairarapa Committee, it will continue to provide leadership with the community as a partner to GWRC in driving the annual and other planning cycles to keep working to realise the vision.

The Living Plan Process allows us to continue developing and improving the plan and address future questions such as: Should the plan become a catchment plan, in line with other catchment group plans, recognizing the interconnectedness of water? Should it seamlessly integrate with storm water management? Should it address the whole of the Waiōhine – including the gorge itself? Can the plan better respect Māori values, culture and wisdom? What impact are willows having on water levels? How can we improve water quality and water quality measurement, pest management, weed control, access – and many more opportunities. So, we ask that you see this document as a start, not an end in itself.

New flood protection structures

The whole river is approximately 66 kilometres long but the short reach of the Waiōhine, running from above the rail bridge (Cross Section or "XS" 43), down to the SH2 Bridge (XS 17), is a steep gradient, gravel bed, river that has been extensively widened from the rail bridge to Fullers Bend, following a previous strategy for flood management.

The river runs atop an alluvial fan, like a delta above the surrounding floodplain. It carries more water than the Ruamahanga itself at the point they join. The catchment sits deep in the Tararuas, well behind catchments for other rivers, it tends to flood only between October and February and floods last from six to twelve hours and do not tend to pond. The floodplain consists of free draining soils.

New flood protection structures and strategies are proposed. New inland stopbanks are to be constructed along the northern side of Greytown's North Street to prevent flooding into the northern outskirts and, if required, across farmland to the North West of the town, close to Kuratawhiti Street, to protect that side of Greytown. Gradual improvement to existing riverside defences is planned, principally using rock groynes, where the river could outflank existing defences and threaten to set a new course across country. We also rely on maintaining the Apple barrel Floodway as a diversion of floodwater away from Greytown.

Figure 4: SH2 North of Greytown.

River management

Ongoing river management is essential for the flood protection strategy to work and will rely on the maintenance and gradual improvement of most existing riverside flood defences, and work to protect some Critical Areas. For example, work needs to continue to gradually improve the protection of the outside of Fullers Bend, with a combination of rock lining and, where practical, snub-nosed rock groynes. Where the river can safely move within buffer zones and develop a more natural "hourglass" shape, this should be allowed but a set of guidelines for preventing this getting out of control and threatening things like stopbanks, town water supplies and so on, have been developed. Gravel extraction will have to continue to be carefully used to manage bed levels, for the purpose of erosion control and flood prevention but more closely surveyed and mostly restricted to specific tasks in Critical Areas, to allow for more precise management by agreement between the community and GWRC.

Where extraction occurs, **recommended extraction methods** have been identified, to minimise impact on the natural character of the river and to have "less than minimal" impact. In some cases, these will be leading edge techniques, proposed by internationally recognized experts. These techniques should be trialled and closely monitored, to prove their ecological value.

Whilst measures of bed level have been made recently, there is insufficient data yet to cover all the cyclical behaviours of the river (See Tonkin and Taylor re: Interdecadal Pacific Oscillation) that cause the gravel bed to build up or lower. Continued measurement is necessary, until a full picture of bed level behaviour can be built up and a long-term strategy finalised, this is expected to be before 2050 (when a compulsory review of this plan occurs anyway).

We recommend using Management of the height of the crown of SH2 in three locations between Greytown and the SH2 Bridge (XS 17).

There is a need for selective planting along the foot of, and extending the end of, the existing Greytown Stopbank. Small, rock, groynes are needed at the toe of and at right angles to that stopbank, that will prevent scouring in the event of a major flood. There is an urgent need for the introduction of flood risk warning signs at locations where the public accesses the river.

Three zones as one way of informing river management have been identified: i) the ideal path or design lines, within which the river will normally run, ii) buffer zones that allow some movement and an "hourglass" or "beaded", shape to develop and iii) the floodplain, where some features and stands of trees will play an important part in spreading and slowing the river in a major flood.

Recommendations are made for a practical approach to planning options for the area between the vegetative buffer zones, bordering the river, and the extent of flood risk. These show high, medium and low flood risk areas, informing District Council planning decisions..

Cost and funding

The capital cost of the proposed stopbank works and related programmes is estimated to be less than $2 million.

It is recommended that where this relates to construction of new stopbanks near North Street and Kuratawhiti Street, this cost should be amortised over 25 years that is, gradually paid for from rates paid by all urban Greytown ratepayers and those rural ratepayers immediately benefiting from the new defences. This is roughly estimated to cost up to $80 per annum on average per ratepayer within the new flood defences. All other works and programmes are recommended to be funded through the existing rating models.

Governance and partnership in the Waiōhine river living plan

MfE States that the local government's aim for flood risk management is: *"Sustainable river and catchment management that achieves the particular level of flood hazard protection desired and accepted by each distinct community of interest, with residual risks fully understood and taken into account."* Planning principles set by this community input to this process have guided decision making and should continue to do so, they include: A whole of river plan. A Living Plan, guided and overseen by the community together. We have taken the concept of co governance and partnership to a new level, one that, to our knowledge, has never been attained before. Our approach complies with law and regulation, and respects and builds on the Memorandum of Partnership between Tangata Whenua ki Te Upoko o te Ika a Maui and Wellington Regional Council. Previous processes recognised the need for some co-governance. The new method builds on this and embraces:

Co-research – all parties (in the room as Project Team Members, the community and subject matter experts) used open and transparent sharing of information and a range of ways to participate.

Co-development – all parties (in the room as Project Team Members, the community and subject matter experts) used open and transparent sharing of information and a range of ways to participate.

Joint decision making – all parties (in the room as Project Team Members, the community and subject matter experts) used open and transparent sharing of information and a range of ways to participate.

Co-governance – The Waiōhine valley community shares governance through both the Steering Group and Wairarapa Committee.

Community participates in the process, through open and transparent feedback by all those not in the room being received and actioned by the Project Team.

Extensive consultation with a wide range of subject matter experts was invaluable and was also shared openly and transparently for feedback.

Frequent public meetings, including drop-ins and discussions encouraged the community to participate directly in making key decisions, such as which flood defence scenario to adopt.

For example, tangata whenua and iwi participate directly in the core Project Team, the Steering Group, the GWRC Wairarapa Committee and the GWRC Environment Committee as well as the Waiōhine Action Group and public meetings.

This approach applies to both the initial plan development and for the Living Plan – taking a long term view that takes into account the needs of all stakeholders, bodies and influences (such as Iwi outcomes and cultural imperatives, Whaitua, Climate Change, amenity) We will continually learn and acquire more facts, so we must make decisions now, that don't box us in – e.g. taking an adaptive management approach (i.e. a Living Plan) to key aspects such as housing and stopbank locations and making allowance for future upgrade to, for instance, meet future needs.

We must incorporate and improve Whaitua outcomes, in a pragmatic way, as it is an essential building block for our vision, for our river. We must use assessment tools that are simple, transparent and where everyone can see their views considered, to meet the needs of as many people as affordable and practical. We must recognize that past decisions mean that some reaches of the river may require more intensive channel maintenance, but we must be able to explain why this is, to each other, and for example, how river management/stopbank locations are interrelated to the community. The overarching principle of community leadership is proclaimed to be a success by GWRC.

We recommend that it continues for the future of our river.

Figure 5: Each Project Team Working Day's outputs are photographed and shared with the community via Facebook and emails with summary links and an invitation for feedback and questions.

1

How this document works

A full table of contents is at the beginning of this document

Read through, or click on the topic link below.

1.1 The structure of the Waiōhine river plan

The structure of the Waiōhine River Plan is based on the structure of the mind map put together on project team working day 1!

The intention is to:

1 **Make this River Plan easy to find your way around**, so that you can click on easy links above or use the table of contents or use word search tools to find what you need, wherever and whenever, on any device

2 **Make this River Plan easy to read** and not too complicated or technical to be useful for everyone,

3 **Make it easy to drill down** and see how the River Plan developed – as new information, fresh expert inputs and community feedback changed thinking and made the plan more relevant.

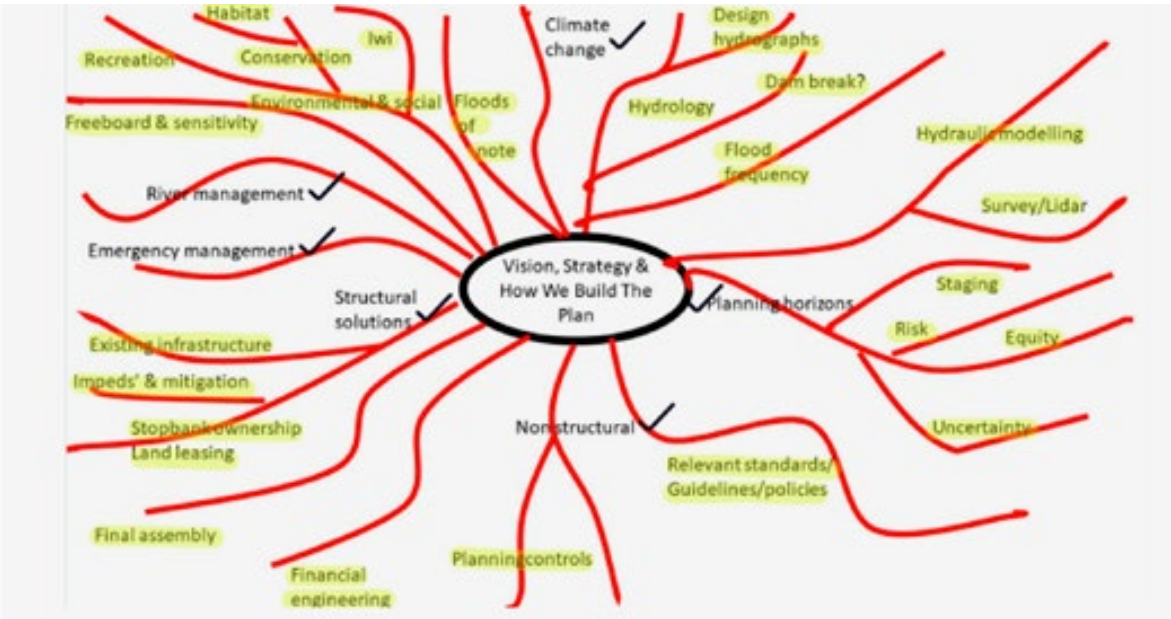


Figure 6: Waiōhine river plan mind map.

The original mind map can be seen above. The Project was broken into 'chunks' by subject, using a mind map technique, and a strategy based on this, was used to develop the Waiōhine River Plan. The many flip charts and white board photos that make up this plan are archived and remain accessible as an audit trail.

Planning horizons were set **and aspects of cost/funding/affordability were chosen**, so stakeholders could understand this and provide useful feedback, when weighed against risks.

Note that Supporting Information, Original Charts, maps and links are retained and are the foundation of the plan. They are shown as examples in the diagram but apply to and can be accessed from links in The Plan and Plan Topics levels. In this way the integrity of the journey, consultation and decision process, is captured for all time, and can be used to retain an understanding of how, and why, decisions were made. Also, the plan allows for the team to change or add elements as the Living Plan aspect of the River Plan develops and adapts, to meet changing needs over time and the availability of significant new data (e.g. restoration strategies and projects, amenity projects, climate change data, flood events or law changes).

Figure 7: Waiōhine river plan Project Team working day.

Throughout the history of this project, the Waiōhine valley community have directly participated in the development of this River Plan through the following widely advertised channels:

1 Open and free participation in the Waiōhine Action Group.

2 Directly choosing and electing community representatives for the majority of the Project Team, who wrote this plan.

3 Facebook, where documentation from every Project Team Working Day has been posted online for reading, comment and question.

4 Public meetings and WAG meetings.

5 Public Drop in Sessions.

6 Sharing information and answering questions at public events.

7 Media releases and Greytown Grapevine articles.

8 Flyers and posters.

9 Speaking to community organisations.

10 Interaction via the "Parking Lot" method.

11 Reports to the Wairarapa Committee of GWRC.

12 Presentation to SWDC, and to joint councils.

13 Invitations to stakeholder groups to participate in Project Team Working Days.

14 Regular emails to an extensive mailing list of interested parties.

1.2 Strategy of the project, the Waiōhine river plan and its living plan

1.2.1 Role of the Waiōhine River Plan Project Team

This River Plan and incorporated Floodplain Management Plan was developed by a Project Team appointed by the Waiōhine community and GWRC. A copy of its Terms of Reference and a description of the working methods can be found at Appendix B.

The Project Team has oversight over production of this River Plan (and Floodplain Management Plan) document on behalf of the community. Everyone has had full access to all the work in progress during the development of the plan and has been able to interact with the plan and process, throughout the project.

Upon completion of the Waiōhine River Plan, the Project Team will continue to lead the Living Plan process as needed by the community, in its current form and terms of reference, but reporting to the community and as a sub-committee to the Wairarapa Committee of GWRC – see Appendix C.

1.2.2 This plan was developed on behalf of all stakeholders by the core of The Project Team (alphabetically)

Mike Ashby (CDC), John Boon (Facilitator and Project Leader), Andy Brown (GWRC Investigations), James Flanagan (Senior Engineer, GWRC), Michael Hewison, Mark Hooker (Team Leader GWRC), Jock McNaught (Engineer GWRC), Michael Roera (Ngati Kahukuraawhitia, Kahungunu, Rangitane, Papawai Marae), Bruce Slater, Colin Wright (SWDC).

Aided by FOW (now WAG) representatives: Ron Sharpe, Tony Waters, Bob Chambers, Rebecca Laird and others.

Hundreds of people: GWRC employees, subject matter experts, stakeholders, community members, landowners and passionate individuals have voted, written, asked questions, suggested changes and improvements, edits and shared valuable information, maps, books, photos, videos and diagrams.

A special thankyou to "Professor RAG" and "Mrs. Smith", without whom this would not have been possible.

1.2.3 This plan is a living plan

It should never be finished or become static. The river changes, legislation changes, cultural understanding and reconciliation advances, communities and economies develop, science grows, climate changes, new threats and triumphs change the needs of flora and fauna, agriculture and land use change, expectations of amenity change.

The most important aspect of this plan is that it offers a process, model and mechanism for everyone who cares about the river and its future, to genuinely participate and have more than just a say but to come together to work towards consensus and find solutions that see the river as much more than a flood problem, a drainage problem, a waste disposal problem, a weed problem and a source of stone and water.

Our children already grow up knowing things we do not, they will find ways to live with the river that we have not. The Living Plan process hands the baton to future generations of our community.

1.2.4 Consulted Stakeholders

A wide variety of community, statutory bodies and stakeholder groups have an interest in the Waiōhine. In alphabetical order (*those with whom workshops were held):

- Academia (Massey University)*
- Adjoining Landowners*
- Anglers*
- Business Owners (within the community)
- CDC
- Community Organizations
- Contractors
- DOC – statutory body*
- Emergency Services (e.g. WREMO)*
- F&B*
- Fish and Game – A statutory body*
- Flora and fauna enthusiasts*
- FOW: Friends of the Waiōhine (now WAG)*
- Gravel extractors
- GWRC Exec*
- Irrigators & water race users
- Kahungunu – statutory body*
- NZR
- NZTA*
- Politicians*
- Rail Trail/Five Trails Trusts*
- Rangitane – statutory body*
- Recreational Users (e.g. swim, boat, canoe)*
- (Residential) developers
- Schools
- Tourists
- SWDC*
- Whaitua*

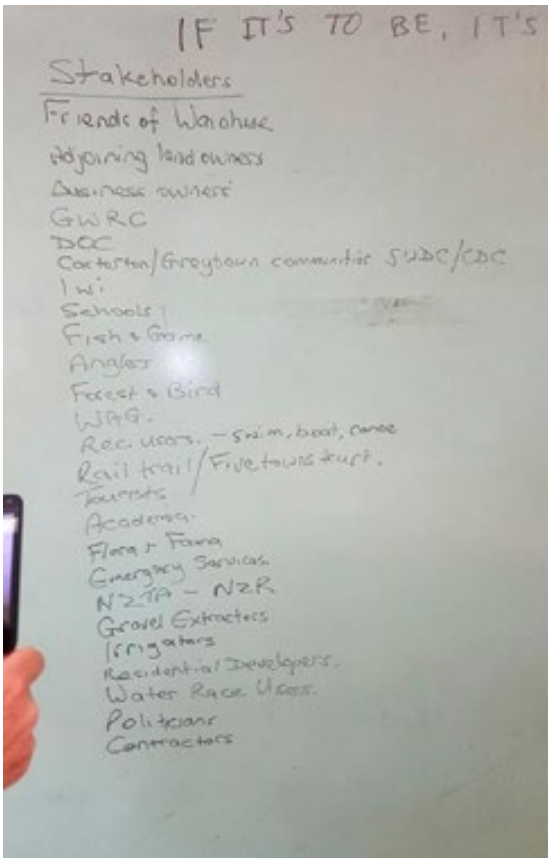
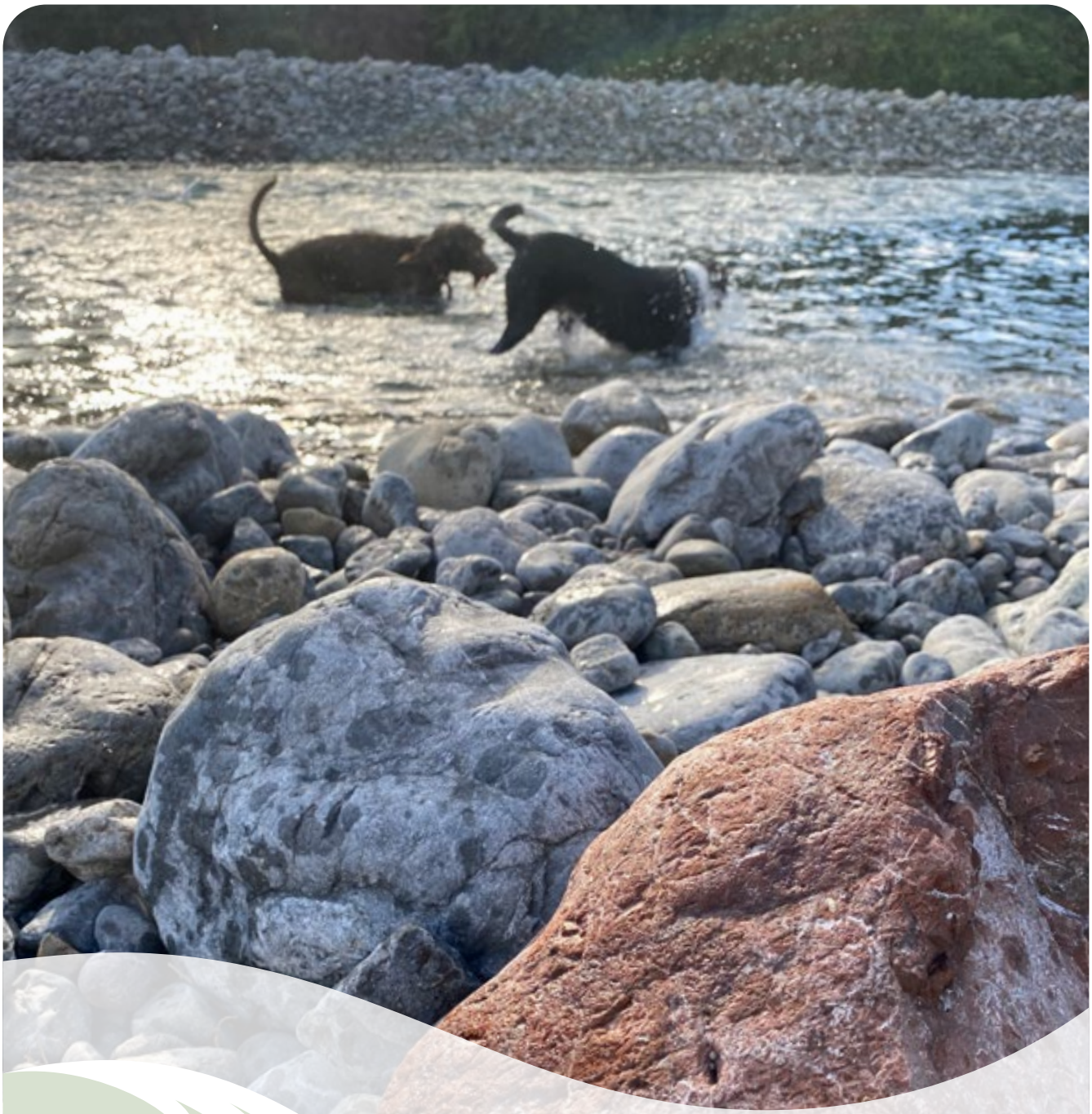


Figure 8: Brainstorm of Stakeholders.

Visions and strategies for all stakeholders are broadly compatible, making it possible to draw these together in a single Living Plan. There is a need to keep looking out for best practices and new data, then weaving this into the River Plan. Represented here are the merged and summarized visions, strategies and concepts identified, as at end of 2019 with further work conducted through 2020 and the beginning of 2021 incorporated as at end March 2021.



2

The vision for the river of the community

The GWRC strategy is that the Waiōhine catchment community should drive outcomes its own way, to set a vision for the catchment, or Freshwater Management Unit (FMU).

2.1 Manaakitanga ki o Papatuanuku (taking care of mother earth) – our vision for our river

The Cultural Impact Assessment written by Ra Smith of Ngati Kahungunu ki Wairarapa, explains that many valued wetlands have been lost through drainage. These included: Papawai, Te Ahikouka and Kuratawhiti (aka Potakakuratawhiti). He states that the author A. G. Bagnall (*Wairarapa, An Historical Excursion*), noted that there were few breaks in the south of the Wairarapa bush cover, *"At Papawai itself there was a much smaller clearing of a few hundred acres and another of approximately the same extent to the north west on the Waiōhine at Ahikouka. The Kuratawhiti clearing, roughly two and a half miles long by half a mile wide, lay parallel to the Waiōhine from which it was separated by a narrow belt of bush."* These clearings might well be indicators of areas affected by flooding, at least in terms of vegetation that did not settle long enough to establish wooded wetlands or dry land forests. On the other side of the river from Kuratawhiti and Ahikouka is Te Uru o Tane, known as an entrance to a forested area, while flood prone, there is an indication that the area was able to recover so it could establish at least wetland forest, typically made up of Kahikatea. On the other side of the river from Papawai is Pukengaki again as the name suggests a hilly area as is still the case today. It is of course a natural stopbank in a major flood event.

It is recommended that a Living Plan strategy of seeing the river and its GWRC environs *(where environ means the area of the river channel between the private property boundaries that run down either side of the river corridor. Includes wetted part of channel, at least some parts of the buffer strip (some of this is on private land))* would benefit from a vision for gradual restoration, to a naturalistic (as distinct from its pre-European natural) state, would best respect its historical and cultural attributes. This plan represents a holistic approach to managing our river and the Wairarapa catchment – ki uta ki tai. We recommend that the vision for the restored flora and fauna of the river should be based upon it being "seen through Māori eyes", empathising with iwi and hapū values, in keeping with Te Mana O Te Wai.

We should use, wherever practical, given the changed landscape and society, Māori understanding of the right flora, fauna and ways to develop appropriate accessible ecosystems as the underlying philosophy, to deliver on the following community vision:

1 A beautiful and safe river for people, flora and fauna.

2 A (linear) park with restored natural beauty, with areas of public access so they can do whatever they want in keeping with the values of the river.

3 Maintaining the best water quality, purity and naturalness and for further conscientious use and local pride.

4 It is our back yard – we want no mess behind Greytown.

5 We must treat it as an holistic living entity, including native fish life and a respect for bird nesting etc.

6 We need to build and maintain practical, unobtrusive flood protection.

7 We will be aware of the whole environment (including the Ruamahanga downstream, Wairarapa Moana and Oneke) and improve it until it will be clean and safe to swim in the downstream lakes in 2090.

2.2 Things we care about for the next 70 Years that require the community and GWRC to work in partnership

1 GWRC will share in good time, with the WAG Project Team and community, all relevant trigger data, events and findings that might inform planning inputs or actions that might need to be taken in between GWRC annual planning cycles.

2 With that in hand, everything listed below will be reviewed by the community including interested stakeholders, prior to each GWRC planning cycle (annual, operational or long term) commencing. New items may be added to this list with the agreement of the Wairarapa Committee. This in no way restricts the other ways in which statutory bodies and other stakeholders may choose to interact.

3 GWRC and the community will share all planning inputs that might affect the river and environs to be discussed as needed, by both parties, prior to the start of each formal GWRC planning cycle.

4 GWRC will produce each type of draft plan that affects the Waiōhine, for instance the annual plan and budget for management of the river, and share this with the WAG Project Team and community, in good time for the community to review it. The community will identify differing views or endorsements and present these along with any proposed initiatives to the Wairarapa Committee at which the GWRC plan is also presented.

5 GWRC will support the day to day running costs budgeted annually.

6 The GWRC Wairarapa Committee will decide what steps, if any, need to be taken where there are significant differences between what the community and GWRC wishes for the river.

2.3 Things that this includes but isn't limited to:

2.3.1 Safety

1 We need reasonably cost-effective measures for the prevention of death or injury between the banks of the river and in the buffer zones. Also, any improvements that can be made to emergency procedures.

2.3.2 Water quality and Te Mana o te Wai

1 Keep improving where and when, on the river, water quality testing is best carried out.

2 Where the results are below target quality, GWRC and the community (linking with Whaitua, citizen science and Mana whenua practising Kaitiakitanga) will jointly define a plan to address any issue including a review of the sample sites as the issue arises.

2.3.3 Flood protection works

The community will monitor the implementation and engagement of the flood defences that are recommended by the FMP. Possible variations to the planned defences will be shared and agreed between the community and GWRC in accordance with the Living Plan process.

The construction of stopbanks, flood protection plantings and other river defence works must be carried out in accordance with this plan. The WAG Project Team and community shall have oversight of their implementation and be party to the planning process for any alterations to the FMP occasioned by the GWRC planning cycles, or any of the review triggers.

The Following Level of Flood Protection is aimed for (with care taken to consider the best affordable level of protection that is practical):

a **Town** – protection from one in one-hundred-year flood plus climate change, freeboard and sensitivity. This applies to Greytown, as flooding of the Waiōhine does not threaten urban Carterton. This level of protection is required for towns and cities.

b **SH2** – no worse than now but with gradual management of levels of State Highway 2, by shaving approximately 100 mm off the crown, in sensitive spots.

c **Fullers Bend** – maintain the status quo but continue to gradually reinforce strength of Greytown side (True Right Bank) defences.

d **Rural** – Attempt to provide protection for dwellings on the floodplain from one in twenty-year floods plus climate change, freeboard and sensitivity.

For new build dwellings **it will be recommended** however that these should be built to withstand a one-in-one-hundred-year flood plus climate change, freeboard and sensitivity allowances.

Apart from the requirement to defend the urban area against one-in-one-hundred-year plus climate change floods, wherever possible the plan must not advantage one area at the disadvantage of another i.e. rob Peter to pay Paul.

2.3.4 Access

1 The community and GWRC will always seek improved access for river maintenance and stone extraction, to minimise impact on flora and fauna where practicable, and for amenity access, where and when agreed with landowners. Care will be taken to protect natural habitats and culturally significant sites.

2.3.5 Commercial use and support for activities that may generate business

1 Any changes in proposed commercial uses of the river is to be discussed between the Iwi, community and GWRC as they arise or are included in the pre-discussion of any planning cycle.

2 Methods of extracting material from the riverbed are set out in detail in this river plan and the subsidiary Code of Practice and will be overseen by the community where it considers this necessary.

3 It is possible that other opportunities for commercial activity might arise beyond the traditional activity of gravel extraction that benefit iwi, tourism and regional development aspirations. Community agreement will be required prior to applying for consents to do business in the environs and the river.

2.3.6 Sustainability of flora, fauna and aquatic life in the gradual development of a wildlife corridor

1 Planning for flora and fauna, including aquatic life, to improve the natural character and beauty will be developed by the community working with GWRC and be incorporated in each planning cycle. The community aspires to incorporate the tenets of the Cultural Impact Assessment (2010) document and the inputs of Iwi, other statutory bodies such as Fish and Game and DOC, recognized conservation groups and organisations e.g. Department Of Conservation.

2 We will restore the natural character of the river (as distinct from the river being "natural" i.e. as it was before humans found it), wherever practical. See Natural Character.

3 A plan to protect nesting birds will be maintained by the community and GWRC. Where rare and protected flora and fauna require extra care, therefore additional expense, GWRC support for this will be requested directly, or through the Wairarapa Committee.

4 Opportunities for and issues arising from riparian plantings will be agreed between the community and GWRC, adjoining landowners, Iwi and other interested parties as part of each GWRC planning cycle.

5 Maintenance of plantings (including necessary ground clearing, spraying and irrigation consents) and the best appropriate use of joint resources, will be planned between GWRC and the community.

6 The Community will work with GWRC to choose the most appropriate measures for pest and weed control. This will dovetail with the Maintenance of Planting and Riparian Planting projects and maintenance. Appropriate protocols will be decided between the Community, GWRC, Iwi, and affected landowners.

7 The community has a long-term vision to enhance specific habitats, such as wetlands, in cooperation with Iwi, GWRC, and landowners willing to participate. The entire Waiōhine River and its environs should become a living corridor for bird life and other flora and fauna to inhabit.

8 Opportunities to enhance the living corridor will be sought by the community and any planning sessions with GWRC should seek to improve this habitat.

9 Actions which substantially affect the natural character and beauty must be decided jointly by the community, including Iwi, GWRC, and other stakeholders. Projects which influence the river environs will require agreement from the community in the planning stage. The community must have oversight in the nature of any proposed activities in the upper reaches via GWRC, DOC or other stakeholders to ensure the river is properly managed.

2.3.7 Water and bed levels

1 GWRC will continue to share all sets of bed level, gravel and water flow and level data with the community as it becomes available. Where issues occur, then GWRC will consult the community on future changes.

2.3.8 Educating the next generation

1 The community will liaise with local schools, enviro-schools and other academic institutions to educate future generations, to develop expertise to address the ongoing living plan and engage future generations. Community engagement with GWRC will provide an opportunity to develop an education plan.

2 Local Iwi knowledge and depth of understanding of the Waiōhine River and its habitat is a valuable resource to help the Community to better plan for and protect the River into the future. The Community will consult with Iwi to see the Waiōhine through Māori eyes, develop knowledge of native plants, medicinal and edible plant sources and information about the health and moods of the River and to identify opportunities to inform visitors to the river about these.

3 The community's long term vision is to support the provision of scholarships for local students who wish to undertake postgraduate study that focuses on the Wairarapa River systems and catchment with a view to helping the community to ensure ongoing expertise and access to the newest learnings to serve the Community. Expertise in the community may serve to mentor and encourage local talent. Scholarship funding may be accessible through the many sources that are available from time to time.

2.3.9 Climate change

The community will receive copies of all relative reports obtained by GWRC relating to climate change that either may, or are certain to, have an impact on the River, its habitat and environs and create or modify plans to mitigate any foreseen risks.

In the event of lack of clarity or conflicting information, GWRC will bring agreed independent experts to offer their advice to the community and GWRC jointly.

2.3.10 Walking, cycling, access tracks and amenities

The development and maintenance of these will be discussed between GWRC, District Councils and the Community. Plans for these projects will be input to GWRC planning cycles.

2.3.11 Protection of sacred places – Waihi Tapu

The community will continue to acknowledge and support the protection and care of cultural and sacred places and cultural practices. It is important that burials are undisturbed in context of any activities in proximity of Te Uru O Tāne Urupa or other known burial sites.

The cultural impact of not acknowledging places of memory is that Wairarapa Māori feel marginalised by work being done in places of significance. A confidential register of memorials should be kept by GWRC at the direction of iwi, or a process of consultation, to ensure care is taken not to damage significant places relating to the river.

If wetlands and/or native flora are used in floodplain buffer zones, a group of weavers could be established to instruct what plants would be best for use in weaving. This approach could also apply to other culturally significant materials.

2.3.12 Sourcing funds

The Community may seek to fundraise for projects to advance its long-term vision of the river or may approach GWRC to jointly fund some projects. Proposals will be input to the Living Plan Process and thence to the Wairarapa Committee.

2.3.13 Events – activities

The community aspires to the river being a site for events from time to time. The improvement of the river and its environs by the community working with GWRC should not exclude this.

The community will require consultation regarding events and activities prior to consents being considered, allowing the community to organise support for activities which are beneficial to the river, and being alerted to any which may impact Iwi rights or the long-term vision for the river.

2.3.14 Keeping our profile high

The community profile will be maintained to provide all stakeholders with regular feedback on activities it is involved with including discussions with GWRC. Communication channels like email lists, Facebook page, and a website will all be used for general coverage. The principal adopted during the FMP process of openness and transparency will be sustained.

2.3.15 Downstream effects

The Waiōhine, Mangatārere and Beef creek have the potential to affect the Ruamahanga and southern Wairarapa lakes downstream through increased flows or degraded water quality. GWRC will discuss with the community, if the Waiōhine has a detrimental effect on waters downstream. The community will liaise with other catchment groups to promote and participate in, where practical, a greater view and vision for Wairarapa rivers and catchments.

2.3.16 Conserving, sustaining and improving our river

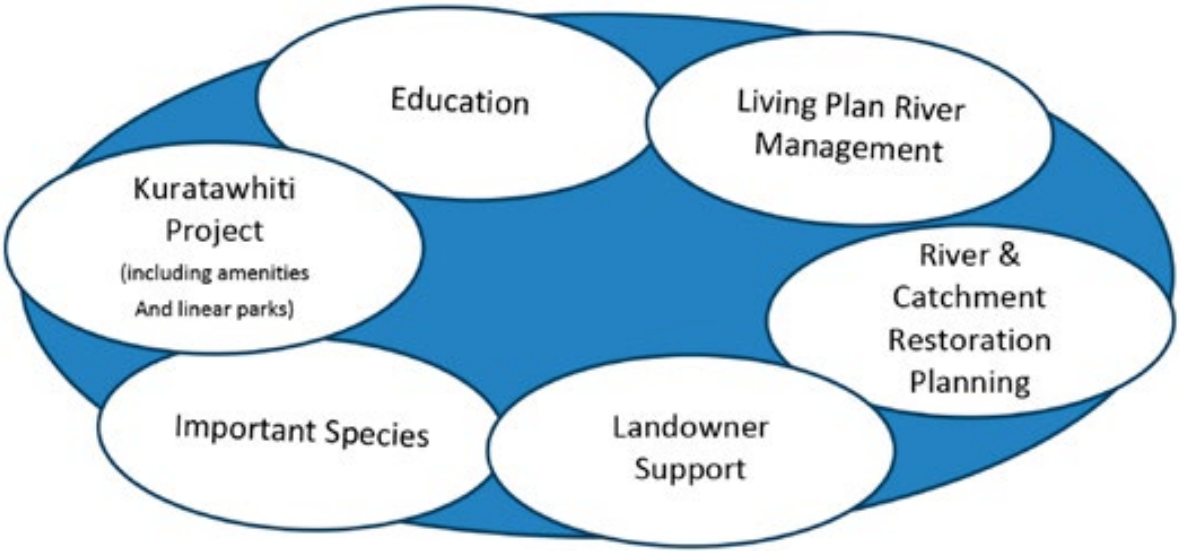


Figure 9: Conserving, sustaining and improving our river.

2.3.17 Conservation, sustainability and restoration strategies

1 We have developed a set of clear statements about how value identification and prioritisation will be set, how decisions will be made reach by reach e.g. balancing flood protection versus river ecology. These statements are our vision for the Waiōhine.

2 Direction is more important than time – we need to have a consistent vision of what the river should be and make sure we are always working and moving closer to realising it

3 GWRC allocates an approximate annual 3% of total budget for the river, to be set aside as river enhancement budget and therefore recognizes the need to sustain and enhance environmental projects.

2.3.18 Freshwater values (incorporating Whaitua)

The concept of a "Catchment Community" to implement the Ruamahanga Whaitua Implementation Programme outcomes is incorporated within the Waiōhine River Plan. Waiōhine has a lot less fine sediment than most other Wairarapa rivers. Flood works do not seem to have had as much ecological impact as may have been thought.

78% Of water quality outcomes, and most macroinvertebrates, come from smaller streams and it can be seen from the illustration below that whilst the river itself has very good water quality, there is opportunity to improve the quality of small feeder streams.

Figure 10: Aerial photograph of Waiōhine valley showing clean water as green and polluted water as orange – Russell Death, Massey University.

2.3.19 Principles for maintaining and improving water quality

2.3.19.1 General

Whilst the Ruamahanga Whaitua Implementation Programme (WIP) has been received in Council, the question remains as to how it is to be practically implemented in a way that meets the general intent of Whaitua.

We recommend that it is for the community in partnership with GWRC to determine how to implement it in a way that delivers useful outcomes and fits to the overall strategy of Whaitua. The carrying out of measurement and working towards Whaitua goals by community catchment groups, such as WAG, is seen as positive.

2.3.19.2 Measurement

As at 2018 the water quality of Waiōhine is rated "A". Ecological Health is rated "C". In accordance with Whaitua, we have set a goal to maintain water quality as a minimum. Improving ecological health is our goal.

We note that the measured natural suspended sediment load is to be reduced to 5% by 2080.

2.3.19.3 Conservation & Restoration Strategies

Objectives that can join up together into a holistic strategy, have been collated from Iwi, FOW, DOC, F&B, F&G, Landowners, Massey University and all other stakeholders' inputs to this plan:

1 Retain the river's natural character of braidedness, backchannels and allow lower high beaches but minimise disturbance to the river itself. Well defined channels are preferable.

> **We recommend** to run Habitat Quality Index measurement every three years, in preparation for revisions to the Long Term Plan, or after trigger events or works, take place.

2 Slow the water down where practical, it helps aquifers recharge and creates habitat. Deep pools are better for aquifer recharge.

> **We recommend** taking care to avoid mobilizing fine sediment in the water ("fines"), which results in:
> a Smothering,
> b Filling in the voids.

> **We recommend** where practical, pools and silt traps should be reinstated or created.

3 Whilst the main river still provides important habitat, riparian planting has the biggest water quality effect in smaller streams.

> **We recommend** removal of 25% of crack willows within a 15 period as per Te Mana o te Wai, and replant with swamp Manuka and others.

2.3.19.4 Water quality measurements should be taken at three locations and eventually meet or exceed Whaitua objectives

1 The beach on the corner of the "Goose Neck" with access off the Waiōhine Valley Road.

2 The beach at SH2 Bridge (XS 17) with access off SH2.

3 The end of Tilson's Road, upstream of the Ruamahanga confluence, downstream of the Mangatārere confluence.

2.3.20 Fauna

1 Fauna (Including Fish and other aquatic life): Implement a "living" realistic recovery plan for the Waiōhine to meet or exceed Whaitua recommendations and to meet the goals of the community between now and the year 2100 including:

a The macro-invertebrate health of the river is to be gradually improved,

b Protect and sustain Dotterels and Black-Billed Gulls that nest along the river,

c Work towards gradually developing the concept of a "corridor" for native birds, that exploits "stepping stones" in the buffer zones and along the river itself,

d Work towards gradually developing more places (pools) where migrating fish can pause and rest when moving up or down the river.

2 Start to designate zoned areas (e.g. dog control to conserve species etc.),

3 It is noted that snub groynes are better for providing habitat for fauna, including fish, than rock walls,

4 Gravel extraction and river maintenance should seek to minimise sediment release into the river and wherever possible, avoid using machines in the wet channel,

We recommend that the known Mangatārere nutrient problem needs to be addressed, as part of the Mangatārere Catchment Plan project, as this feeds the lower Waiōhine.

We recommend that a regular count of pools, riffles and runs should be made and shared with all interested Stakeholders at least annually.

5 Reintroduce Kaakahi.

2.3.21 Flora

1 To collaborate with individual landowners, who wish to help develop joined-up plans, to restore the ecology of the buffers and edges of the Waiōhine.

2 Focus on gradually restoring the planting and ecosystems at the end of Kuratawhiti street on GWRC land, as a priority area, to develop a sustainable environment and amenity for the community and native wildlife.

3 Develop the offer by DOC, for Involvement in planning, planting and advice.

4 Develop and maintain wetlands in buffer zones, to create a "wildlife ladder" or corridor, along the river.

5 Wetlands – seek opportunities for native planting, restoration and sustenance of wetlands.

6 "Ring fence" identified wetlands, engage Iwi and interested stakeholders to jointly develop the best planting strategy.

7 To seek appropriate management of browsing animals on the catchment, within the gorge.

8 Plan and prioritise pest control throughout the river and buffer zones.

9 Where practical, leave room for the river to move around (see River Management).

10 Keep vegetation clear (within the defined fairway) on "dry" beaches, to minimise impact on fauna; mechanical spray work is OK to control weeds vegetation.

11 Consider the use of Manuka and Mahoe as recommended planting, where flood protection is required, as well as Kanuka, Carexes also for underplanting (Germinata).

12 Where there is a general degrade of the riverbed next to high banks, willows planted on the high ground will struggle to hold mass – which can result in bank failure. Planting should be carried out on beaches below the high banks where practical.

2.3.22 Cultural considerations

The whole river is considered taonga. There are historic sites of habitation, Urupa and other sites of significance along the length of the river. **Mana Whenua and Iwi should always be consulted regarding cultural considerations.**

2.3.23 Rural Landowner Considerations

Structural and non-structural solutions are addressed elsewhere. Several landowners occupy rural land adjacent to the river, whilst this brings some benefits, they are affected by environmental and social aspects of the river, including the necessity to site inland stopbanks on their land. Factors considered in the development of this plan include:

1 Impact on commercial use of land for Inland Western (near Kuratawhiti Street) and Eastern (North Street) stopbanks,

2 Impact on farming operations.

There is a desire by landowners that proactive river management must continue, so that flood erosion management for rural land minimises the destruction of viable farmland. The Waiōhine Flood Plain contains some very high-quality agrarian soils, suitable for food production. The project team recognises that these soils may be needed for food production in future years. More Flood control systems may need to be considered at some point, by the Project Team, to protect this type of Farming within the Living Plan.

KEY FINDINGS:

- Target urban areas to be defended against 1:100-year floods plus climate change (1% annual probability)
- Target rural dwellings to be defended against 1:20 year floods plus climate change (5% annual probability)
- Work towards gradual realisation of the vision for the river within the framework of the plan and the Living Plan process.

3 Climate Change

"Our changing climate will affect our economy, environment and way of life. We are uncertain about the pace and scale of future change. We do know that planning for the future means planning for a different climate. New Zealand needs resilient systems able to deal with the scale and pace of change." Ministry for the Environment.

3.1 What we plan for

Climate change will increase river levels in an extreme rainfall event by up to 10% by the year 2050 (high confidence) and up to a further 6% by the year 2100 (low confidence in climate change predictability).

3.2 Why this increase?

There is an overall increase in temperature annually by 2090, which will vary by season. Total rainfall appears to have little annual change, but large seasonal changes. It will rain more on the western side of the Tararua Range. Drought days (over 25 degrees) will increase from thirty to seventy each year here in the Wairarapa. An increase in extreme rainfall events is predicted under RCP6.0 (0-5% increase), it is not known how this is shared amongst the seasons (but the Waiōhine historically floods only between October and February). The number of ex-tropical cyclones affecting New Zealand is unlikely to change due to climate change by 2090, however they will likely intensify, with an increase in rainfall accumulations and wind speeds. It is expected these will mainly affect the Western side of the Tararuas but with rain falling in the Waiōhine catchment, which is deep in the hills. Some research suggests that storm intensity, small scale wind extremes and occurrence of thunderstorms, is likely to increase in New Zealand (Mullan et al. 2011 in MfE 2016). Temperature rise from climate change increases the amount of moisture that can be held in a column of air. This in turn makes rain events more extreme and increases the volume of water in a flood.

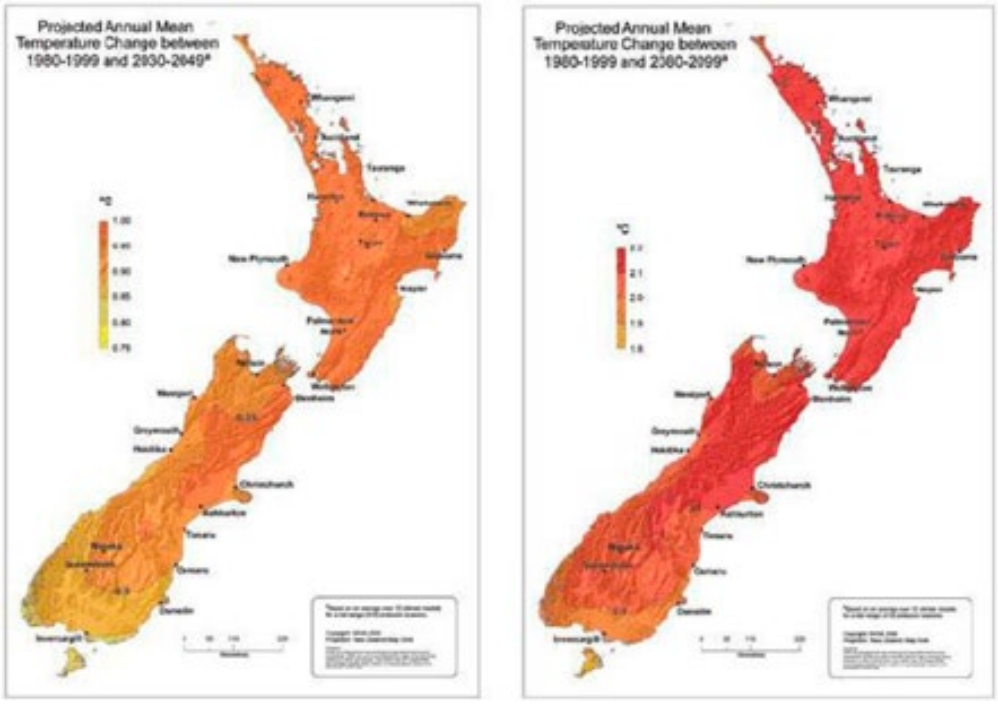


Figure 11: Regional Seasonal Changes in Rainfall – NIWA.

The increase in annual temperatures with a decrease in annual precipitation, may lead to a decrease in vegetation condition in the upper catchment, and possibly even a vegetation community shift (long term). Should this occur, then hillslopes will be less protected during rain events. This suggests that more landslides could occur with smaller rain events, than in the past. This would increase gravel build up in the Waiōhine River, should it eventuate. See Tonkin and Taylor Report.

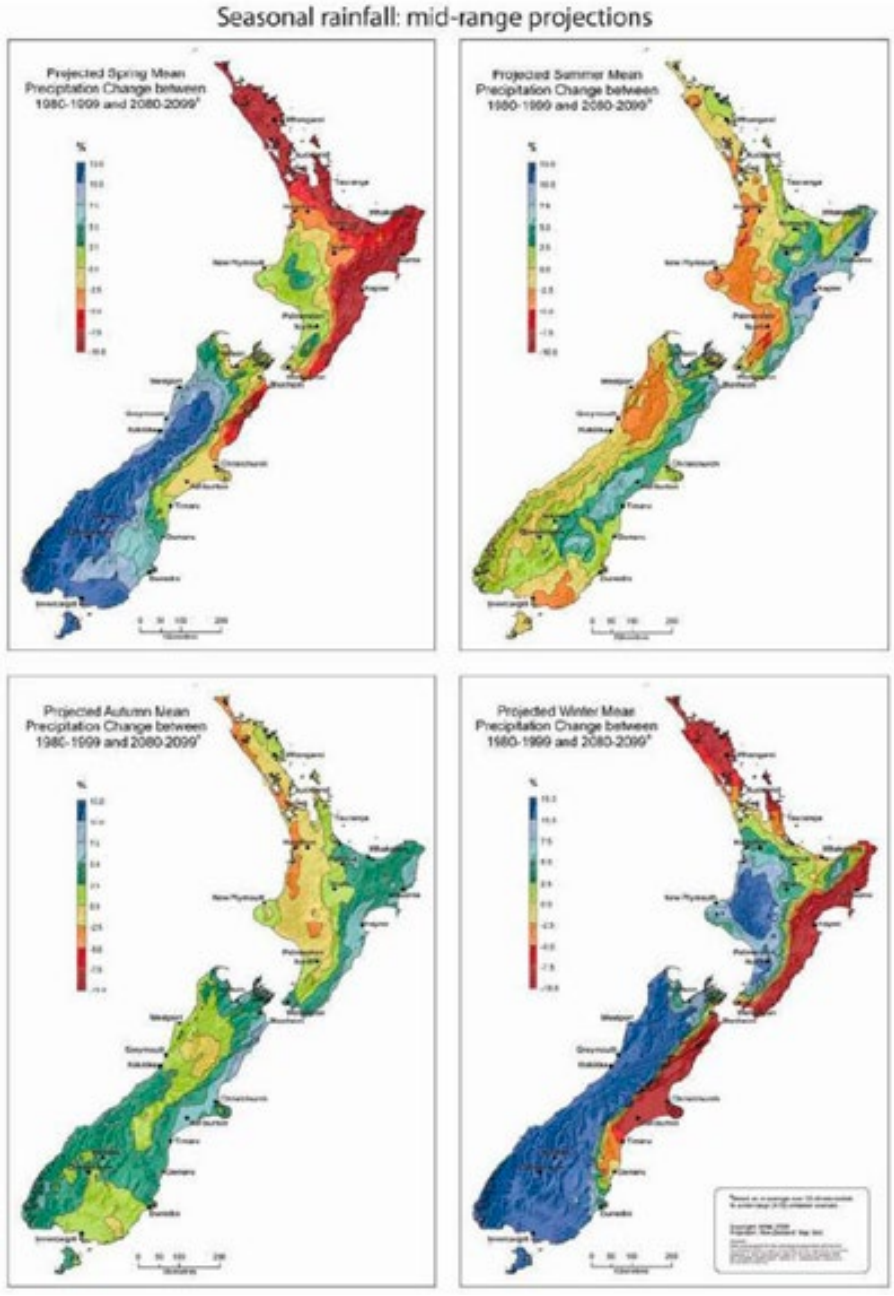


Figure 12: Seasonal Rainfall Mid-Range Projections – NIWA.

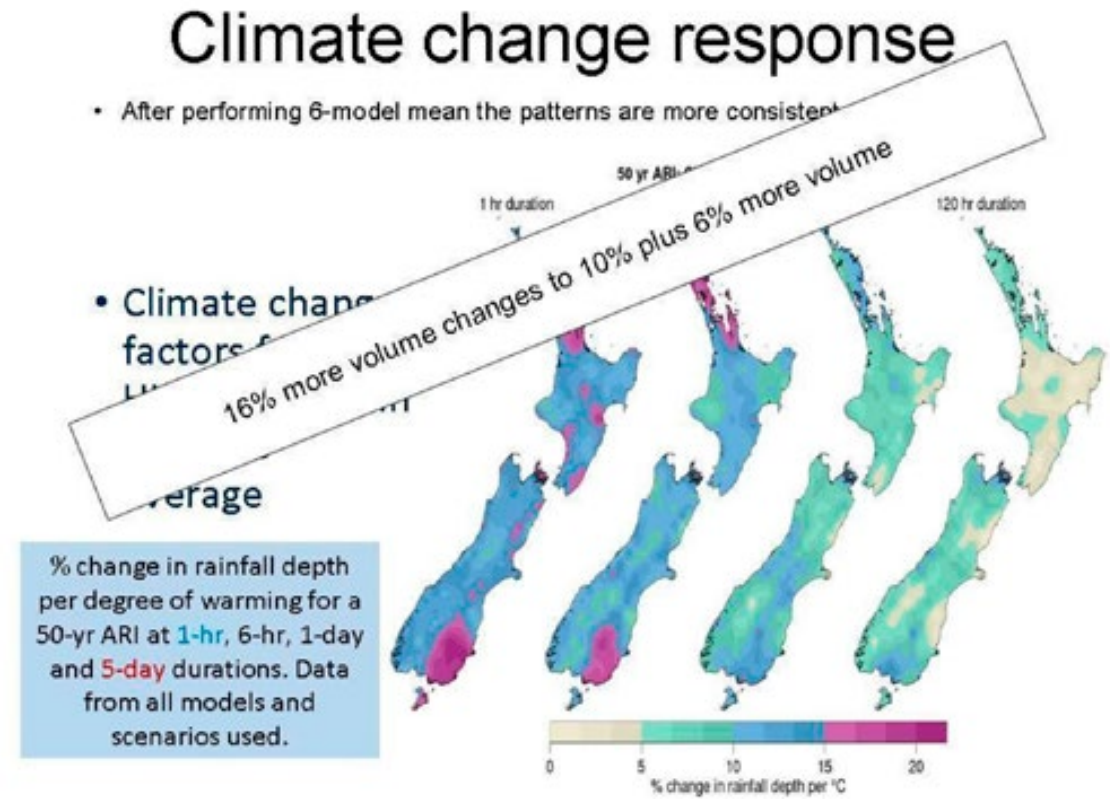


Figure 13: Climate Change Response.

3.3 How much climate change do we think there will be and when?

We have two planning horizons in this river plan, chiefly because of climate change: 2040/2050 and 2090/2100. Climate change is reasonably predictable up until sometime between 2040 and 2050, by then the actions of humans in the meantime, will dictate which of many climate change paths will be set in train between then and at least 2100. So, post 2050, climate change scenarios will be highly divergent (they fan out a lot). Therefore, until we can see what humans do to combat climate change, there can be little confidence in predictions of what path climate change will take, after 2050, and out until 2100.

Whilst current climate change information suggests that we should not need to worry about sea level rise influencing the Waiōhine, as a precaution, we have chosen to include it as a Trigger to be included in the mandated 2050 review.

Note: Further work needs to been done on the impact of climate change on: flora and fauna in the Waiōhine, the upstream effects of sea level rise on flora and fauna in the Waiōhine and the effects of the impact from increases in drought days on river water levels, water tables, irrigation channels, artesian water or springs.

3.4 What did we choose?

After extensive consultation with climate change experts from NIWA, we chose a flood modelling guideline of:

- By 2040/2050 +10% flood water volume and
- By 2090/2100 +16% flood water volume.

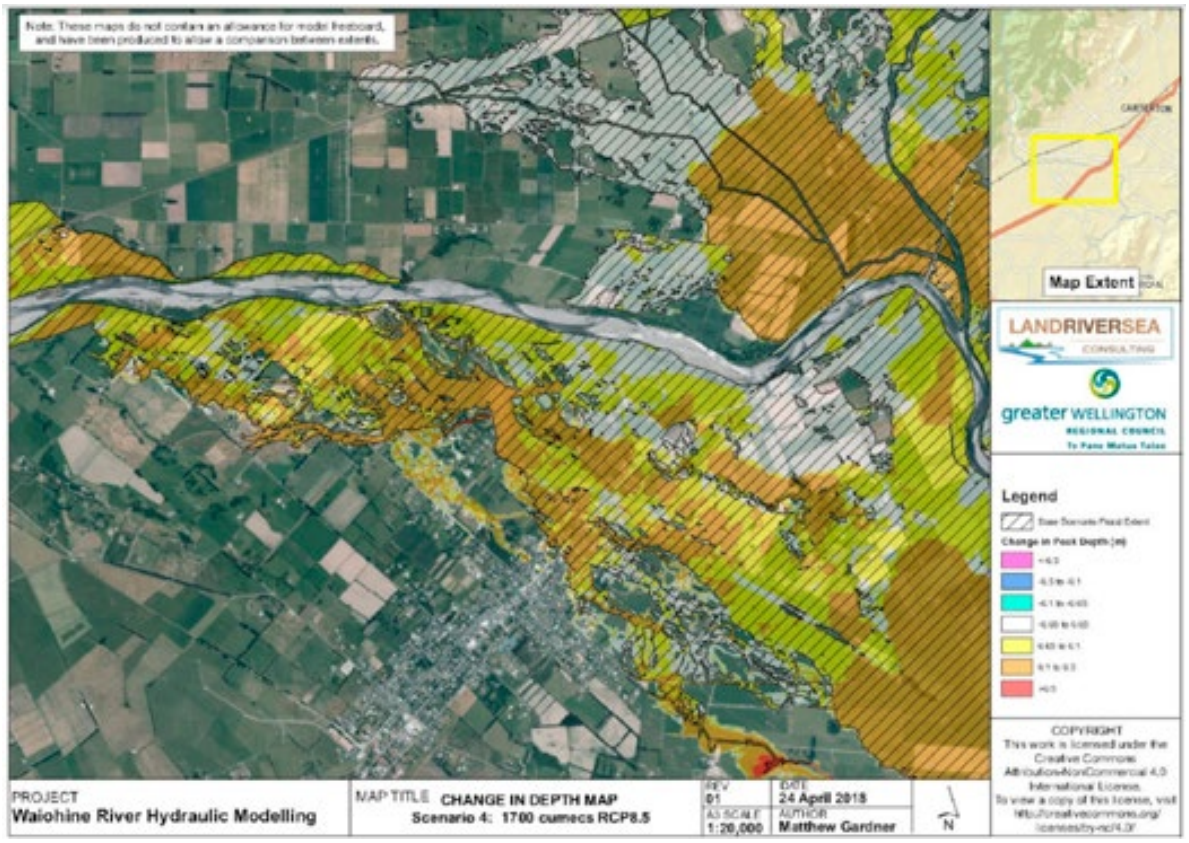


Figure 14: A flood map option showing a severe 1% flood with severe climate change (IPCC RCP 8.5 – landriversea Consulting).

3.5 Where does this come from and will it change?

World-wide data is accumulated and published on an 8-year cycle and of course, more is understood about climate change as time passes. Furthermore, as time passes our base of historical flood data extends and enables more accurate flood modelling. NIWA and other New Zealand agencies work to try to understand what this means to New Zealand. New Zealand has limited climate data measurement and a complex local climate, because of oceans and mountain ranges. So, our scientists must work hard to try to come up with what this might mean to an area as small as the Wairarapa, with limited historical data.

3.6 We expect that as much more information on climate change will be available by 2040/2050

Tools to more accurately model that and ways we can analyse it, will become more sophisticated. There will be a review of the climate change implications by then. So that is an obvious first planning horizon (there are other reasons for this, in addition to climate change). We are obliged to try to plan out towards 2090/2100: so, have that as the second planning horizon – although it is still difficult to predict how severe the impact of climate change will be by then.

3.7 Which climate change scenario did we use?

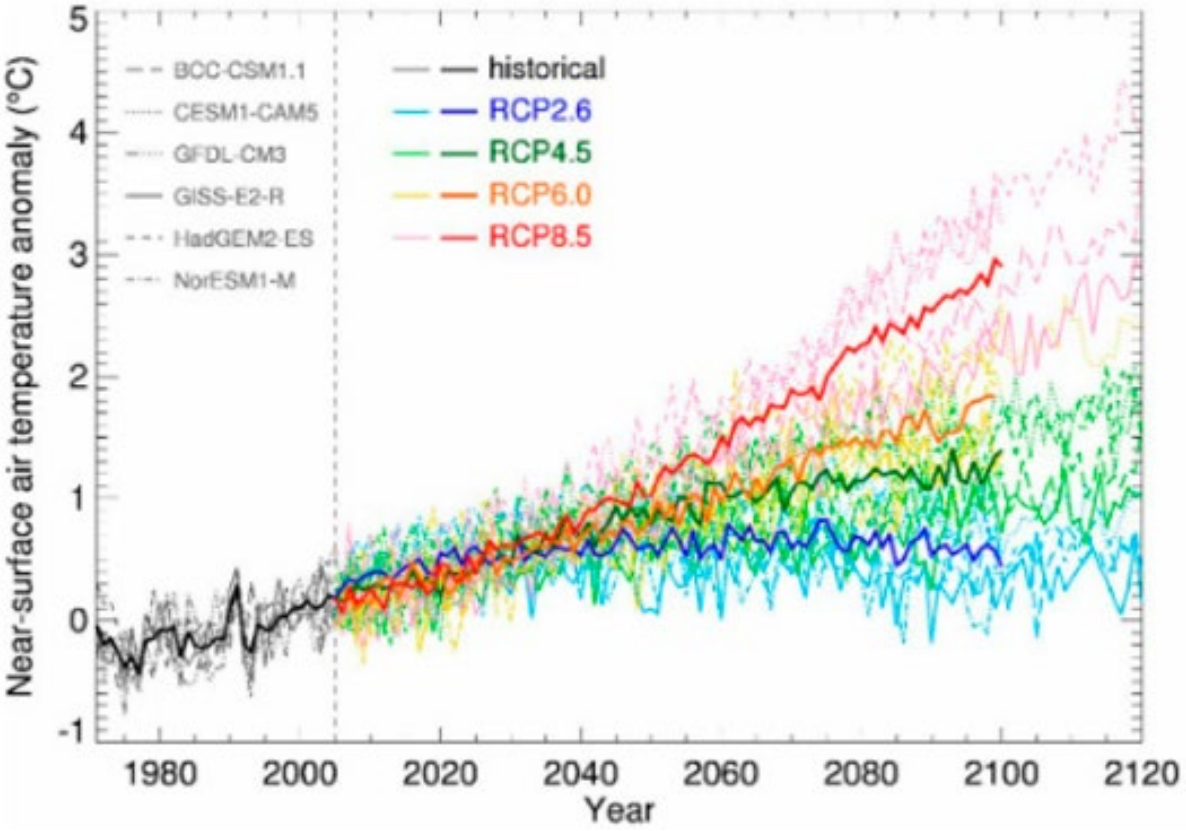


Figure 15: IPCC scenarios diverging – IPCC.

An explanation of climate change as it could affect the Wellington Region can be found here.

3.7.1 We Selected RCP 6.0 – what does that mean?

It's complicated. RCP6.0 is a high mid-range outcome for climate change. It's not as aggressive as RCP8.5, which was created as a worse case scenario, in which the world fails to curb the use of fossil fuels, or take other measures to slow or reverse climate change. RCP 8.5 is sometimes called "Business as Usual" because way back in the 1990's journalists quite rightly latched onto the idea that if we continued as we were then, then disaster was certain – if we carried on with "business as usual". Some things have already changed – some worse, some better. Following discussions with NIWA, the feeling of the project team was to have more faith in humanity than the grimness of RCP 8.5, but we did pick the next worse modelled scenario: RCP 6.0. Of course things will change and the models will improve but this is the best it is possible to do, before new data comes to light. Much more information about RCP6.0 versus other scenarios can be found here.

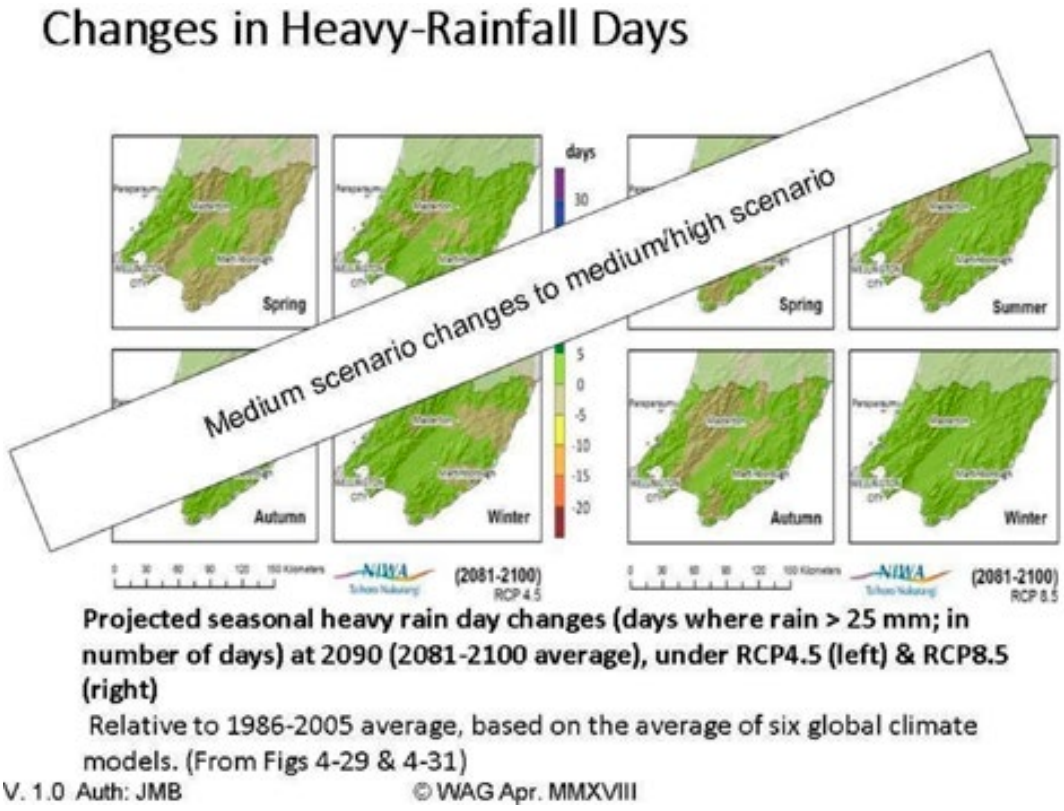
See NIWA's Presentation to the Project Team on Climate Change and on Rainfall factors that influence the Waiōhine.

3.8 Note that floods do not last long on the Waiōhine

Examining data on past floods we see that major floods last between 6 and 12 hours on the Waiōhine.

A worst case 12 hour flood, once in every one hundred years on average flood (1:100), with additional volume of water for climate change scenario RCP 6.0. was looked at as an exploratory model. This gave a modelling guideline of 19.2% additional flood water volume for a 12-hour flood duration at 2090/2100. This will not be used because it is a highly unlikely combination of events, climate modelling out to 2100 is wildly unpredictable and we will review the climate change aspects of the River Plan by 2050, when a lot more data will be available anyway.

The soils of the floodplain are very free draining, so residual flood water drains away very quickly.



Projected seasonal heavy rain day changes (days where rain > 25 mm; in number of days) at 2090 (2081-2100 average), under RCP4.5 (left) & RCP8.5 (right)

Relative to 1986-2005 average, based on the average of six global climate models. (From Figs 4-29 & 4-31)

Figure 16: Changes in heavy rainfall days – NIWA.

KEY FINDINGS:

- +10% increased volume of flood water by 2050,
- +16% flood water by 2100,

We recommend that stakeholders review this:

- By 2050,
- If climate change exceeds 1 degree during that period,
- Or if significant new data becomes available from NIWA.

4 Planning Horizon

We have adopted two planning horizons for the Waiōhine River Plan: 2050 and 2100. Factors that have contributed to the selection of these:

1 Ministry for the Environment (MFE) guidance recommends up to 35 years span of time to pay off investment in major structural works.

2 The borrowing horizon for loans to build structural assets such as stopbanks, is typically 20-25 years.

3 Also, by 30 years we will see a generational change, the next generation may see things differently and see things better.

4 Councils typically have 30-year infrastructure strategies.

5 Climate change is reasonably predictable in the near term and by and large, has its course set until 2040-2050.

4.1 We have selected 2050 as the first planning horizon

Most of the factors that determine planning horizon above suggests a time for review between 2040 and 2050.

1 For new stopbank design, we will initially design to 2050 but will frequently test this and plan contingency for possible future needs.

2 Where the difference in estimated cost between building to 2050 and 2100 is insubstantial, we may opt to build to the 2100 horizon.

3 If we build to only the 2050 horizon, we will ensure that adjacent bare land is enough to allow addition to the stopbank, to cater for a possible "as at 2100" increase in height.

Note: This also means we will have tried to consider wider circumstances and the longer time horizon in choosing stopbank locations to keep our options open in future.

4.2 The principle of adaptive management

Is being able to set a point in future for a known decision that may be triggered by an event (the types of event that can trigger a revisit of this plan and new decisions being made have been catalogued here). This allows us to pick more than one planning horizon and a list of events which, if they occur, may trigger a review of this plan. This is seen as a key driver for the principle of a "Living Plan". In other words, "if this happens, get the community together, quickly agree actions, and review this plan".

4.3 What do these planning horizons inform?

1 House design life.

2 Stopbank location security, room to grow if needed.

3 Zoning implications, where future subdivision and development should occur and how.

4 Important horizons for understanding climate change.

5 Horizons for inter-generational change.

6 Ideal investment planning horizons, balancing cost of money versus spreading repayment.

5

Which flood could we use as the basis for developing and proving our models?

A wide range of information sources were correlated and used to cross validate the flood history of the Waiōhine, including:

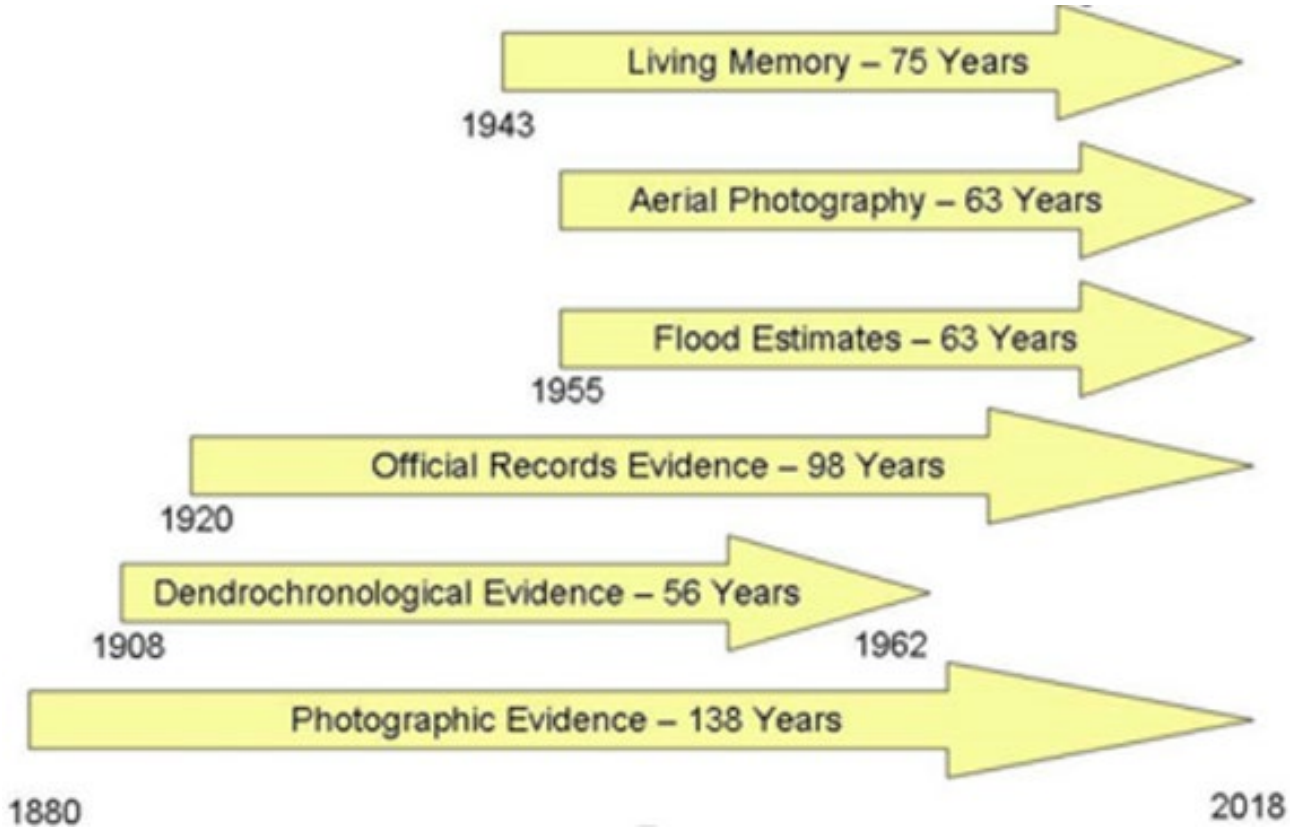


Figure 17: Sources of information on past floods tally.

5.1 The kind of things that had to be determined

1 Which floods are of note?

2 Which of these is best to base a model on?

3 Which flood events can be used to calibrate against (i.e. more than one flood)?

4 Is there enough data to inform design scenarios from these?

5 Is an analysis of flood frequency needed? Are there historic floods to consider?

6 Given 1990 is being modelled, which other floods might be important?

5.2 Which flood did we use?

It was decided to create a base model from which all other models could be derived, using the flood of 1990. Whilst several other floods were considered (see table below), those did not offer the larger return period (a one in twenty-year event or average frequency), or the relative wealth of information for cross referencing, such as aerial photographs.

New computer modelling software available to LandRiverSea Consulting allowed a far more detailed LIDAR (Light Detection And Ranging) sourced model for critical flood sensitive areas of the map. New sections and drone data were also correlated and used to improve the accuracy of the model. The map for a one in one hundred year flood, including climate change and allowance for flood

sensitivity, was subsequently cross-checked against data modelled for the 2004 flood, which also was further cross-checked against local knowledge and aerial photography. As a result of this exhaustive process, a very high degree of confidence in the base model was reached. This base model was then confidently used to develop all further map sets and models, used to investigate flood risk and develop flood defence options.

Figure 18: Waiōhine in flood.

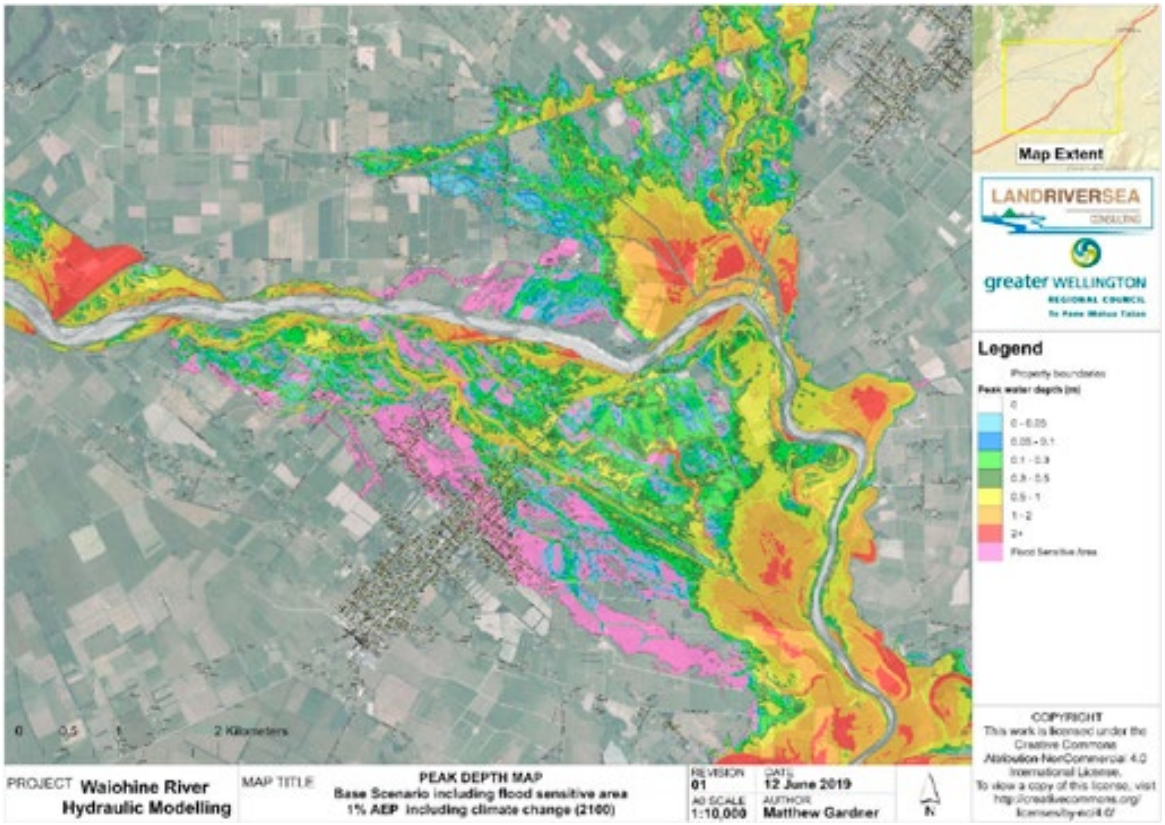


Figure 19: One in one hundred year flood, with climate change as at 2100, also showing Flood Sensitive Areas (where there may be some possible flooding in the event of unusual things happening in addition to climate change and a one in one hundred year flood).

Date	Flood – and – [quality of flood, out of 10, for deriving base model]
01/1980	1424 cubic metres per second. Some photos. Long duration – 2 peaks. Extensive land flooding. Getting old [4/10]
12/12/1982	1558 cubic metres per second (some doubt about this number). Biggest on record. Some photos. Long duration (30 hours) Gauge validation/ Matt/ Hydrographs. New stopbank at Platform Farm [4 to 7/10]
1990	1408 cubic metres a second, single peak, plenty of aerial photos and other reference material [8/10]
06/09/1998	1104 cubic metres per second Long duration. Stopbank failure at TiceHurst. (used for validation) [0/10] Flooding at Papawai and behind the Urupa.
2002*	915 cubic metres per second [0/10]
12/02/2004	1362 cubic metres per second. Small amount into Apple Barrel. Lack of photos. At night and short duration [5/10]
2005*	857 cubic metres per second
18/01/2006*	762 cubic metres per second. Small amount into Apple Barrel.
07/10/2008 (Phil Wallace)*	982 cubic metres per second. New bridge was in place
2009 (Phil Wallace)*	Too small. Didn't leave channel

**These floods were too small to use to model.*

Figure 20: Floods of note – to identify candidates from which to develop a base model.

As can be seen from the table above, the 1980 flood was also eminent and therefore of interest as one of the largest recent floods on record. Although there is some useful aerial photography, the double peak profile and landslide damming the Waiōhine in the gorge was atypical, and it was therefore set aside in favour of the more typical 1990 flood event.

The earliest full cross section set dates from 1984. Given that there were major floods in 1982 and 1980, it's questionable whether the 1984 data set could represent the river cross sections at the peak of the 1980 flood, based on experience calibrating the 1990 event. Also, there were no flood marks to check against (showing the wet extent of the flood at peak), only flood photos.

Finally, the 2004 event was chosen to be used to cross check and calibrate the new flood model. There were two floods in Feb 2004 – our candidate is the first one on 12th Feb. Surveys were done in 1999, and May 2004 after the floods. These were validated against the May 2004 survey.

Assumption Used for Modelling: – agricultural land is to be grazed grass (in modelling we must choose the degree of roughness for land surface and of course for farmland, use may change).

Figure 21: Landslip in gorge during 1982 flood – GWRC.

5.3 Initial findings from review of the 1990 and 2004 floods (used to verify 1990)

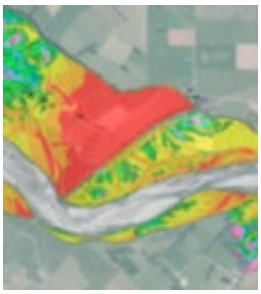


Figure 22: Detail from base scenario – landriversea Consulting.

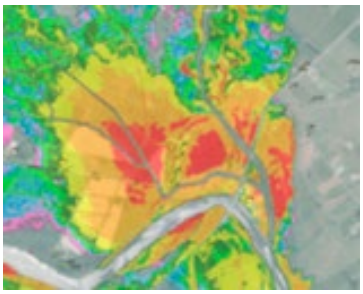


Figure 23: Detail of Mangatārere convergence.

1 The 2m deep "red" area behind the north side of the railway initially looked too high. After further investigation it was found this was entirely reasonable, it could be put down to the lack of spill from the channel due to the fast/sharp rise and fall of the river during this flood.

2 The modelling of the State Highway 2 Bridge did not appear to show the correct amount of overflow from that flood event (remembering this flood occurred when the old State Highway Bridge was still in place).

3 The flooding on the Mangatārere looked incorrect but we do not yet have Mangatārere data with which we might understand the real impact of this. Local experience suggests this might be more like 1m. It was noted that any findings of the yet to be completed Catchment Plan Incorporating Floodplain Management Plan for the Mangatārere should be used to verify this aspect of the Waiōhine model and any substantial variation can be used to Trigger a review of this plan.

4 Note that: Once the Catchment Planning project for the Mangatārere is completed, it is proposed that the boundary between the rivers be aligned with the Freshwater Management Unit boundaries, i.e. at the actual confluence of the Mangatārere and Waiōhine rivers.

5 The model showed riverbed widening effects – this is to be expected.

6 The 1990 flood calibration results do not reflect the exact observations on the ground e.g. flood levels on North Street.

5.4 Waiōhine FMP – flood modelling and mapping audit

Once the 1990 flood had been identified as by far the best on which to base the development of a base flood model – and that model had been developed and verified against the 2004 flood model and a variety of other cross referenceable sources of data, we were able to develop a high degree of confidence in the base model.

We then asked Beca Ltd to return to the project to conduct an independent peer review of the model to help verify it and to ensure that several key shortcomings identified in the preceding draft Waiōhine Floodplain Management Plan had been successfully addressed. This report can be found here. It was completed and presented to the Project Team and community on 14th February 2018. It was subsequently also reviewed by the Ian Heslop led, additional Independent Peer Review process.

This then allowed us to create a wide variety of other models to study floods of various intensities, durations, profiles and a wide range of other factors, such as climate change, channel blockages or gravel build up. In fact, the base model has provided the foundation for all subsequent floodplain management work in this River Plan.

Key Findings:

- **We recommended** that Ages/Dates attributed to photos 1990: 1980 needed correcting.
- **We recommended** newer modelling software with the ability to use variable mesh sizes allowed more detailed modelling.
- The model is as accurate as it can be today: there is a high degree of confidence in its accuracy. This has been independently peer reviewed.
- The area of the lower Mangatārere tributary perhaps shows more overflow than occurred – but this could be attributable to a higher bed as cross sections for this stretch of river are not available. This has not impacted the plan or stopbank design.
- Bed levels have a very high impact on flood levels, especially in the stretch between the end of Kuratawhiti Street and Fullers Bend (XS-20) and therefore we note that river maintenance is key.
- Bed level was found to be more significant in comparison to increased Mannings 'n' (riverbed roughness) and peak river flow volumes for the 1990 flood event calibration.
- Once the Catchment Planning project for the Mangatārere is completed, **it is recommended** that the boundary between the rivers be aligned with the Freshwater Management Unit boundaries, i.e. at the actual confluence of the Mangatārere and Waiōhine rivers.

6

Understanding the Waiōhine Hydrology

6.1 Background

The vast majority of the length of the Waiōhine from its source to it's confluence with the Ruamahanga, is uncomplicated and can be by-and-large, left to behave naturally. From the Gooseneck, where the river emerges from it's gorge down to the State Highway 2 bridge, perhaps less than 5% of the river's length, is complicated and therefore the focus of this plan. We have identified seven Critical Areas of river and bank along this length that need particular attention.

Climate change and weather patterns combine with its hydrology to make the Waiōhine a challenge to manage well. The combined impact of these three factors on gravel and bed levels is a major concern for the community. Higher bed levels increase the risk of flooding, erosion and course change.

Gravel. When we use the term "gravel" we mean stones of every size carried down the river. From boulders to fine sand (sometimes called "fines").

Issues were identified within the previous draft Floodplain Management Plan. Consequently, Matt Gardner of LandRiverSea Consulting was contracted to this project team, as a hydraulic modelling specialist, and extensive use was made of his skills and services. In addition, the Project Team conducted workshops with Mike Gordon (GWRC), commissioned a detailed study by Tonkin and Taylor Consulting and also sought expert opinions from others, such as Professor Ian Fuller of Massey University. Independent Peer reviews of this work were conducted by Beca and Ian Heslop.

Establishing which floods of note from past events could be best relied upon, from which to develop and prove a trustworthy hydraulic model, was of vital importance. From there an understanding of the characteristic hydrology could be pieced together and gaps in data, as well as areas where more detailed surveys, independent expert advice and models were needed, assembled. These have been used to explore options and outcomes for flood defence, river management and maintenance, for the Waiōhine. These were reviewed by the community as well as independently peer reviewed. A considerable number of sources of data, from living memory to a study of the dendrochronology of Kahikatea trees in the Waiōhine floodplain carried out by Rob Kennedy, were compared and found to be remarkably consistent. Note that they have also helped in the development of the vision, conservation and restoration strategies in this river plan.

The outcome is a set of hydrological modelling data that the Project Team now has a high level of confidence in, together with a range of hydrology maps used throughout this plan.

6.2 Factors affecting Waiōhine hydrology

6.2.1 Climate cycles mean floods occur for 20-30 year periods that are 20-30 years apart

Tonkin & Taylor identify a number of key influences that shape the Waiōhine: *"The character and behaviour of the Waiōhine River is influenced by and responding to a range of climatic cycles including those that occur over long timeframes (stadials/glacial maximums), those that operate over multi-decades (the Interdecadal Pacific Oscillation – IPO) and those that happen more frequently (El Niño and La Niña). Further to this, the Waiōhine River has shown a significant change in behaviour following a large-scale episodic event (1855 Wairarapa fault rupture)."*

Some of these, such as the Interdecadal Pacific Oscillation appear to be responsible for the periods of large flooding and then little or no flooding (as at present) on the Waiōhine, **this in turn influences gravel and bed levels** in the river.

The report goes on to say: *"Increases in temperatures and decreases in base flows under two of three climate scenarios may lead to vegetation changes in the upper catchment. This **may lead to increases in sediment supply** to the valley floor under less intense rainfall events than current conditions. These predicted sediment stores will possibly be redistributed under less frequent but larger flood events in the future... The IPO is a large-scale, long-period oscillation that affects climate variability over the Pacific Basin, **with phases lasting around 20 to 30 years** (NIWA 2016). Positive IPO phases are generally associated with an increase in anticyclones resulting in drier than normal conditions, with some catchments showing lower than average base flow conditions (e.g. Manawatu River) (NIWA 2016). However, the Waiōhine River shows an increase in large magnitude flood events during positive phases of the IPO (PDP 2014, and* chart below*). Conversely, negative IPO phases are generally associated with more north easterlies over northern regions of New Zealand (NIWA 2016; MfE 2008) which is likely to increase annual precipitation in the Tararua Ranges, possibly resulting in higher base flows in the Waiōhine River. **There was a switch to a negative IPO phase in 1999** (NIWA 2016, PDP 2014; MfE 2008)."*

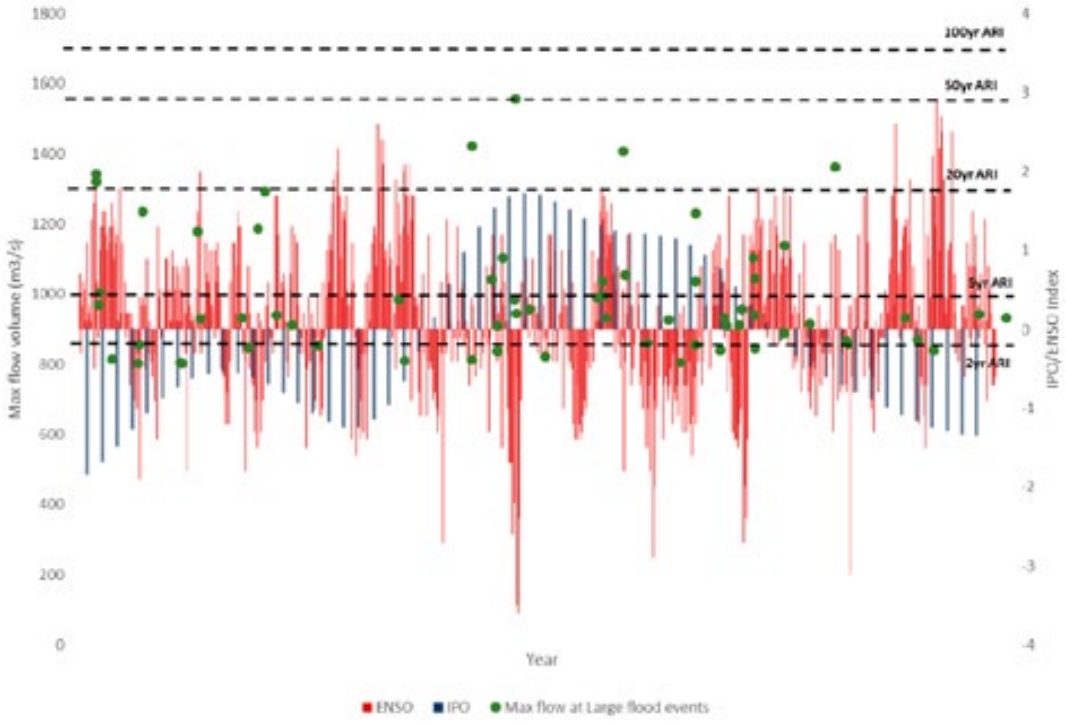


Figure 24: Maximum flood peaks for the 50 largest recorded floods in the Waiōhine River Catchment are shown as green dots, El Nino Southern Oscillation (ENSO) cycles are shown in red, IPO cycles are in blue. Tonkin and Taylor from Creative Commons.

6.2.2 Stream characteristics – gravel trapping and build up, spreading in flood

Note on chart below (Tonkin and Taylor): *"Reach 2 (this is between the Goose Neck and State Highway 2 Bridge) is an unconfined wandering gravel-bed river. Wandering gravel-bed rivers are a transitional form of river form between a single thread meandering channel, and a braided river. This reach has previously been described as a braided river, and evidence of paleo-channels on some of the terrace surfaces suggest it would have been a braided river at some point in history. This reach also acts as a large instream sediment store, effectively trapping the larger gravels in this reach (Brierley et al 2011)."*

	Stream location	Reach length	Valley setting	Thalweg	Valley slope (%)	Valley width	Dominant sediment process	Sediment type
Reach 1	The gorge to the gooseneck	5.5km	Partly confined	1 channel well defined	0.45	236m	Transport reach	Course (boulder/ gravel)
Reach 2	The gooseneck to SH2	8.7km	Unconfined	1 channel regularly shifting	0.43	1,352m	Deposition reach	Course (cobble/ gravel fining downstream)
Reach 3	SH2 to the confluence	6.15	Unconfined	1 channel well defined meandering	0.19	>2,000m	Deposition reach	Fine (sands and small gravels)

Figure 25: Identified stream characterisation reaches of the Waiōhine River and their characteristic attributes. Tonkin and Taylor 2018.

Tonkin and Taylor further identify: *"...localised bank retreat in some areas of up to 110 m. In a wandering gravel bed river, with limited change in bed level despite gravel extraction, lateral adjustment is expected. As the entire true right and true left floodplain comprises alluvial material, lateral adjustment of the channel is possible across the whole floodplain and is not limited to the current managed active channel extents. Engagement of the floodplain during out of bank events may limit the extent and severity of lateral erosion, by reducing flood peak velocities."* i.e. allowing floods to spread out will reduce the overall damage from erosion.

6.2.3 How big is a one-in-one-hundred year flood?

The Project team considered the important subject of what a 1:100-year (1% chance of occurring in any year) flood volume of water really should be, given the inaccuracy of measuring this in a major flood. Three formulae were considered:

1 Based on data for major floods between 1955 and 2008, we arrived at a volume of 1738 cubic metres per second (M^3 per second) within plus or minus 110 M^3 per second,

2 Based on data between 1955 and 2016, we arrived at a volume of 1700 M^3/s within plus or minus 200 M^3 per second,

3 Based on data between 1979 and 2016, we arrived at a volume of 1730 M^3/s within plus or minus 230 M^3per second.

The Waiōhine sometimes has double peak floods, such as the 1980 flood. The nature of the catchment with its two separated major tributaries can cause a double peak if the wind direction carries rain over first one, then the other.

The decision was therefore made to model using 1700 m3/ per second $\pm$ 200 m^3 per second, using two temporal patterns, i.e. double and single peak hydrographs. Note that the largest estimated flood volume known in the Waiōhine was around 1558 M^3/s – a double-peak flood in 1982. 1700 m^3/s plus 200^3/s plus up to 16% extra for climate change plus flood sensitivity where applicable may help put this in context.

What does "one-in-one-hundred-year" mean? A one-in-one-hundred-year flood is a flood event that has a one in one hundred chance (1%) of being equalled or exceeded in any one year. For more information click here.

Findings:

- Flood hydrology, models and maps were peer-reviewed by Ian Heslop who found that "the adopted Waiōhine and Mangatārere River 100 and 20 year return period design and flow estimates are reasonable and appropriate."
- **We recommend** that any measurements or observations of the hydrology of the Waiōhine must be viewed within the context of the full cycle of successive extended periods of major floods and periods of little or no flooding to account for the effect of the Interdecadal Pacific Oscillation.
- The decision was made to model using 1700 m3 per second $\pm$ 200 m^3 per second.

6.3 How do climate and hydrology affect bed level and gravel management?

Tonkin & Taylor note: *"The predicted river response to the 1855 fault rupture (earthquake) would have increased sediment supply and transport and would have been additional to any sediment contributed to the catchment through landslides generated by the rupture earthquake. It is possible that the Waiōhine River is still trying to achieve bed grade equilibrium from this event through incremental incision of the bed, especially in upstream reaches of the river. Any bedrock within the channel (below the gravel bed) will limit the depth of incision."*

Community history also shows that Waiōhine riverbed levels were lower in the 1930s than they are today. In addition to the 1855 quake, the 1942 Earthquake also caused bed levels to rise. This event led to the present Stopbanks being built in 1951 by Feast Contractors and paid for by the Ministry of Works, before the Catchment Board took over in 1953. Events suggest high beaches have caused past bank and berm erosion. The best-known estimate of frequency of the Wairarapa fault line earthquakes is an estimated 1:1200 years.

The Ministry of Works also built a weir above the previous State Highway 2 Bridge in 1945. The aim of this weir was to clear the gravel under the Bridge, which, at that time, only had half a metre of clearance However, within two months the weir was destroyed by a flood. With so much flooding of State Highway 2 and the high bed levels, the present stopbanks were built in 1951.

These events and records suggest that the natural bed level may be lower than present bed levels and perhaps may indeed be lower than they were in the 1930s.

In contrast to the records of issues caused by high bed levels, there is no record of lower bed levels being a problem.

In April 2019 GWRC Flood Protection produced a document suggesting "significant" lowering of the entire riverbed (degradation) during the recent Interdecadal Pacific Oscillation (IPO) phase – approximately the last thirty years. This depended on a series of very widely spaced, cross section surveys taken at five year intervals and specifically excluded all other sources of existing available data, context and independent subject matter expert reports and observations (see for example Tonkin and Taylor report, commissioned by GWRC themselves, cited later in this section).

Once it became known that this document and its companions existed – in mid-2020, in keeping with the Terms of Reference, an attempt was made to validate its content, recommendations and data in these documents. The analysis of these documents "Gravel subproject for the Waiōhine River Plan – Documentation and Tolerance Analysis – Discovered Documents Unpacked and Categorised." At Appendix L. For a long list of reasons covered in this analysis, the data, conclusions

and recommendations in the analysed documents, with some exceptions, have been found to be extremely unreliable. Fortunately GWRC have advised that these documents have been withdrawn from use and are not being relied upon. Unfortunately, there is evidence that they were, unbeknownst to the community, relied upon heavily in the management of the river for a period of around two years prior to 2021 and may still in one way or another, be misinforming operational decisions in the river as at January 2021.

Therefore it has been agreed with GWRC executive that these reports and their contents are set aside and will not be relied on. They are therefore not considered fit for purpose and are mentioned here solely for purposes of historical completeness and to learn lessons from this and apply these to the recommendations relating to the River Plan and its Living Plan provisions, including how any consent should reflect the intent of the Waihone River Plan.

Unfortunately it appears that, as the unreliable information was depended upon for maintaining the river, this will create additional burdens of cost and work to put right over time.

Tonkin & Taylor: *"The Waiōhine River immediately upstream of Greytown is thought to be showing a degrading trend. Degradation (lowering) of the bed has been specifically noted in the gorge, where the flow gauge was left perched in 1954. Previous research suggests that the Waiōhine River may have cyclical periods of aggradation and degradation depending on several climatic factors (PDP 2014; NIWA 2016)."* See Climate Cycles Mean Floods Occur For 20-30 Year Periods that are 20-30 Years Apart above.

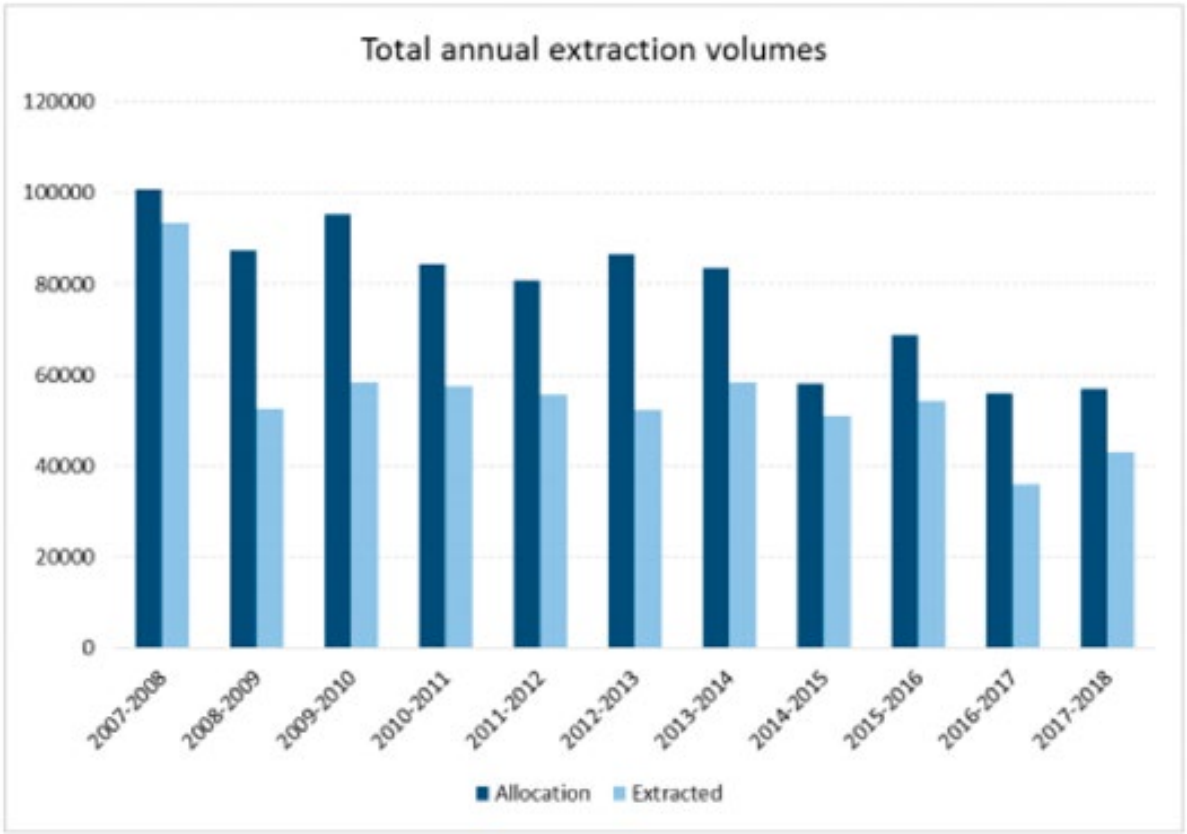


Figure 26: Gravel extraction Analysis Tonkin and Taylor from GWRC.

When major flooding occurs, the river tends to flood many times over a period of around twenty or thirty years (influenced by the IPO climate effect), with considerable build-up of gravel brought down from the gorge (XS 43 and above) and the stretch of the river reaching far back into the Tararua hills upstream – see figure 33 for a photograph of this. The last major flood was in 1990, with a smaller flood in 2004 that saw a "trickle" enter the Apple Barrel Floodway. It is therefore over 29 years since a flood of a scale likely to bring substantial amounts of gravel down from the gorge has occurred.

Detailed records of bed levels and gravel extraction have only been kept during the current period of limited or no significant flooding. The large distances between survey points and long times between surveys and massive re-engineering of the river shape, make this data far less useful than, for example, the techniques used on Western Rivers of Kapiti and Horowhenua. It is no surprise therefore that relying on just that limited data might imply a gradual decline in bed levels. However, history, the experience of past officers responsible for flood protection and records show that this will be followed soon, by a similar length period during which major flooding is more likely. Recent more accurate surveys support this.

Tonkin and Taylor: *"While data provided to T+T shows a minor degradation response (between the Rail Bridge (XS 37) and State Highway 2 Bridge) in Reach 2 of the Waiōhine River since 1986, assessment of the wider landscape supports a slow-long term incision trend as secondary sediment stores in the upper catchment associated with the end of the last stadial are slowly exhausted. Annual gravel extraction of between 35,000 and 60,000 m^3, does not appear to be having a detrimental impact on bed levels in Reach 3 with only minor incision observed at 5 of the 17 cross section locations downstream of SH2 bridge (XS 17), all of which are located on a straight section that has recently lost a meander. This suggests that gravel extraction at these volumes is not interrupting bed load transport, and acceptable bed level envelopes could be adapted for gravel management, instead of total allowable extraction volumes."*

We do not have enough measurements yet to understand both the "dry" and "wet" climate cycles affecting gravel build up or reduction in the Waiōhine. Clearly completing this set of measurements is critical to knowing where we could set high and low marks to arrive at a meaningful "bed level envelope", to confidently manage gravel between. Such an "envelope" is desirable and will be important to long-term management, erosion control and flood prevention.

As noted in the Independent Peer Review by Ian Heslop, "It would be ideal if the design bed level question could be clarified... It is understood that the river has a stable to degrade trend, so gravel extraction volumes and locations need to be carefully managed. A design bed envelope will greatly assist this."

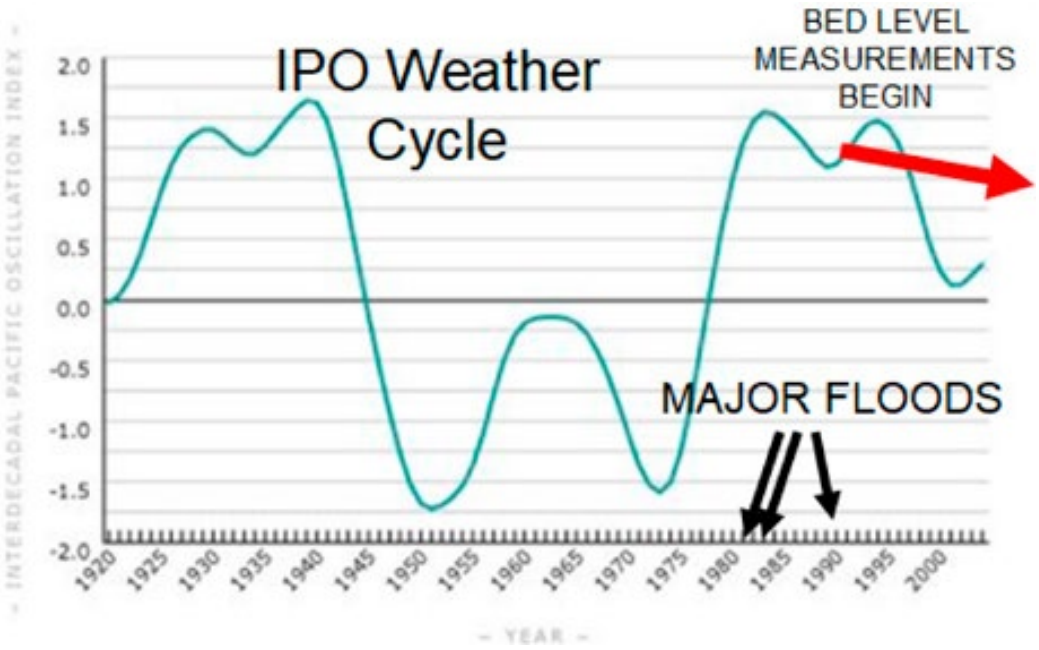


Figure 27: Major floods and start of bed level measurements shown against stages of IPO weather cycle.

As also noted in "Independent Gravel Management Review – Wairarapa Regional Gravel Status" of June 2020 by Laddie Kuta of E2 Environmental Consulting Engineers: "further work to understand an "optimum" bed level that is aligned with flood protection goals for each river is required".

Findings:

- Stretches 3 and 4 (from above Kuratawhiti to the confluence with the Ruamahanga) are prone to aggradation (depositing) gravel (stones).
- During the current phase of the IPO (Interdecadal Pacific Oscillation) cycle, the riverbed tends to deposit far less gravel in these stretches.
- Nevertheless, there appears to be enough gravel deposited in these stretches to recommend a substantial extraction regime, even during this quieter phase of the IPO cycle. Indeed, in the most recent year (2019) more than 60,000 cubic metres has been extracted from below the SH2 bridge to control aggradation).
- This can be mainly constrained to Critical Areas where important assets (e.g. town water supply) need to be protected and channel alignment maintained.
- During the coming IPO cycle the riverbed will be likely to aggrade (deposit a lot more gravel), this has not been measured but is the very thoroughly observed and understood experience of those responsible for managing the river, during the last such phase (prior to 1999).
- It is recommended that being able to set a reliable bed level envelope would be very useful in the future management of the river, particularly as regards gravel extraction and flood prevention.
- Note that we do not yet have sufficient data to usefully indicate upper or lower limits for a bed level envelope. Aerial bed level surveying techniques are likely to make measurement possible.

In the absence of a reliable bed level envelope, we have developed a flexible but conservative rules-based approach that meets the needs of the current regulatory environment. This recommend that this be applied within the context and intent of this plan using the "stitch in time saves nine" principle for each of the seven Critical Areas of the river could be impacted by gravel raising or constricting flow, or diverting the river to attack critical high banks, the loss of which could lead to disaster in a major flood event. We have also created a Trigger within the Living Plan to implement a bed level envelope, as soon as it is agreed that a reliable one can be created from measurements.

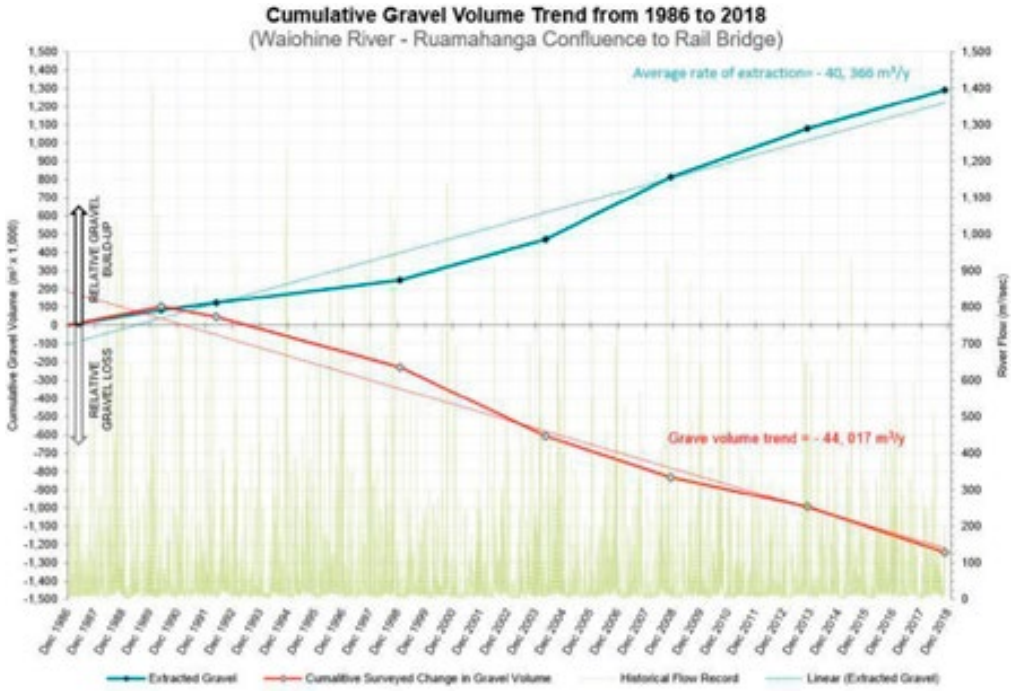


Figure 28: GWRC Study of measured bed levels and gravel extraction for the period after a cycle of major flooding occurred.

6.3.1 Qualifying notes to lend context to the diagram above

1 A more accurate and recent survey of the reach of the river adjacent to Kuratawhiti Street found the trends in the above diagram to be incorrect and that the river is in fact aggrading, this may well be true of other reaches of the river as well.

2 In 1986, when bed levels began to be measured the river was not in ideal condition, as a result of the following factors:

a River scheme funding deficits had run-down maintenance and led to several maintenance crises,

b The river had experienced several significant major floods, especially 1980 and then 1982 which involved the bursting and carrying away of large amounts of dammed gravels, which raised (aggraded) the riverbed.

The April 2019 "Gravel Management Review and Recommendations – Waiōhine River" shows a total deficit of 1.2 million cubic metres of gravel and 1.3 million cubic metres of extracted gravel. Once this and accompanying documents were revealed and able to be evaluated, the only conclusion that could be drawn was that they do not provide any reliable evidence of either degradation or aggradation and that the methods employed and data are insufficient, in isolation, to draw a conclusion about where a bed envelope or gravel extraction limit could be set (See Appendix L).

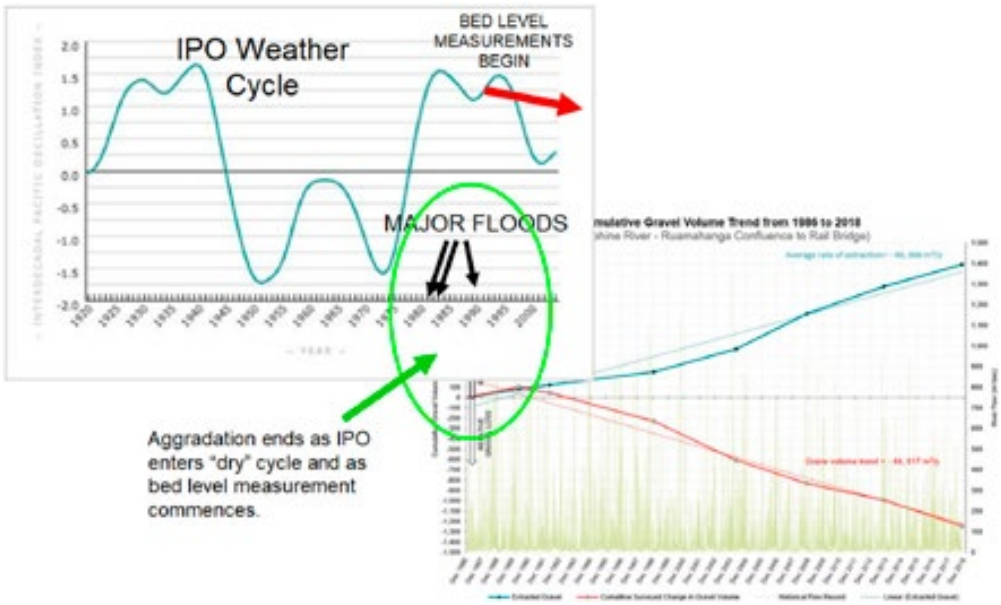


Figure 29: IPO "Dry" cycle begins as bed degradation and measurement begin.

In effect the years of inconclusive bed level measurement since 1990 have helped us learn how much we do not know. If we were, for instance, measuring a sine wave, it would give us an idea of less than one half of it. Because we have not experienced a change of IPO phase, we do not yet know where the high and low points of a bed level envelope should be. Continuing measurement through the change in IPO phase and through periods of major floods, that are likely to accompany that, will give us the other half of the sine wave, so to speak, as well as a reasonable idea of where the top and bottom of the wave occurs. As we take into account other factors, such as gravel increases following slips and seismic events, as well as each of these changes between phases of the IPO cycle, we will be able to successively set a lower and an upper bed level envelope limit for each stretch of the river. With each subsequent change of IPO cycle phase, we will be able to tweak and improve on the bed level envelope to consider the effects of ENSO, climate change etc.

Findings:

- Current techniques used for measuring bed levels and gravel are inaccurate and unreliable.
- We do not know whether each section of the river is in aggrade or degrade with enough accuracy to act on the faulty data we do have.
- **We recommend** a start needs to be made using newer techniques for bed level recording and past attempts to measure must be seen in the light of the limitations of the techniques and practices identified in the "Gravel Sub Project for the Waiōhine River Plan – Documentation and Tolerance Analysis – Discovered Documents Unpacked and categorised." At Appendix L.
- The nature of the Waiōhine River emphasizes the importance of care in drawing conclusions from poor data and contextual information as the unintended consequences beginning to be evidenced in the deterioration of the river and natural flood defences (as at early 2021) bear out. See modelled flood scenario below – highlighting the impact of gravel restricting river flow.

6.3.2 How serious a threat could gravel build up be?

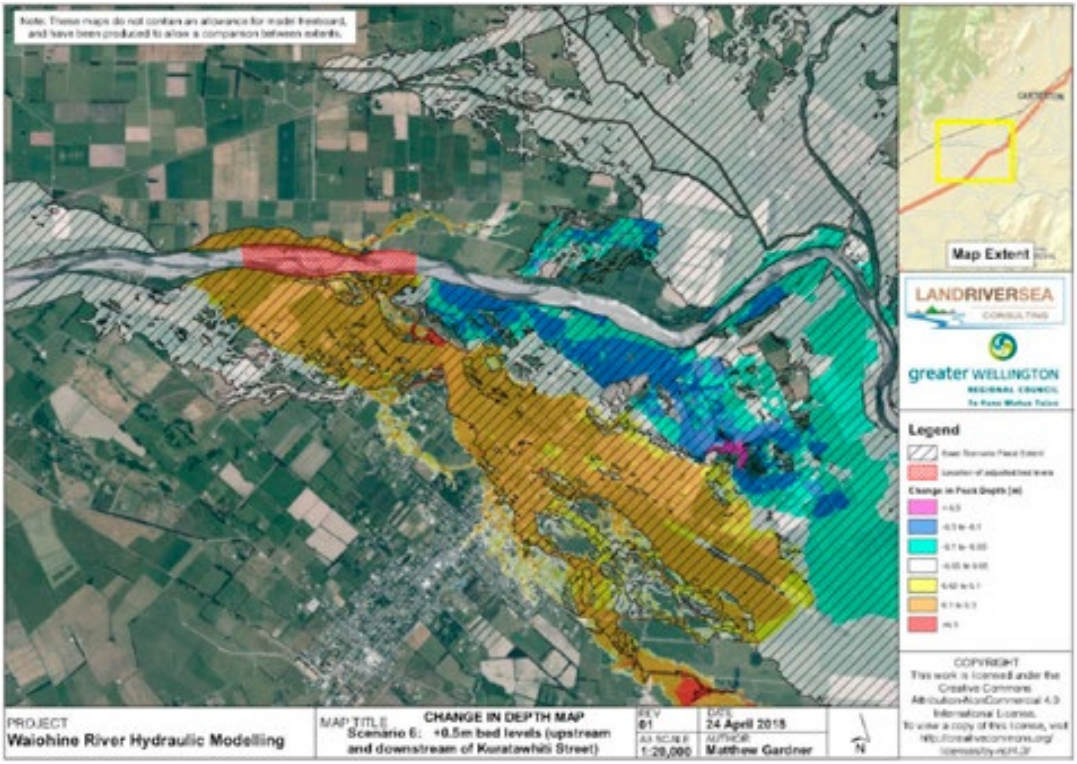


Figure 30: How the build-up of gravel beaches creates flood risk – yellow colour shows additional flooding.

Studies and computer modelling show that the reach between SH2 Bridge (XS 17) and the Rail Bridge (XS 37), particularly around and above the end of Wood Street and Kuratawhiti Street, is the most dynamic and the most critical for erosion control and flood protection. This stretch may be important as a "transport reach" i.e. transporting substantial amounts of gravel down the steep river and helping to prevent problematic build-up of gravel. The elevated risk of river course change (avulsion) here is noted by Tonkin and Taylor: *"The end of Wood Street was identified as being an avulsion risk area for climate change scenarios RCP6.0 and RCP8.5, with the risk increasing if lateral bank erosion immediately upstream is initiated."*

Indeed, as will be seen later in this plan: in the analysis of flood sensitivity scenarios that could make flooding worse, the risk of gravel build-up had by far the greatest impact. This reflected the experience of the community and those with past responsibility for flood prevention and river management in the Waiōhine valley and wider Wairarapa.

The risk posed by insufficient gravel management, in the event of gravel aggradation, caused by one or more successive major floods, expected to occur in the next Interdecadal Pacific Oscillation (IPO) phase, has had a substantial impact on the size and extent of stopbanking needed. If we could be sure gravel would continue to be well managed, or that the IPO would not change phase and that we will never lose adequate gravel extraction as a management tool, or that there would never be two major flood events in very quick succession, then a major savings could be made, as the Western (Kuratawhiti Street Stopbank) may not be required to be so substantial.

6.4 Critical areas

6.4.1 Overview

There are a number of Critical Areas at points along the managed stretch of the Waiōhine. Collectively they comprise a small percentage of the overall river length.

The hydrology, flood modelling of the river and resulting flood maps were created at a single point in time for a dynamic, mobile river. The proposed flood defences rely on channel and bank being maintained in the condition and alignment they were in at the time of modelling and mapping. This was emphasized as vitally important in the Independent Peer Review of the recommended flood protection strategy. Given the desire for a balance between a naturalistic river and effective flood defence, we propose restricting the concept of maintaining channels and banks as per the modelling, to a set of Critical Areas. This leaves the vast majority of the river free to adopt a more naturalistic shape. However, even in the Critical Areas, we have developed a series of measures that allow for more interplanting, back-channels, pools, riffles and runs to continually enhance habitat and ecosystems for flora and fauna.

Critical Areas shown in the workshop map below, where the practice of early intervention or: "A stitch in time, saves nine" is required in order to prevent serious later consequences in the form of damage to critical assets, such as dwellings, towns, water supplies, state highway, areas of key ecological importance or sacred urupa and surrounds. The cost of putting these right, after late or otherwise less effective gravel management intervention, can be excessive. It could be many times higher than effective early work and use of the range of measures in the river management "tool box", including gravel extraction. Therefore, where in doubt, the overarching principle of "a stitch in time, saves nine" should be applied.

Figure 31: Identification of critical areas as at 2021 – Project Team.

6.4.2 Definition of Critical Area

Where the consequence of doing nothing risks things that are important to the community. examples of such risks are:

1 Risk to life.

2 Critical assets are placed at possible future risk.

3 A risk to essential services.

4 A Negative cultural impact.

5 A future risk of change of course of the river.

6 A negative environmental impact, now or in the future.

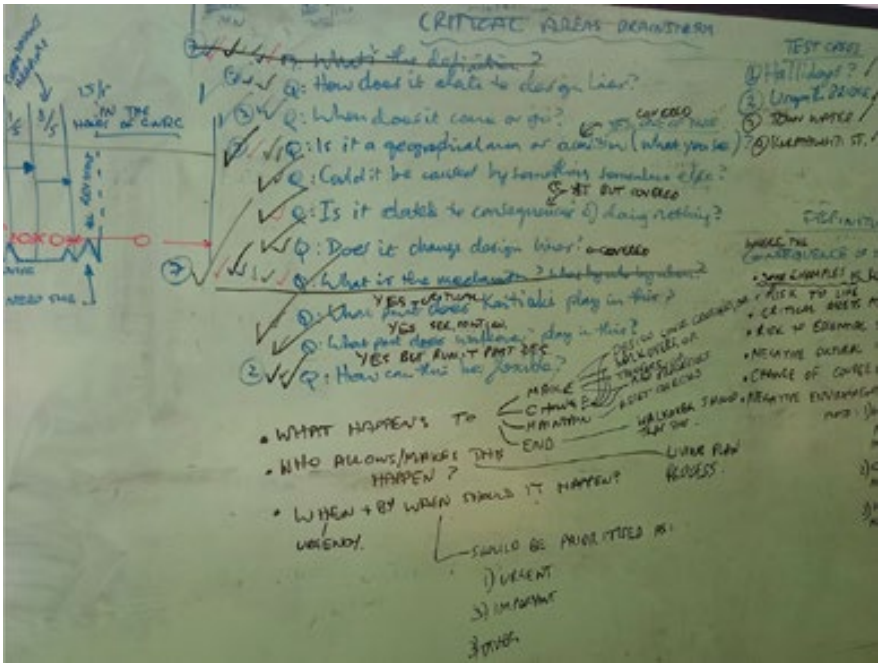


Figure 32: Analysing Critical Areas Lifecycle – Project Team.

Notes to definition:

1 We will comply with MPSFM, NRP and Te Mana O Te Wai in spirit, wherever practicable.

2 The cause of the risk needs to be identified, not just an attempt to address symptoms.

3 Kaitiakitanga should be used to monitor and report to stakeholders issues and actions agreed to be taken. We recommend this be adequately budgeted for.

In developing the definition a number of test cases were worked through and the risks involved were identified. Test Cases of Critical Areas:

1 Ecological and river bank damage at the place known as "Hallidays".

2 The Urupa and SH2 Bridge approach.

3 Near the bore fields for the Greytown and Featherston town water supplies.

4 The stretch of river alongside the end of Kuratawhiti Street.

In designing the definition of critical area, the following test questions were answered

1 Q: What's the definition? A: See above.

2 Q: How does it relate to design lines? A: It does not rely on design lines, they may help inform actions.

3 Q: When does a Critical Area come or go? A: See below.

4 Q: Is it a geographical area or condition of the river? A: Either or both.

5 Q: Could it be caused by something somewhere else? A: Yes it could be.

6 Q: Is it related to the consequences of doing nothing? A: Yes it could be.

7 Q: Does it change design lines? A: See 2. above.

8 Q: What is the mechanism? The "What is done by Who, by When"? A: See below.

9 Q: What part does Kaitiakitanga play in this? A: It is important – see Notes above.

10 Q: What part do "walkovers" play in this? A: They are important but should engage local GWRC staff.

11 Q: How can it be flexible? A: See below.

6.4.3 How it works

1 What happens to the lifecycle of a Critical Area: i.e. Make, Change, Maintain or End a Critical Area?

   a Make – A design line is crossed by the river or a changed state is identified on a walkover, or a trigger event occurs there, or plan processes capture the need.

   b Change – as for Make above.

   c Maintain – Any check or review of "assets" – important structures at or near the river, e.g. the river bank at the end of Kuratawhiti Street

   d End the designation of a Critical Asset – This should be spotted at a "walkover" to inspect the river.

2 Who allows/makes one of these events happen?

   a The Living Plan Process governs this.

3 When and by when should it happen?

   a It should happen as a matter of urgency, the Waiōhine changes very quickly and a great deal of damage can be done in a short space of time.

   b Each time a Critical Area is reviewed for any reason e.g. a "walkover", it should be categorised as either:

      i Urgent – do something right away.

      ii Important – agree by when something should be done, and keep a watching brief in the meantime.

      iii Other – keep a watching brief.

6.4.4 Related Trigger events

We have a Trigger in the Living Plan that is affected by issues arising from significant changes in gravel levels (aggradation or degradation).

We have a Trigger in the Living Plan that if something occurs that makes it obvious that an aspect of these techniques is failing to protect the banks and channels within the Critical Areas, then these techniques may need tuning.

6.5 Survey frequency and technology

Survey data is taken once every five years and at distant intervals on the river. Again, more frequent, ideally every two years, as well as more detailed surveying using new technology, would be helpful. The cost of this would be more than justified given the nature of the river and the potential cost of bank erosion or flood. The annual maintenance budget for the river is approximately $300,000. The cost of second and subsequent aerial surveys would be in the region of $10,000 and by supporting better informed decisions would likely be a sound investment.

Note that GWRC has invested in drone technology which would help to begin to build up a more detailed picture over time. Drone LIDAR is needed to be used for far more regular and detailed surveying between the Rail Bridge (XS 37) and SH2 Bridge (XS 17).

6.6 Proposed: rules for gravel extraction

As noted above, until sufficient data is collected to record gravel and bed levels through both "wet" and "dry" phases of the IPO, an uncomplicated but conservative set of gravel extraction rules are needed, to ensure there is no unnecessary lowering of bed levels, and no unnecessary flood risk created.

To be able to develop a simple strategy for a complex problem, a set of Test Questions were developed, which are recommended as a simple but effective set of rules for gravel extraction, well within the current allocation. These are to be used within the context of the Living Plan Process in accordance with Appendices B and C. Any proposed gravel extraction should satisfy one or more of these:

6.6.1 Gravel extraction must pass these tests

Is it for flood protection or erosion control? And especially so where:

It will either protect assets or protect critical banks (or banks in Critical Areas)? or;
Is it in a Critical Area of the river i.e. known to be a flood or erosion sensitive reach, identified in this plan between SH2 bridge (XS-17) and the railway bridge (Appendix J: Which Cross Section is Where)?

Note that: Gravel extraction should not detrimentally affect water quality (MCI) and a number of techniques to improve this have been identified with the help of experts from Massey University and "Ecological effects of flood management activities in Wairarapa Rivers" by aquanet Consulting Limited for GWRC.

Findings:

- Waiōhine hydrology is heavily affected by weather patterns, including climate change.
- There is a lot of concern within the community over related issues such as gravel build up and flood risk.
- A great deal of emphasis has been placed on understanding flood patterns and behaviours to get the best possible basis on which to model many future scenarios.
- There is a high level of confidence in the base model upon which the many scenarios and flood maps have been developed.
- If gravel build up should cause the river to change course (avulse) it may threaten urban Greytown or key assets such as the State Highway 2 Bridge, roads and dwellings. See Figure 30. This may not simply be a case of an increase in the overall bed level of the river but can be caused by a buildup of gravel beaches in a particular spot causing restriction of the river and damage to high banks that protect key assets, enabling later changes of river course during flood.

- It is not clear whether each stretch of the river is degrading or aggrading – as at the end of 2020 the most recent surveys indicate slight aggradation in the critical Kuratawhiti to SH2 stretch. There are many factors influencing gravel at any one point, including:
  a Measurements largely being taken in an IPO "dry" cycle when gravel is not refreshed by large floods and
  b Gravel extraction lowering (degrading) bed levels,
  c A possible long-term trend since the 1855 earthquake, of the river very slowly lowering its bed level towards its natural state.
- Measurements taken prior to December 2020 have a number of issues affecting quality, accuracy and reliability of data, as well as lack of history and contextual information, without a full understating of these factors, they should not be relied upon to influence decision making.
- We do not have a complete set of measurements until there have been a series of further major floods in the coming IPO "wet" cycle or until a useful series of measurements over time have been taken in aerial surveying of the river bed .
- **It is recommended** that bed level measurements are regularly made on a continuing basis to provide the data that can be used in developing a long term strategy.
- **It is recommended** that until this is completed, we are not able to create a complete set of bed levels – (as recommended by Tonkin and Taylor and Ian Heslop) – between which we can manage gravel extraction with any confidence.
- Evidence of river management issues between mid 2019 and early 2021, during which time no gravel was extracted from the river above the SH2 bridge clearly indicates that the preceding regime of gravel extraction is necessary for the safe and ecologically positive maintenance of the river.

We therefore recommend continued collection of measurements towards developing a bed level envelope and in the meantime, a flexible but conservative, rules and River Plan based approach to extraction of gravel for necessary flood prevention and erosion control purposes.

We are concerned to sustain the viability of gravel extraction to ensure it can be used for flood prevention and erosion control when needed in future. Especially considering the increased size and power of flooding expected due to climate change (estimated to be an additional 16% volume of flood water by 2090).

We recommend that the current upper limit of extraction of 90,000 cubic metres is retained, as a contingency against sudden major successive floods creating severe aggradation (gravel build-up), from the next series of big flood events. Until there is certainty that a cycle of major floods has been recorded and the full picture is understood. Too much or too little gravel, could result in increased flood risk to assets such as the State Highway 2 Bridge, Urupa, stopbanks, roads and dwellings. There has been no evidence to date of issues caused by too little gravel but definite issues caused by gravel build up.

We recommend that the extraction test questions, and hierarchy identified above should be adhered to, to avoid unnecessary gravel removal but ensure flood protection, within the context and intent of the River Plan overall.

6.7 Dam breaks – how likely are they and what happens if we get one?

The history of earthquakes and their effects on the Waiōhine and similar rivers can be found in Section 3 of the Tonkin and Taylor report.

In recent history, the flood of 1982 is included in the data for 100-year flood analysis. In 1982, despite large-scale landslides in the Waiōhine Gorge, no damage occurred. The combination of a 100-year flood & (erosion or quake) slip is a combination of frequency of two rare events and therefore is very rare. If due to a landslip a dam forms but doesn't breach, it may in fact serve to attenuate, rather than exacerbate, the flood peak.

As can be seen from the photograph above, large floods introduce a very large amount of gravel (stones) to the river, which is then carried down the gorge and into the stretch of river between the Rail Bridge (XS 37) and State Highway 2 Bridge (XS 17).

There are no special features of the Waiōhine River that indicate it is more prone to damming caused by slippages than other rivers. The risk and impact of damming of the river in its catchment due to slips, is so rare and has no history of causing additional damage that, in keeping with other flood plans, it is regarded as impractical to regard it as other than Force Majeure.

Emergency Management procedures will come into effect should a slip cause damming of the gorge that might result in sudden flooding. A slip forming that dams the river is to be a Trigger for the Living Plan provisions to come into effect.

Finding:

Damming and other effects of slips and earthquakes to be regarded as force majeure – it is extremely hard to prevent the effects of them.

Figure 33: Major landslip and dam break in 1982 flood – GWRC.

6.8 Gauging and rating

For a brief explanation of stream gauging, see here.

It is known that the best gauging to date is unreliable at higher ratings and can only cope with less than an annual flood (therefore gauging is seen to not be very accurate or useful).

Therefore, **it is recommended** to investigate what investment is involved in installing better gauging systems. NOTE: that this would improve emergency management capability. Improving gauging and rating will eventually pay for itself through being able to optimise future works/costs.

Finding:

It is recommended to investigate what investment is involved in installing better gauging systems.

6.9 Mangatārere hydrology

The Hydrology of the Mangatārere is the subject of a separate study, which, when completed should be assessed for possible impact on the Waiōhine, including whether any aspect of the Waiōhine River Plan may need adjusting to take its findings into account. See Living Plan Triggers.

6.10 1:20 Year (5% annual flood risk) flood map discussion

The Project Team has evaluated the impact of the road surface elevation (on State Highway 2) at the end of the Apple Barrel Floodway. We considered the impact on flood levels in the local area from changes in the road surface elevation, we did this with hydraulic modelling. It was found that an improvement (reduction) in these flood levels could be achieved by lowering the surface elevation of the road by 0.1m. We also discovered that lowering the road surface by 0.2m or more would have a negative effect by increasing flooding to local properties. In addition, any increase in the road surface elevation above the existing level would directly increase the flooding levels for local properties. We had an opportunity to discuss this with a representative of NZTA on Thursday 25 October 2018. In our conversation we outlined our discoveries and the fact that we would like the road surface decreased slightly (by 0.1m) in the future and that the road surface should not get higher than this as a result of any future NZTA works on State Highway 2. Greater Wellington Regional Council also sent a letter outlining this and requesting the permanent lowering of State Highway 2 at these locations by 0.1m as opportunity permits.

Finding:

NZTA Asked to consider lowering the SH2 crown by 100mm in selected places to minimise the flood effect. It is recommended to maintain the road crown at that level.

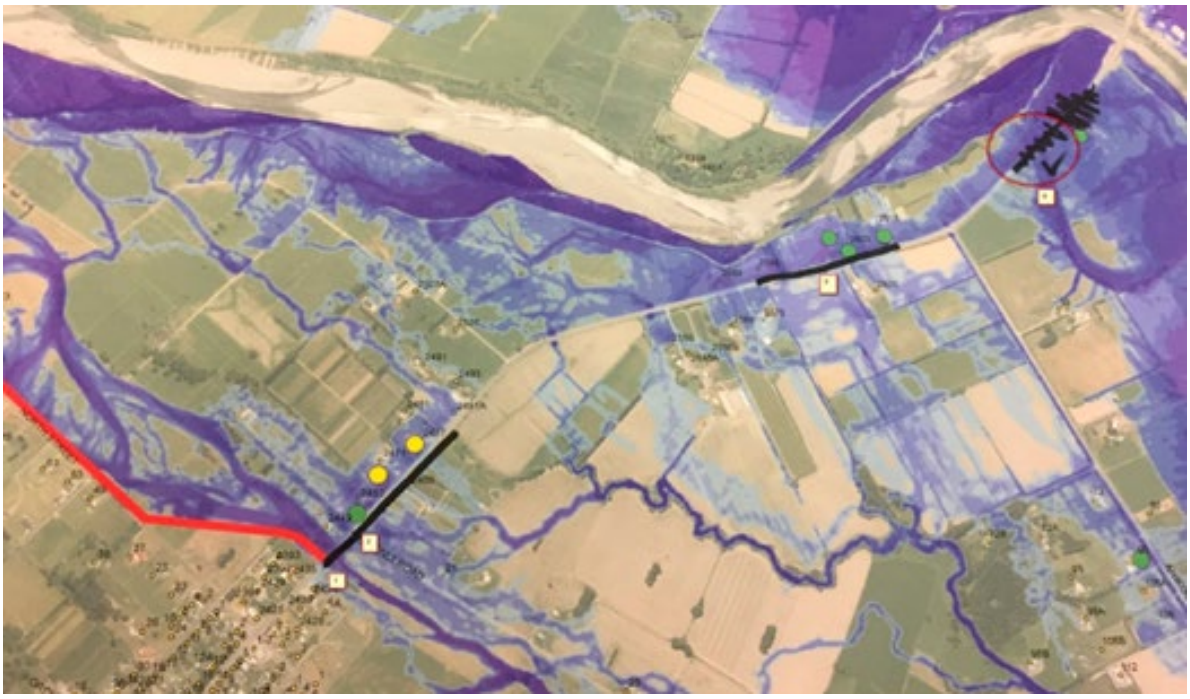


Figure 34: Flood Map – 1:20 Year Flood Risk Discussion – landriversea Consulting

6.11 Freeboard and flood sensitivity

What is a Flood Sensitive Area? The Flood Sensitive Area shows where, if exceptional things happen, above and beyond the modelled flood, the extra floodwater, might spread to.

For instance, the flood modelled for the Waiōhine River by the year 2090, is a one-in-one hundred-year flood (1% probability in any year), plus an extra 16% of water volume to represent climate change. In addition to this it is possible, but unlikely, that other factors could come into play and, however unlikely, might slightly extend the area affected by flood. Also, usually but not always, because these are typically, not major additional factors, the area and depth of extra flooding is relatively small. An example of an exception to this is the possible impact of gravel build-up (aggradation) in the stretch of river above the end of Kuratawhiti Street.

For instance, a flood sensitivity scenario might be:

- A one-in-one-hundred-year (with a chance of happening on average once every 100 years – i.e. a 1%) flood,
- PLUS 16% extra water volume for climate change,
- PLUS, a culvert being blocked by debris,
- EQUALS a slightly larger coloured area on the map (we've used pink colours to show what extra flooding might occur).

Figure 35: Showing Raised Bed Level At End of Kuratawhiti Street – landriversea Consulting.

6.12 Setting the flood sensitive area

A range of things were identified as possible contributors to flood sensitivity and each one became a separate "scenario". In his study of flood sensitivity "Waiōhine River – Hydraulic Modelling – Summary of Sensitivity and Stopbank Runs", Matt Gardner of LandRiverSea Consulting worked with the Project Team to identify, then model a wide range of possible factors that may influence flood sensitivity.

These included:

- Scenario 1 – LandRiverSea Consulting explain this as: "The base scenario simulates a 100-year event (peak inflow of 1700 Cumecs, or cubic metres per second of water, for the Waiōhine River), plus a climate change allowance until year 2100, running through the calibrated model setup. The climate change allowance is defined in terms of increase in peak rainfall intensity, which is 16% for this scenario (see Table 1). The inflow hydrograph for Waiōhine River has a single peak (temporal pattern 2 or "TP2") for this run. The sensitivity runs detailed in the following paragraphs are defined with respect to this base scenario. "
- Scenario 2 – 20% increase of Mannings 'n' (a measure of bed "roughness" or friction caused by a build-up of stones or other detritus)
- Scenario 3 – 20% decrease of Mannings 'n'
- Scenario 4 – IPCC climate change scenario RCP 8.5
- Scenario 5 – IPCC climate change scenario RCP 2.6
- Scenario 6 – Bed levels near Kuratawhiti Street raised.
  Note that for Scenario 6, the bed levels near Kuratawhiti Street have been raised uniformly by 0.5m. The reach of the Waiōhine over which the bed levels have been adjusted, is highlighted in the following diagram. These alterations were in practice, applied between cross sections 26 and 29:
- Scenario 7 – Bed levels near Kuratawhiti St lowered 0.5m
- Scenario 8 – Blockage at bridges and Apple Barrell floodway
- Scenario 9 – Small banks removed
- Scenario 10 – 1500 cumecs (cubic metres per second of water) single peak plus climate change up to year 2100
- Scenario 11 – 1500 cumecs double peak plus climate change up to 2100
- Scenario 12 – 1700 cumecs double peak plus climate change up to 2100
- Scenario 13 – 1900 cumecs single peak plus climate change up to 2100
- Scenario 14 – 1900 cumecs double peak plus climate change up to 2100
- Scenario 15 – 20-year (5% probability in any year) event temporal pattern 1 (current climate)
- Scenario 16 – 20-year event temporal pattern 2 (current climate)
- Scenario 17 – 50-year event temporal pattern 1 (current climate)
- Scenario 18 – 50-year event temporal pattern 2 (current climate)
- Scenario 19 – Bank erosion 1
- Scenario 20 – Bank erosion 2
- Scenario 21 – 1700 cumecs single peak (current climate)
- Scenario 22 – 50-year event temporal pattern 1 plus climate change up to 2100
- Scenario 23 – 20-year event temporal pattern 1 plus climate change up to 2050
- Scenario 24 – 20-year event temporal pattern 2 plus climate change up to 2050

- Scenario 25 – 20-year event temporal pattern 2 plus climate change up to 2100
- Scenario 26 – 50-year event temporal pattern 2 plus climate change up to 2050
- Scenario 27 – 50-year event temporal pattern 2 plus climate change up to 2100
- Scenario 28 – Base Scenario + Increase in Manning's 'n' by 20% between XS33 to XS38
- Scenario 29 – 20-year event temporal pattern 2 plus climate change up to 2050 + Increase in Manning's 'n' by 20% between XS33 to XS38
- Scenario 30 – 50-year event temporal pattern 2 plus climate change up to 2050 + Increase in Manning's 'n' by 20% between XS33 to XS38
- Scenario 31 – Base Scenario + Increase in Bed LEVELS by 1m between XS27 and XS28
- Scenario 32 – Base Scenario + Increase in Bed LEVELS by 0.5m between XS25 and XS18

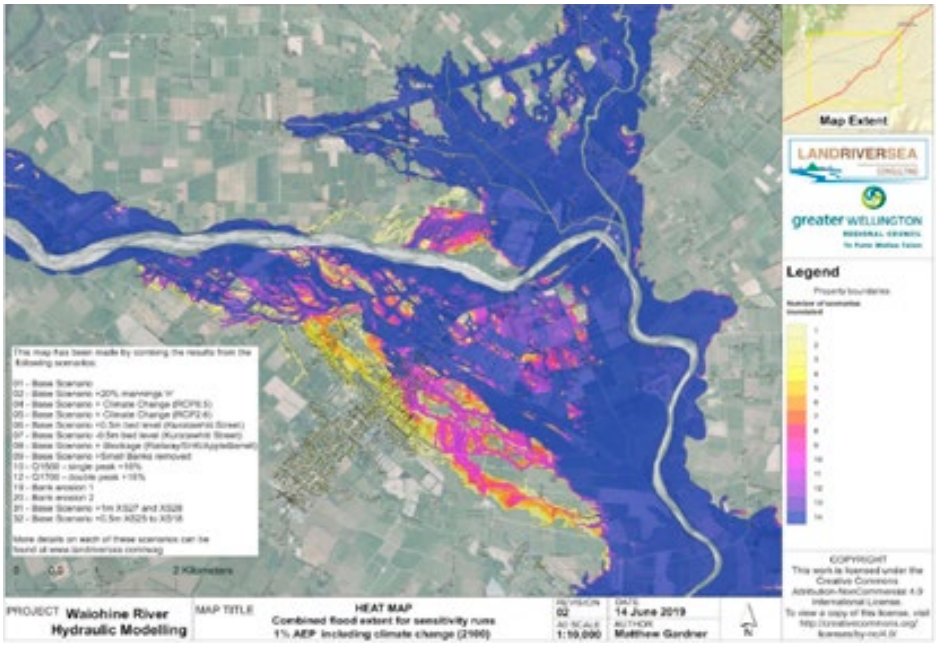


Figure 36: Significant flood sensitivity scenarios laid one on top of another to see maximum extent – landriversea Consulting.

All of these "what if" factors were modelled in turn and the resulting maps were laid one over the other, to find the outer edge of the flood sensitive zone, that accounted for every identified scenario. This was then added to the flood map as a pink area. Where the proposed stopbanks prevent this possible extra flooding, a paler pink "ghost" was left on the maps to show the area protected from flooding and flood sensitivity.

Investigations into all these contingent risks were exhaustive. For a more detailed description refer to: https://drive.google.com/open?id=1UcZ0GXzm_UXNG38wuQh4fbP4fgoZDkP7.

How could the area of flood sensitivity be used? For instance, councils might ask for new houses constructed there, to be higher than normal above ground.

Findings:

We recommend setting a Flood Sensitive Area to allow for an informative, comprehensive view of any possible risks, no matter how unlikely, that could occur that may exacerbate flood conditions.

By far and away the most significant sensitivity is that of gravel build up/increase in bed "roughness" (as modelled using Manning's "n" tool).

It is recommended that Local councils can make best use of a tool that allows them, and their clients, to readily identify the potential depth and velocity of modelled floods in each location on a given property, with an accompanying guideline on the nature of the risk. The ARR guidelines offer such a tool.

Using this approach, we are able to offer local councils and the community useful advice on minimum height for a build in a flood sensitive zone based upon the use of High, Medium and Low Hazard classification labels for land within the floodplain.

7

Structural Solutions

Structural solutions are designed to keep floods away from people.

Ministry for the Environment: *"Flooding will always be a part of living in New Zealand, and decisions will need to be made continually on the best ways to manage the flood risk in response to the weather and people's expectations. The challenge New Zealand faces now is how best to reduce the damages and losses from flooding as part of our everyday living and working lives."*

7.1 Identifying important flood defence factors

To guide decision making, factors justifying flood defence have been identified, by the Project Team, in response to community feedback:

1 Protect the town
2 Erosion Control/optimisation
3 Keep Apple Barrel Working
4 Beware of old river courses
5 Avoid ponding next to stopbank
6 Total Cost of Ownership (explained opposite)
7 Landowner preferences
8 Safety of people
9 Consentability
10 Insurability of dwellings
11 Sustainability

Total cost of ownership

The total cost of ownership (TCO) is the purchase price of an asset plus the costs of operation. Assessing the total cost of ownership represents taking a bigger picture look at what the asset is and what its value is over time.

When choosing among alternatives in a purchasing decision, buyers should look not just at an item's short-term price, known as its purchase price, but also at its long-term price, which is its total cost of ownership. The item with the lower total cost of ownership is the better value in the long run.

7.2 Goal set for flood defence design

The design criteria chosen for urban defences is: to be protected from an average once in 100 year flood (1%)* in the urban area of Greytown, up until the adaptive management Trigger of reaching the year 2050; by when this plan is to be refreshed or when another relevant Trigger event occurs beforehand.

Where * above is:

1 Flow is 1,700 cubic metres per second plus climate change (10% by 2050, 16% by 2100) + flood sensitivity,

2 Excludes projects completed within the annual works programme (budgeted c. $350k p.a. at present),

3 Upgradeability should result in "no regrets" i.e. that the space is reserved alongside flood defences that allow them to be upgraded if a trigger or the 2050 review requires it.

Rules adopted for considering flood defence options:

1 All comparisons to be as at 2050,

2 All comparisons are on base model,

3 All design must allow for it to be possible to upgrade/extend flood defences, to be able to deal with conditions we may face by the year 2100.

Note however, it may be justified to build the new stopbanks to the estimated 2100 specification straight away, where the cost differential between design to 2050 and design to 2100, is small enough. Such a decision would be subject to the Living Plan process.

The design criteria chosen for rural defences is for dwellings to be protected from an average once-in-20-year flood (5%), plus climate change in the floodplain area.

It is however, recommended that planning authorities consider that:

- New build dwellings should be constructed to a one-in-one-hundred year plus climate change (1% risk each year of such a major flood happening) standard.

Where applicable, cases should be worked through to be fully understood, prior to resource consent being applied for.

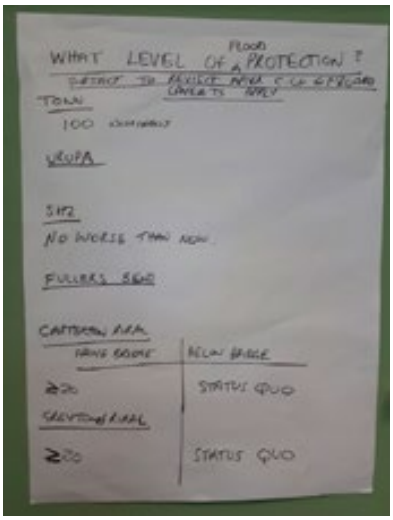


Figure 37: What Level of Flood Protection is Required – Project Team.

7.3 Principles for location and land ownership of stopbanks

Several things determine the recommended location of the two new stopbanks:

1 Protection of urban Greytown.

2 Avoiding existing dwellings.

3 Avoiding public roads.

4 Using existing high ground where practical.

5 Try to minimise impact on farm operations.

6 Cost.

The community needs security for its investment – so some form of control over the land beneath stopbanks is critical. Easements are an acceptable tool to try to meet landowners' needs. An example of an Easement agreement is included at Appendix E.

Which bank does what?

Stopbank – A shaped earth and gravel formation generally parallel to the river channel to confine floodwaters.

Training bank – A training bank is used to direct the flow and speed of floodwater to a better path during a minor flood. A training bank may be used to protect low risk assets, such as open farmland, from high frequency events, but will allow the area to be flooded in a large flood event to alleviate pressure on higher risk assets.

Sill Banks – provide a slightly higher edge to ground, or in many cases, reinstate a higher edge that had been lost by erosion. Not a stopbank.

7.4 Identifying stretches of the river sides that might need differing flood defences

TRUE LEFT BANK (Carterton):	TRUE RIGHT BANK (Greytown):
River Road to Fullers Bend (XS 20)	Greytown Stopbank to between Vines and Kuratawhiti Street
	Bottom Greater Wellington Land to Kuratawhiti Street
Fullers Bend inside	Kuratawhiti Street to Fullers Bend
	Fullers Bend outside
Fullers Bend to SH2 Road Bridge (XS 17)	Fullers Bend to SH2 Road Bridge

Figure 38: Stretches of River Needing Differing Flood Defences – Project Team.

7.5 What stopbank design is needed for this river plan?

A topographical survey of the proposed alignments was made – including the full width of road reserve where required. This showed the preliminary footprint and height of the stopbank, with respect to boundaries, and confirmed any works needed on or near State Highway 2.

The option to combine stopbank construction with North Street widening, or to use the lateral grass reserve alongside North Street road, was rejected. As building within the road reserve offered insufficient space, inboard of the existing power poles and we are advised against combining the stopbank with a foot or cycle way, for reasons of maintainability or of considering relocating the power poles there.

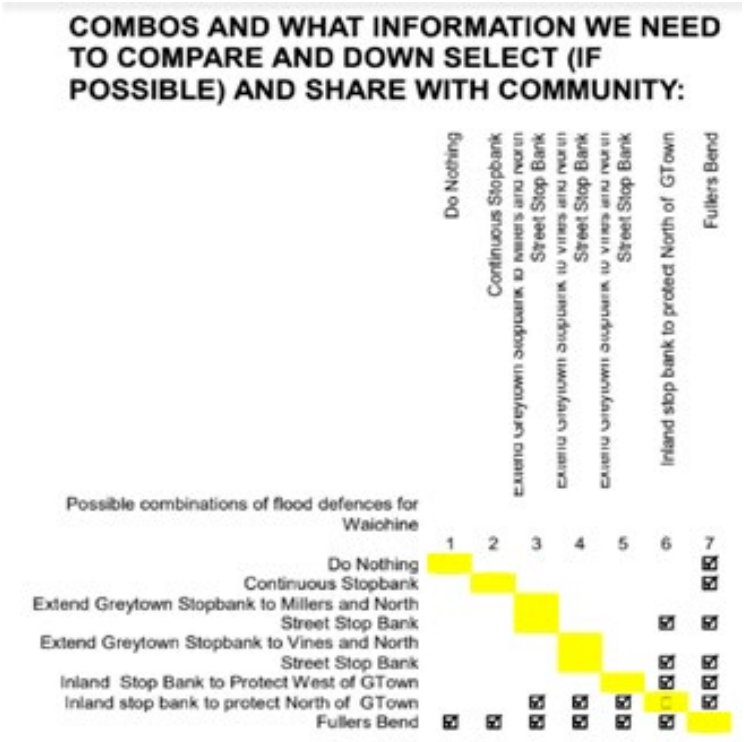


Figure 39: Various combinations of flood defences were analysed to find viable combinations.

The legal boundary of the North Street road corridor extends into the farmland to the north and east of the existing carriageway. SWDC has told the project team that they would like to ensure that the location of the North Street stopbank does not inhibit their future ability to widen the road corridor. The alignment of the North Street stopbank will therefore need to reflect the legal road boundary. There will also need to be at least 5 m between the bottom of the stopbank and the road boundary to allow for maintenance of the stopbank. This will also allow contingency if, for any reason such as failure to combat rampant climate change, the stopbank needs to be topped up.

As it is necessary to build on private land, then factors such as safety, security and access must be considered.

It is recommended that stopbanks constructed on the land of Platform Farm will consist of silt or mixed silt/gravel banks only and have a shape with sloping sides (batter) that minimizes impact on farm operation and grazing pasture.

It is recommended that stopbanks should be built where there is an optimum mix of minimal impact on farming operations, combined with minimal cost, yet maximised flood defence.

Full preliminary costing of these works has been provided. It has been necessary to push the design work to the next stage, to survey more detailed stopbank placement, height etc. to give more certainty to the conversation with landowners, and cost information to the ratepayers. Interim information has been obtained from Cameron Fauvel, who was engaged to complete this work. Note that this will still be regarded as not yet a completed estimation, until final detailed design is completed, and all costs and works are fully known.

It is recommended that rock work on the true right bank (outside of) Fullers Bend (XS 20) should be gradually completed, from river maintenance budgets, over coming years. Following advice from the Ian Heslop review, where practical snub rock groynes should be considered, working from upstream, from proposed rock armouring on the True Right Bank (TRB or Greytown side) of Fullers Bend.

Regarding the area on Platform Farm characterised as the underside of the low bank with a hook, it is proposed not to attempt to protect this from erosion with trees on the high ground above the river as this is proven to be ineffective. The river simply would undercut the bank below the tree roots. Instead we recommend planting the resulting beach, if erosion creates one. This is necessary in order to maintain channel alignment and deter further erosion.

Regarding protecting the True Right Bank (Greytown side) at the Vines' Farm (XS 28-30) it is proposed a similar strategy is to be adopted, i.e. to plant the resulting beach if the high ground erodes (to deter further erosion). If this occurs and it is necessary, a sill bank should be constructed, to maintain height of the edge if necessary, to prevent substantial incursion.

7.6 Analysis of six options identified for flood defences

Notes: The "charts" accompanying the maps of each of the flood defence options below were based upon the best information available at the time (July 2018) of the very well attended public drop-in sessions. These were accompanied by the following cautionary note:

*"**Proceed with Caution** – this is our first sneak preview of what will be tightened up as we work to consult with community and stakeholders*

***Rough as Guts (RAG)** – all figures may appear smaller than they really are. Excludes stakeholder related costs, detailed design and costing, GST and other stuff we haven't thought of. CAPEX is rounded up to the nearest $.5m.*

***For Comparison:** Areas of star charts are for the sole purpose of drawing attention to the comparative strengths and weaknesses of options. Some work remains to be done on firming up the statements of benefits for community and stakeholders.*

***This is Not the Whole Picture of Cost:** It does not include a range of things that relate to an FMP that we have not completed work on yet. For instance, in the revoked draft FMP there was a budget of $1.5 million for the rock lining of the outside curve bank (Greytown side) of Fuller's Bend (XS 20), near the SH2 bridge (XS 17). So, we should not, in any way, view these numbers as being close to the final, total cost of the FMP.*

***Planning, building, consenting, LIMS etc.** are the province of District Councils, we won't know all the implications for those topics for each of the options here, until we've done more work and also have their considered view of this.*

***Opinions are just that.** There is a lot more work to do and a lot of community and stakeholder consultation to go before the Waiōhine FMP Project Team can offer a recommendation, based upon all those things, as to what may be the best option for flood defences. In the meantime, personal opinions should not be assumed to be the collective view of the team, or the community, or the other stakeholders and anyway, as we do more and more work, as you would expect, our opinions do change."*

The Independent Peer Review of the following options by Ian Heslop noted: *"The range of modelling options considered is comprehensive, and appropriate for the adopted design standard".*

7.6.1 Option 1: Build Nothing

Option 1 was provided as a basis for comparison and to show what impact there would be if a decision were made not to invest in any additional form of flood protection and a major flood event occurred in the future.

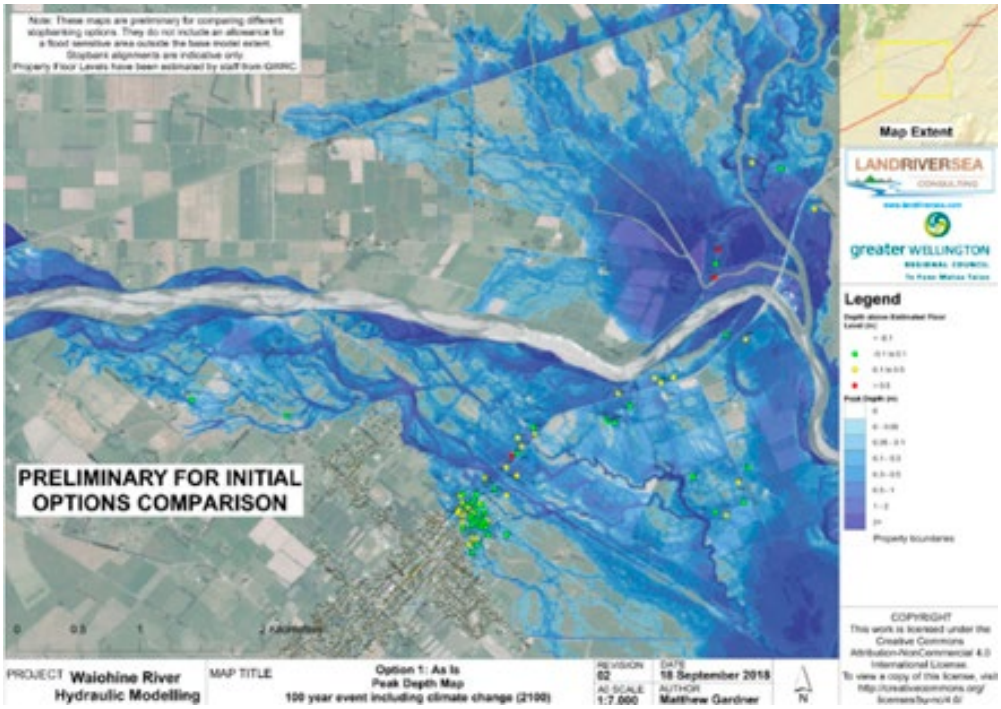


Figure 40: Used to identify impact if no defences are constructed. Note that there is some impact on urban dwellings at the North end of Greytown and along State Highway 2.

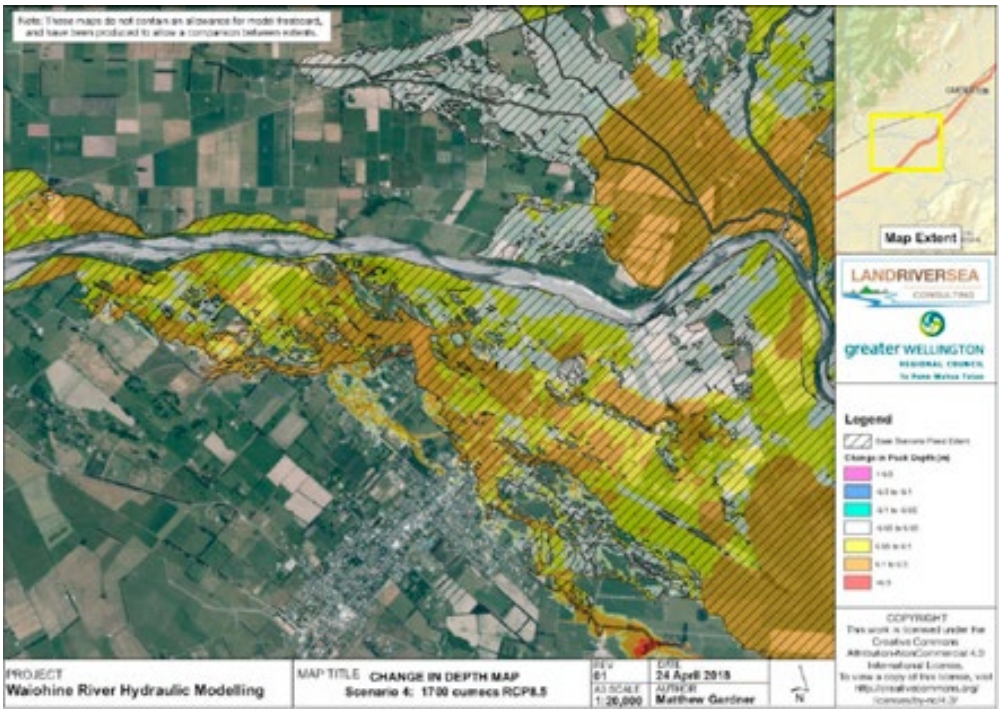


Figure 41: An option showing a severe 1% flood with severe climate change (IPCC RPC 8.5).

Option	Rough Cost (plus or minus 30%)	Water somewhere on property (no. of houses)	Below >-0.1m below floor joists (no. of houses)	Above >0.1m above bottom of floor joists (no. of houses)	>0.5m above bottom of floor joists (no. of houses)
1 (build nothing)	$0	128	45	18	1
2 Inland Stopbanks (North Street & K Street)	$0.7m	46	23	11	1
3 (North Street and Beban (XS 30))	$1.3m	41	23	11	1
4 (North St. & Vines (XS 28-30))	$2.3m	33	20	10	1
5 (North St, Vines and Fullers Bend (XS 20)	$2.5m	35	19	10	1
6 (Continuous Stopbank)	$3m	24	14	6	0

Figure 42: Table showing Option 1 Implications – Project Team.

7.6.2 Option 2: Inland stopbanks – near North Street and western near Kuratawhiti Street.

Option 2 allows the river to behave relatively naturally, to spread out and slow down in flood. Relatively inexpensive stopbanks can be constructed near the edges of the urban area to provide one-in-one-hundred year, flood plus climate change, plus sensitivity standard. Seeking a slight change in road crown height on selected stretches of SH2 would enhance protection to some rural properties. This approach relies on continued good river and gravel management to prevent the river from taking a new course.

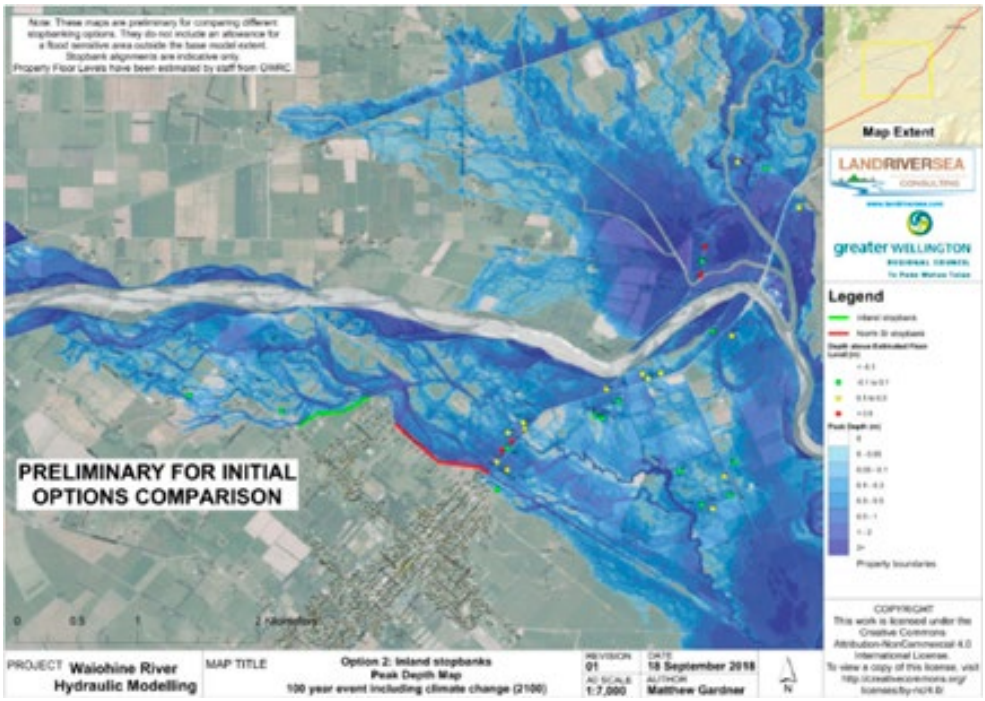


Figure 43: Flood Map – Option 2 Inland Stopbanks – landriversea Consulting.

Option	Rough Cost (plus or minus 30%)	Water somewhere on property (no. of houses)	Below >-0.1m below floor joists (no. of houses)	Above >0.1m above bottom of floor joists (no. of houses)	>0.5m above bottom of floor joists (no. of houses)
1 (build nothing)	$0	128	45	18	1
2 Inland Stopbanks (North Street & K Street)	$0.7m	46	23	11	1
3 (North Street and Beban (XS 30))	$1.3m	41	23	11	1
4 (North St. & Vines (XS 28-30))	$2.3m	33	20	10	1
5 (North St, Vines and Fullers Bend (XS 20)	$2.5m	35	19	10	1
6 (Continuous Stopbank)	$3m	24	14	6	0

Figure 44: The option strongly preferred by most of the community and the Project Team.

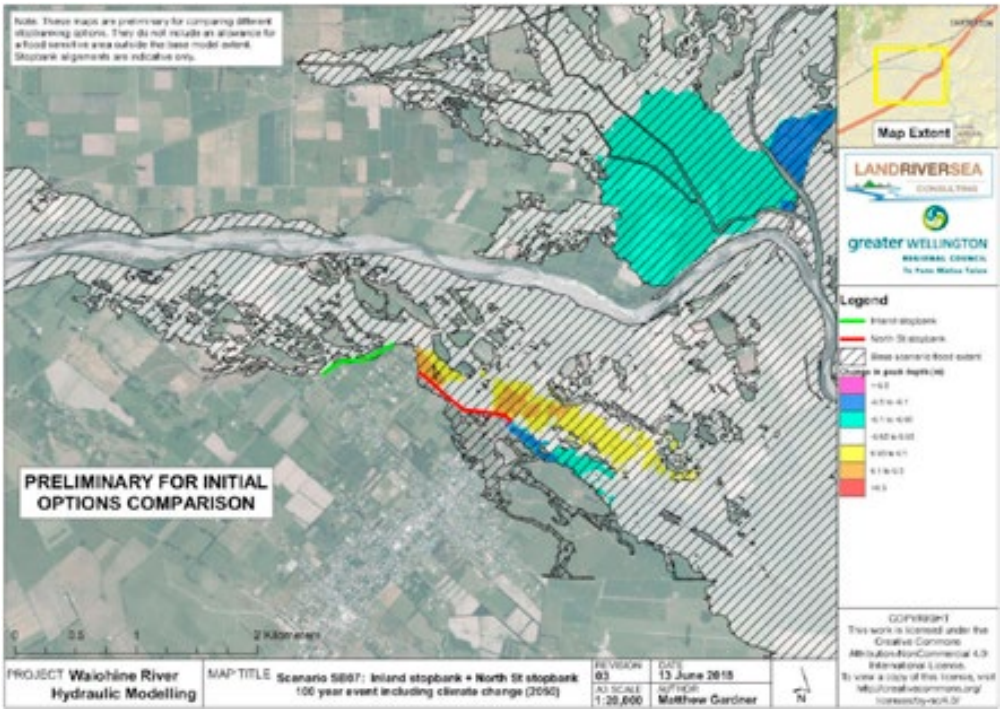


Figure 45: Shows minimal change in flood depth due to inland stopbanks and shows urban area saved from flooding.

Further study of Option 2 above, showing that a cross-hatched urban area is recommended to be saved from flooding by the urgent and important North Street Stopbank – shown as a red line.

The Inland Western or Kuratawhiti Street Stop Bank, shown in green, is close to Kuratawhiti Street. It is recommended that, whilst not as urgent as the North Street Stop Bank, this stop bank is built as soon as is practical.

A series of flood sensitivity models showed the risk of much greater flooding, as the result of possible gravel build up (aggradation) – see Tonkin and Taylor report, in the stretch of river near the end of Kuratawhiti Street, although unlikely, would necessitate the Kuratawhiti Street Stopbank being built to avoid planning, permitting and insurance issues, for a large part of urban Greytown. The combinations of factors and possible outcomes are shown in this diagram:

IF	1:100 Year Flood (1%)	PLUS	Climate Change RCP 6 (+16% water)	THEN			North Street Stop Bank is **Needed**	BUT	Kuratawhiti Street Stop Bank is **Not Needed**
IF	1:100 Year Flood (1%)	PLUS	Climate Change RCP 6 (+16% water)	PLUS	Gravel builds up from poor management	THEN	North Street Stop Bank is **Needed**	AND	Kuratawhiti Street Stop Bank is **Needed**
	or								
IF	1:100 Year Flood (1%)	PLUS	Climate Change RCP 6 (+16% water)	PLUS	Gravel extractor quits	THEN	North Street Stop Bank is **Needed**	AND	Kuratawhiti Street Stop Bank is **Needed**
	or								
IF	1:100 Year Flood (1%)	PLUS	Climate Change RCP 6 (+16% water)	PLUS	Second 1:100 Year Flood (1%) follows	THEN	North Street Stop Bank is **Needed**	AND	Kuratawhiti Street Stop Bank is **Needed**

Figure 46: Table analysing which stopbanks are needed for which scenario – Project Team.

The Ian Heslop led Independent Peer Review noted that: *"The preferred option is the combined North Street and Inland (Kuratawhiti Street) Stopbank. This option ticks the most boxes given least capital and ongoing maintenance costs, minimal flood diversion effects, negligible erosion and under-design breach risk, and least need for channel management. The prospect of securing high community support and resource consent will be high, and risk of inappropriate ongoing floodplain development minimised. One key point that needs to be reinforced is that bed level and channel management will need to continue, to maintain the current river alignment and both the rural and flood protection standards. Stopbanks on the northern side will continue to be protected and maintained."*

7.6.3 Option 3 – inland stopbank near North Street and extension of Greytown stopbank to Beban's Farm

In scenario 3, the existing Greytown Stopbank near the end of Wood Street is extended to force flood water back towards the Waiōhine river channel (see pale yellow line on map below). No significant difference could be found in flood risk to either urban or rural dwellings but the cost to build and maintain was substantially more than Option 2. See diagram below:

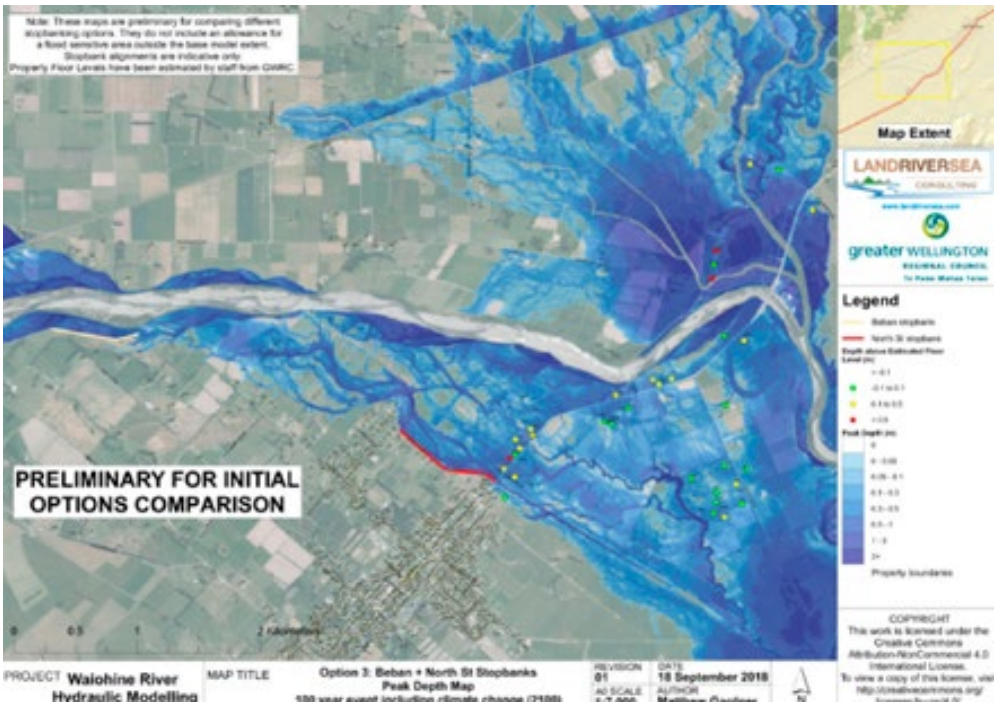


Figure 47: Option 3 North St Stopbank plus Greytown Stopbank Extension – landriversea Consulting.

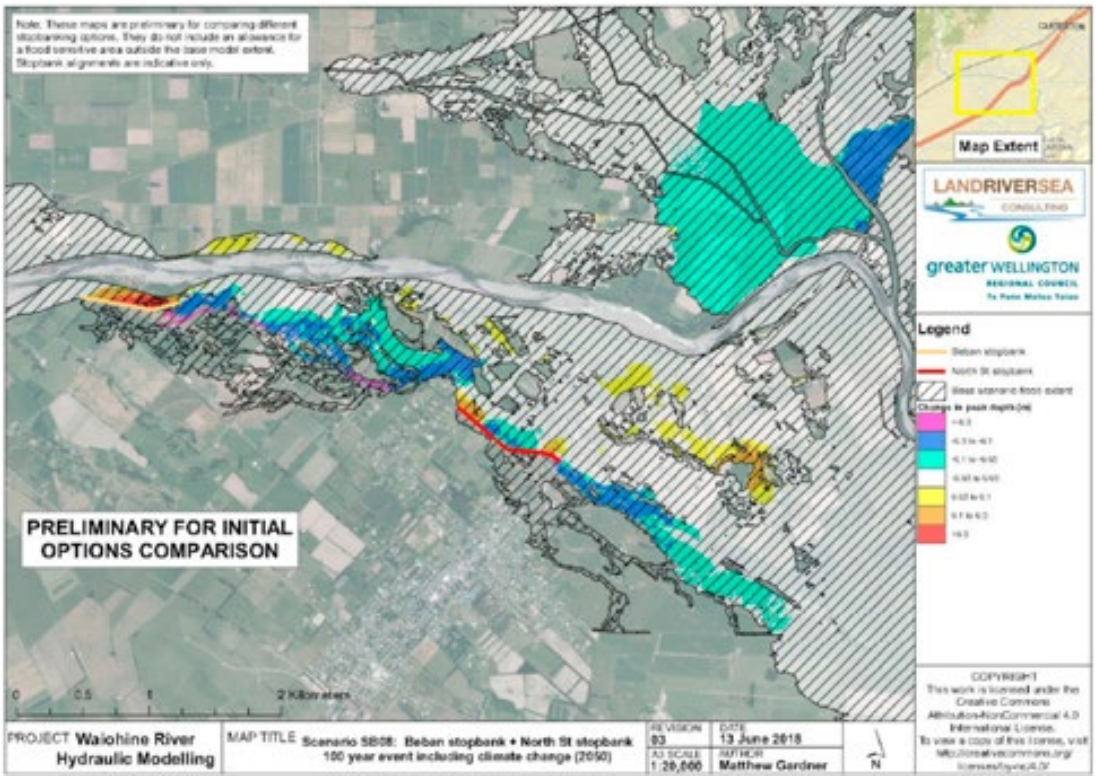


Figure 48: Option 3 North St Stopbank plus Greytown Stopbank Extension to XS 30 – landriversea Consulting.

Much of the "spread out and slow down the flood" effect was lost. Attempts were made through subsequent studies to try to model the effect of a much rougher/higher riverbed to force more water onto the Greytown Stopbank to see if it was justified through the creation of additional risks, either:

- Through scouring the lowest parts of the Greytown Stopbank and threatening to undercut the bank itself or,
- Through pushing more water around the end of the Greytown Stopbank to take a new path and threaten dwellings outside the floodplain.

Neither of these things could be made to happen. At that point the Project Team, supported by the strong public preference for Option 2 decided this option was less attractive and provided inconsistent flood protection for the rural community. However, it was nevertheless decided to:

- Plant trees along the toe of the existing Greytown Stopbank to help prevent scouring along it that might undermine the bank. If this is not viable, to alternatively build three small rock groynes, at right angles to the toe of Greytown Stopbank, to disrupt flood water and reduce the risk of scouring of the stopbank and;

It is recommended that planners require the retention of the row of mature trees that continue the line of Greytown Stopbank towards the river. Also, to plant additional trees on the toe and slope of the small escarpment on top of which the existing mature trees stand. The aim of this is to reinforce the escarpment and protect the mature trees to slow down any major flood and help to reduce excessive scouring of farmland etc.

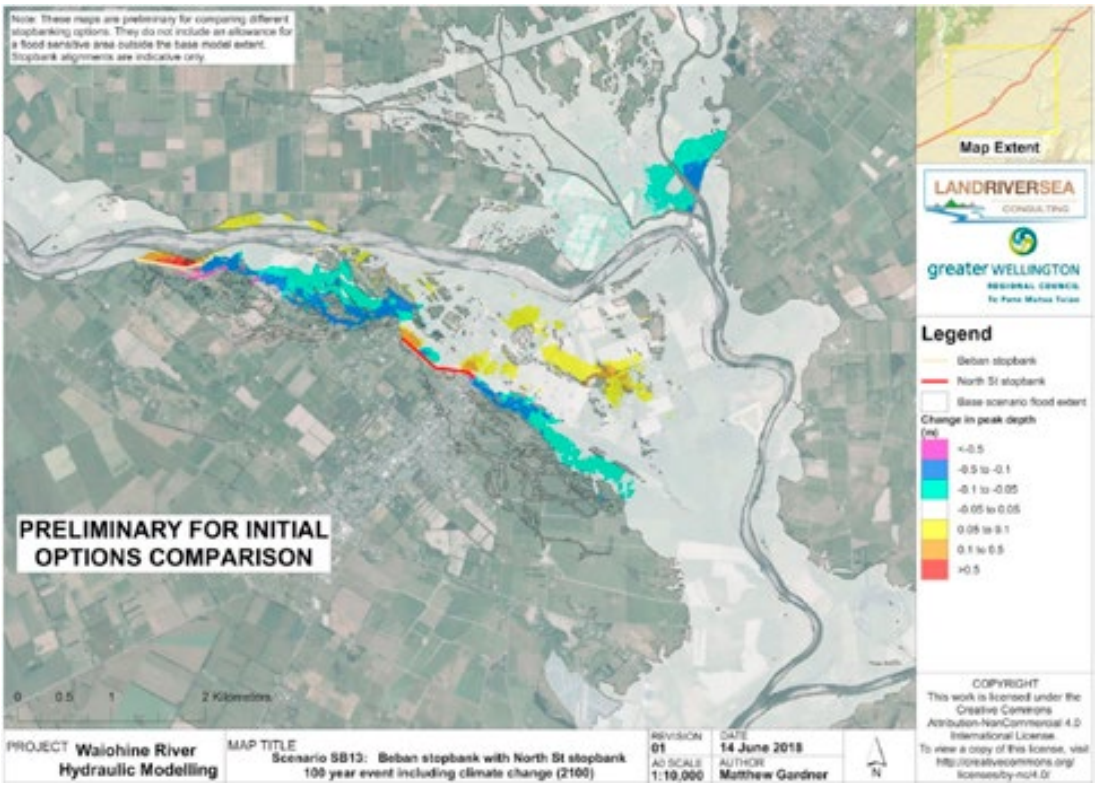


Figure 49: Showing changes in flood depth - principally to farmland but some downstream consequences in the SH2 and Ahikouka area.

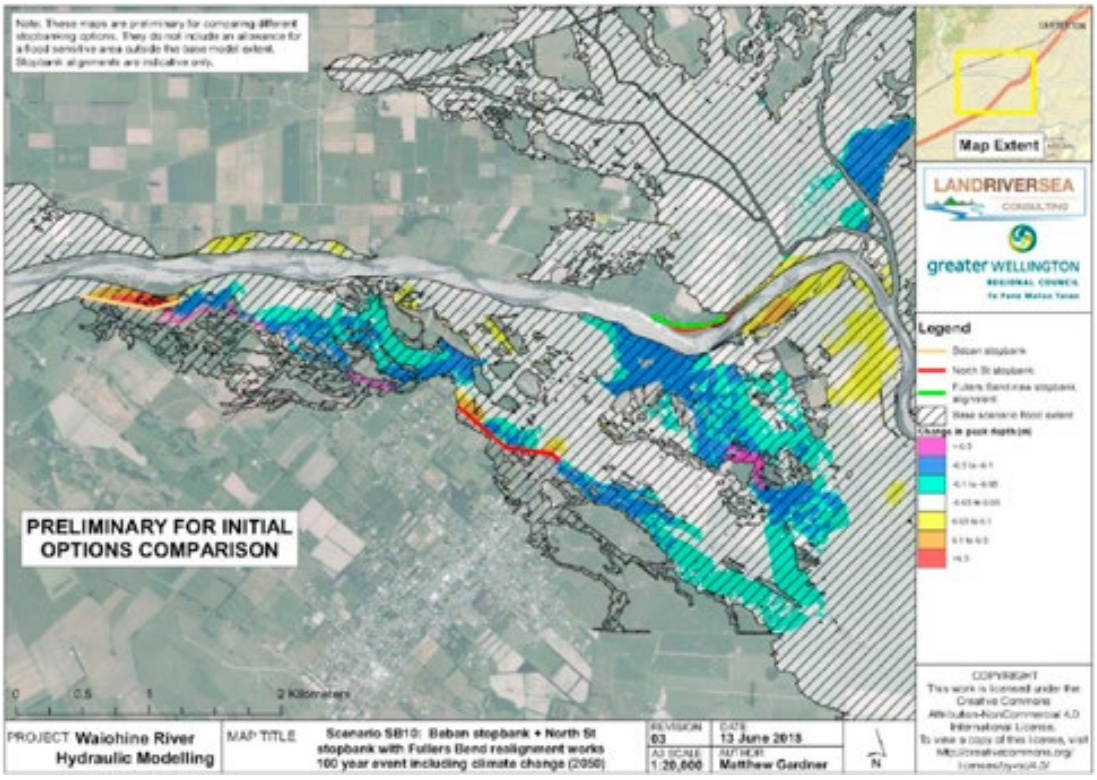


Figure 50: Option explored of adding the realignment of the inside of Fullers Bend to this scenario.

Option	Rough Cost (plus or minus 30%)	Water somewhere on property (no. of houses)	Below >-0.1m below floor joists (no. of houses)	Above >0.1m above bottom of floor joists (no. of houses)	>0.5m above bottom of floor joists (no. of houses)
1 (build nothing)	$0	128	45	18	1
2 Inland Stopbanks (North Street & K Street)	$0.7m	46	23	11	1
3 (North Street and Beban (XS 30))	$1.3m	41	23	11	1
4 (North St. & Vines (XS 28-30))	$2.3m	33	20	10	1
5 (North St, Vines and Fullers Bend)	$2.5m	35	19	10	1
6 (Continuous Stopbank)	$3m	24	14	6	0

Figure 51: Table showing Option 3 Implications – Project Team.

7.6.4 Option 4 – Inland stopbank near North Street and extension of Greytown stopbank beyond Beban's Farm(XS 30)

The idea of a long extension to Greytown Stopbank as well as a Stopbank at North Street and the re-alignment of the inside of Fuller's Bend (XS 20), was explored in Option 4. This added no improvement over Option 2 or 3, in terms of dwellings protected, or spreading out and slowing down the flood. In fact, it served to increase the flood depth in some areas, downstream from the long stopbank. The cost was considerably higher than options 2 or 3 for this approach with no discernible benefit and considerable downside.

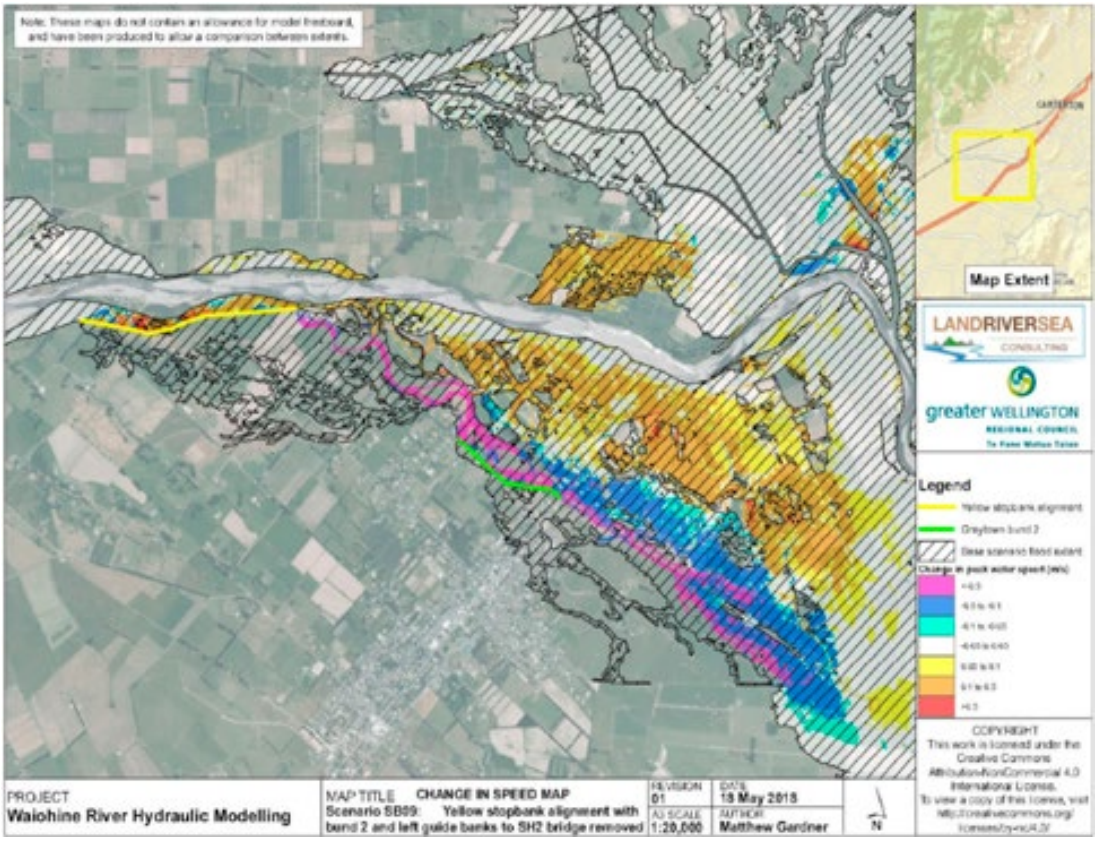


Figure 52: Option 4 North St Stopbank plus Greytown Stopbank Extension Beyond Bebans Farm – landriversea Consulting.

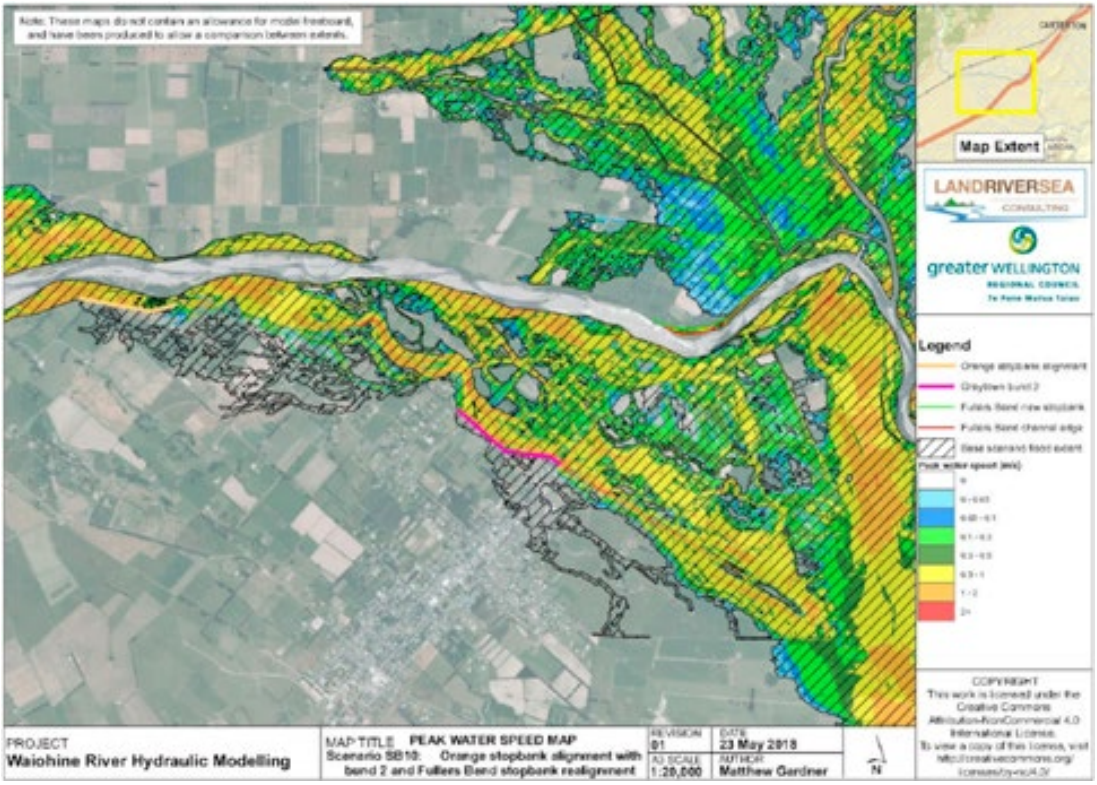


Figure 53: Peak Water Speed Map at Fullers Bend – landriversea Consulting.

Option	Rough Cost (plus or minus 30%)	Water somewhere on property (no. of houses)	Below >-0.1m below floor joists (no. of houses)	Above >0.1m above bottom of floor joists (no. of houses)	>0.5m above bottom of floor joists (no. of houses)
1 (build nothing)	$0	128	45	18	1
2 Inland Stopbanks (North Street & K Street)	$0.7m	46	23	11	1
3 (North Street and Beban (XS 30))	$1.3m	41	23	11	1
4 (North St. & Vines)	$2.3m	33	20	10	1
5 (North St, Vines (XS 28-30) and Fullers Bend	$2.5m	35	19	10	1
6 (Continuous Stopbank)	$3m	24	14	6	0

Figure 54: Table showing Option 4 Implications – Project Team.

7.6.5 Option 5 – Inland stopbank near North Street and extension of Greytown Stopbank beyond Beban's Farm (XS 30) with realignment of stopbank inside Fuller's Bend

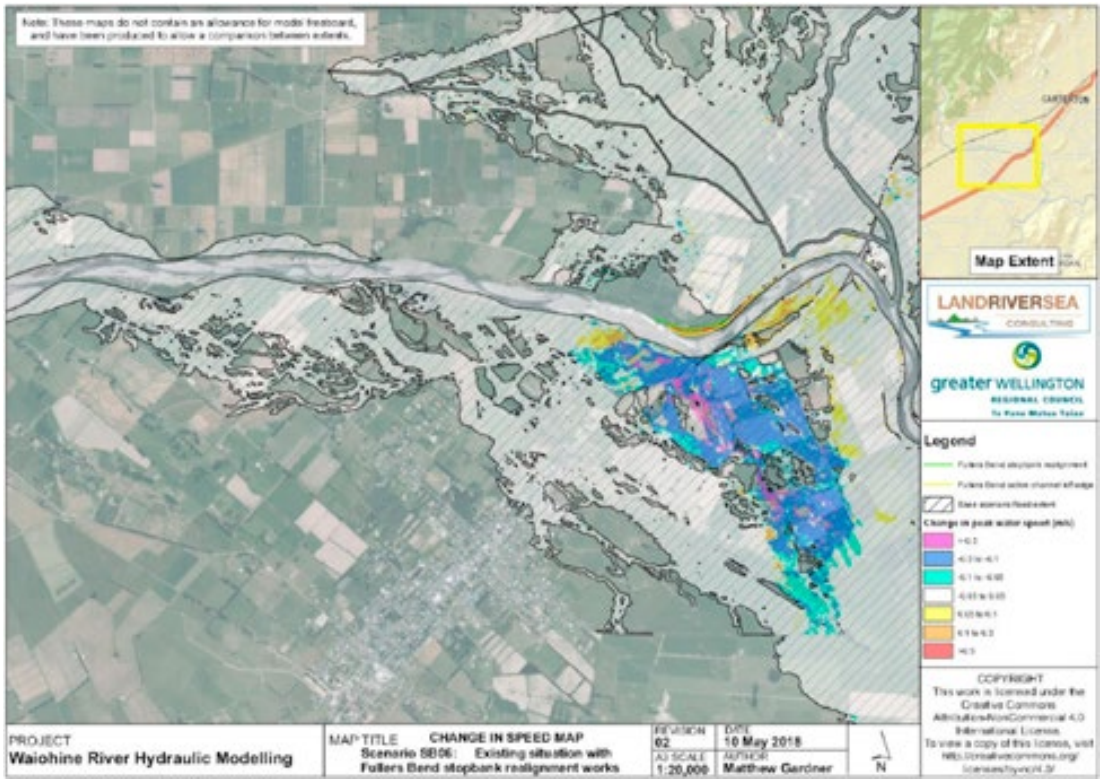


Figure 55: A study of the impact on flood depth of re-aligning the inside of Fuller's Bend – showing little benefit in flood depth.

Option 5 shares the same concept as Option 4 but includes the realignment of Fuller's Bend (XS 20), on the Carterton (true left) bank. Again, this added no improvement over Option 2 or 3 or 4 in terms of dwellings protected or spreading out and slowing down the flood and in fact increased the flood depth in some areas downstream from the long stopbank. The cost was considerably higher than options 2 through 4 and this approach was unpopular with the public.

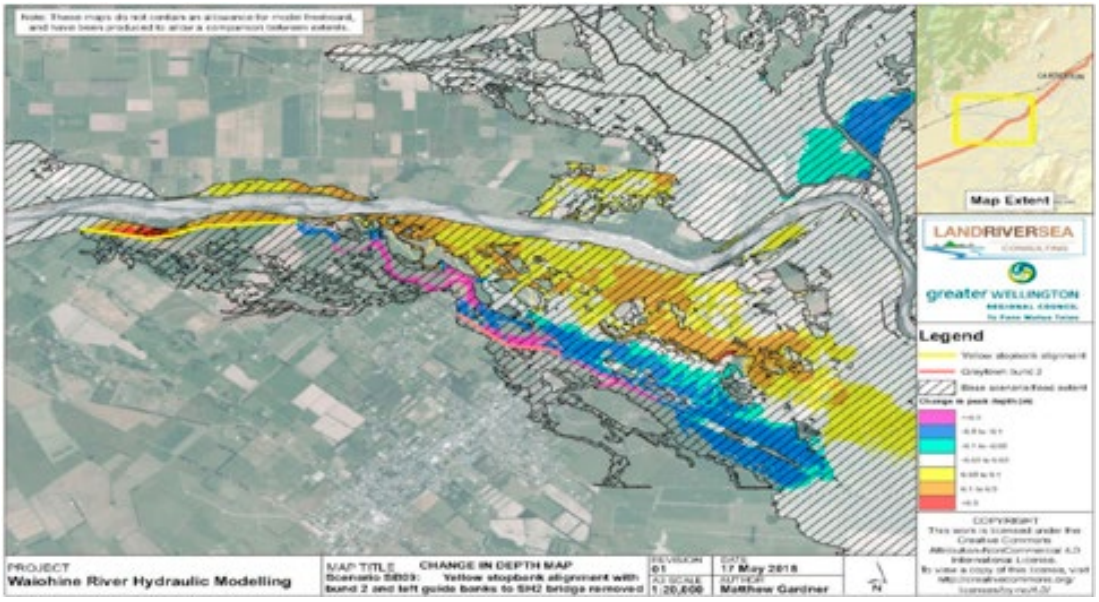


Figure 56: Option 5 – Long extension to Greytown Stopbank and Nth. Street Stopbank, showing change to depth.

Option	Rough Cost (plus or minus 30%)	Water somewhere on property (no. of houses)	Below >-0.1m below floor joists (no. of houses)	Above >0.1m above bottom of floor joists (no. of houses)	>0.5m above bottom of floor joists (no. of houses)
1 (build nothing)	$0	128	45	18	1
2 Inland Stopbanks (North Street & K Street)	$0.7m	46	23	11	1
3 (North Street and Beban (XS 30))	$1.3m	41	23	11	1
4 (North St. & Vines)	$2.3m	33	20	10	1
5 (North St, Vines (XS 28-30) and Fullers Bend (XS 20)	$2.5m	35	19	10	1
6 (Continuous Stopbank)	$3m	24	14	6	0

Figure 57: Table showing Option 5 Implications – Project Team.

7.6.6 Option 6 – Full true right bank (Greytown Side) stopbank with realignment of stopbank inside Fuller's Bend (XS 20)

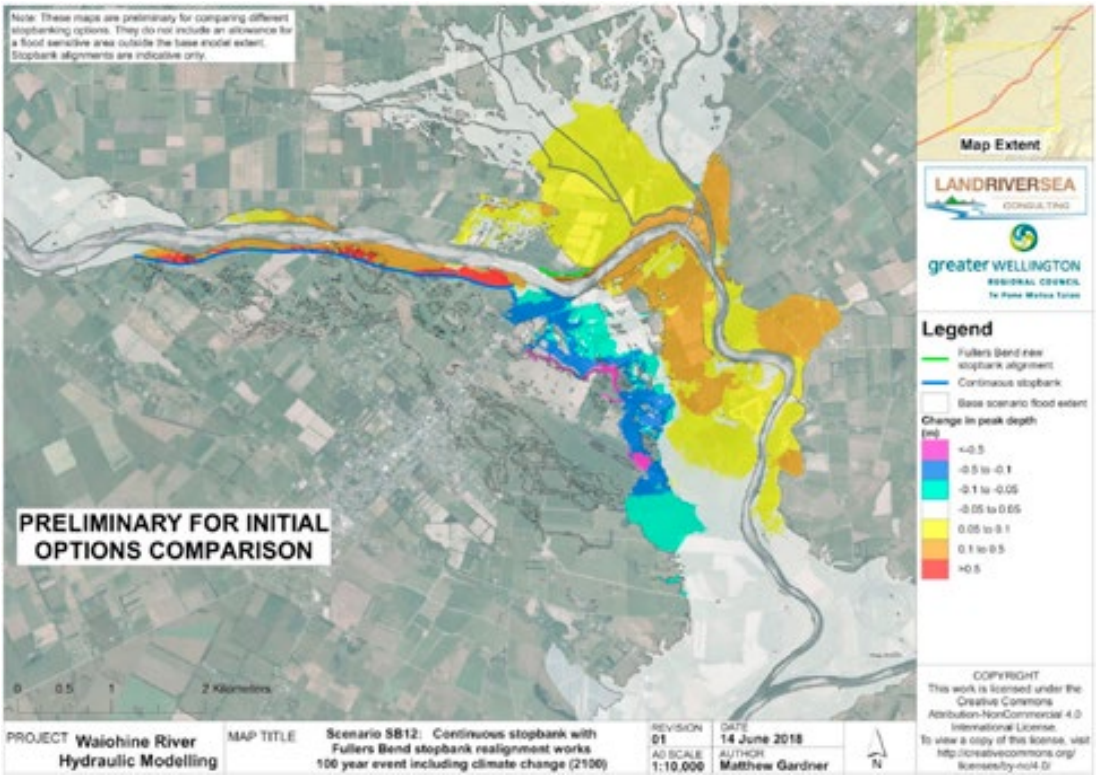


Figure 58: Study of impact of increasing depth and flooding created by a continuous stopbank. Bank is blue line.

One of the principles adopted at the beginning of the design stage was that beyond our obligation to try to protect the urban area against "one-in-one-hundred year" (1%) floods, it was unacceptable to protect one area at the expense of another – to "rob Peter to pay Paul". The above map shows that the option of building a continuous stopbank on the Greytown (true right) bank simply pushes deeper flood water onto the Carterton (True Left) bank and downstream SH2 Road Bridge (XS 17) and Ahikouka Road area. A continuous stopbank, close to the river, also would lead to maintenance challenges, disruption of farm operations and higher build and maintenance costs. Furthermore, by implication, this approach of hemming the flooding river in fails to take the opportunity to spread out, and thus slow down and dissipate the flood, with consequences for downstream properties and assets. It was further noted that all the solutions that required stopbanks close to the river or works to encourage the river to realign may struggle in the consenting process. See map study of this effect below:

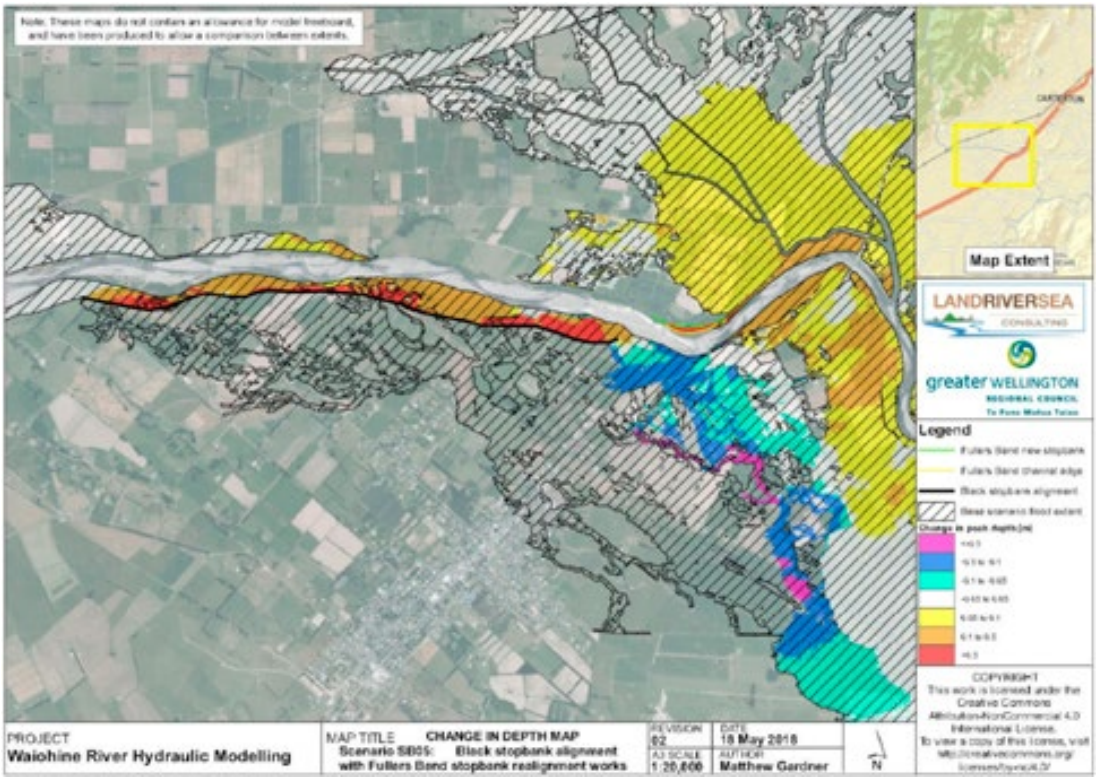


Figure 59: Study of increased flood depth downstream caused by continuous stopbank.

Option	Rough Cost (plus or minus 30%)	Water somewhere on property (no. of houses)	Below >-0.1m below floor joists (no. of houses)	Above >0.1m above bottom of floor joists (no. of houses)	>0.5m above bottom of floor joists (no. of houses)
1 (build nothing)	$0	128	45	18	1
2 Inland Stopbanks (North Street & K Street)	$0.7m	46	23	11	1
3 (North Street and Beban (XS 30))	$1.3m	41	23	11	1
4 (North St. & Vines (XS 28-30))	$2.3m	33	20	10	1
5 (North St, Vines and Fullers Bend (XS 20)	$2.5m	35	19	10	1
6 (Continuous Stopbank)	$3m	24	14	6	0

Figure 60: Table showing Option 6 Implications – Project Team.

Findings:

- **Option 2 is recommended** as likely to be the best solution, best meeting criteria for defending against a one in one-hundred-year flood event (1%) i.e. a straw man of 1700 cubic metres per second plus or minus 200 M^3 per second.
- Option 2 is more likely to meet the requirement of the solution being consentable.
- Option 2 was also far more popular than other options for the large number of people who attended the two community drop-in events, WAG meetings and online feedback.
- Other options revealed a very poor trade off of much higher cost for little or no additional protection of dwellings and critical assets and/or protected some agricultural land at the expense of greater flooding on other agricultural land (robbed Peter to pay Paul).

7.7 Table of initial estimates of materials and costs of components of structural works

Note: Re-aligning by widening the inside of Fuller's Bend is approximately $1m build cost, is required for Options 4, 5 and 6. Other options also allow the sale of three parcels of land on the inside of Fullers Bend that were acquired to facilitate those works, freeing the annual cost of servicing this debt to boost river maintenance work.

'Rough As Guts' estimates	Volume of Material	$ Cost of Build	$ Maintenance Cost +/- $	$ Contingencies (at 30% of Construction cost)
Continuous Stopbank	99.4k M^3 111.6k M^3	1.9m	0.56	0.57m
Fullers Bend (XS 20)		0.3m		0.85m
Inland	1.6k M^3	0.04m	0.075	0.01m
Beban (XS 30)	19.0k M^3	0.44m		0.13m
Vines (XS 28-30)	43.0k M^3	0.82m		0.25m
North Street	14.8k M^3 11.0k M^3 18.0k M^3	0.34m 0.25m 0.41m		0.10m 0.075m 0.123m

Figure 61: Table of Initial Estimates of Materials and Costs – Project Team.

Notes:

1 From James Flanagan's Preliminary Numbers.

2 Excludes investigation.

3 Excludes normal river maintenance.

4 Plus sourcing the material from the Mangatārere banks near SH2, if practical, will allow trapped flood water to escape better from that area.

5 Plus "right hand column costs".

6 Subject to refinement see Cameron/Fauvel report.

7.8 The six options for flood defence strategies were opened to public consultation using the following channels

1 Publishing on social media (Facebook and Neighbourly) and email (WAG email list) to share information about the options.

2 Two very well advertised (posters, WAG meetings, word of mouth and local newspapers and publications) 'open day' type events for the public to drop in, ask questions and voice opinions to help with the decision making – one in the evening and one on a Saturday afternoon to provide alternatives for widest reach, attended by approximately one hundred and fifty residents.

3 Offers to community groups to meet and share (ongoing).

4 Public meetings were hosted by Waiōhine Action Group prior to and after the drop-in sessions for the same purpose (public meetings were hosted by WAG (open membership to everyone in Waiōhine valley) throughout this project – to share information and seek questions, feedback and help with decision making).

5 For each of the six options the following information was provided:
   a Detailed maps, showing flood defences and impact on flooding,
   b RAG ('Rough As Guts') comparative build costs,
   c Best available data on the number of dwellings affected and impact on them,
   d Project Team members to provide further information and answer questions.

6 What was learned:
   a What information resonated well with the community,
   b That there was an overwhelmingly obvious response as to which options were most favoured and which were not,
   c Ideas for additional improvements were received to the most favoured options (these were all investigated and some adopted).

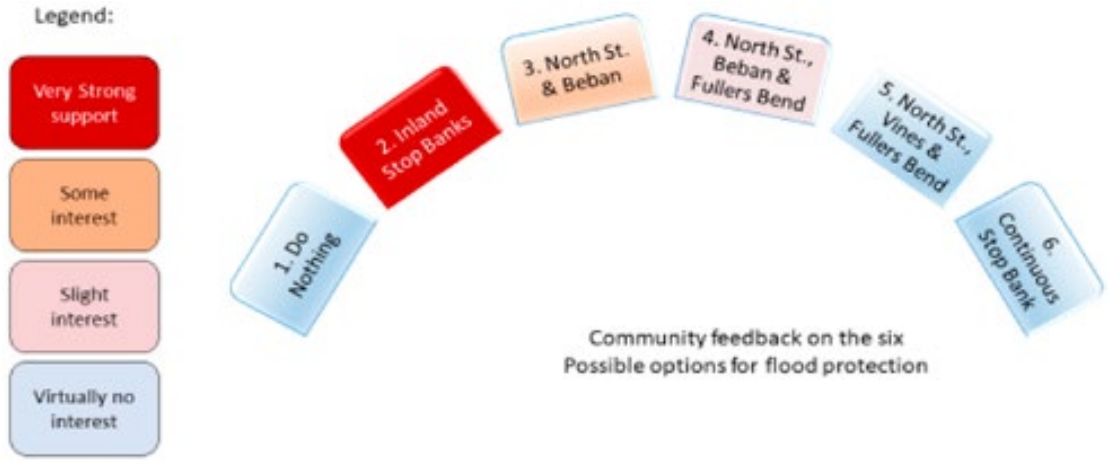


Figure 62: Community feedback on the six scenarios.

7.9 Options comparison of costs and property impacts (out to 2050, without sensitivity)

Note: All numbers are 'Rough As Guts' (RAG) and subject to refinement.

Option	Rough Cost (plus or minus 30%)	Water on property (no. houses)	Below >-0.1m (no. of houses)	Above >0.1m (no. of houses)	>0.5m (no. of houses)
1 (build nothing)	$0	128	45	18	1
2 Inland Stopbanks (North Street & K Street)	$0.7m	46	23	11	1
3 (North Street and Beban (XS 30))	$1.3m	41	23	11	1
4 (North St. & Vines (XS 28-30))	$2.3m	33	20	10	1
5 (North St, Vines and Fullers Bend)	$2.5m	35	19	10	1
6 (Continuous Stopbank)	$3m	24	14	6	0

Figure 63: Comparisons of Costs and Property Impacts – Project Team.

Notes:

- Based on visual assessment of floor levels as at present for recently built dwellings as well as data on other dwellings from the GWRC database. Excludes outbuildings.
- Projected to 2050 (this allows +10% extra flood water for climate change)
- Costs exclude the remaining cost of purchasing the three parcels of land for the Fullers Bend (XS 20) re-alignment in options 4,5,6. For options 4-6 this additional cost (of around $1.2 million plus mortgage interest) and for options 1-3 any net profit from sale will contribute to the scheme.
- In estimating costs of this solution, a 50% loading was added to land values, to represent fees etc. that could be incurred. This was adjusted to 60% if the land is close to the town.

7.10 Decision reached at 1:30pm on 15th August 2018

Having reviewed all the public feedback from the August 2018 public drop-in sessions, the six available options were short-listed to just three flood protection options, in order of public preference (high to low):

- **Recommended:** inland North Street (Eastern) and Western stopbank, near Kuratawhiti Street (was option 2 at drop-ins) also known as 'Protect the Town'.
- North Street and Beban (XS 30) (was option 3 at drop-ins) also known as 'Protect the town and short extension to Greytown Stopbank'.
- North Street, Bebans and Fuller's Bend(XS 20), (was option 4 at drop-ins) also known as 'Protect the town, short extension to Greytown Stopbank and re-align Fuller's Bend'.

The highlighted cells in the table above show the best available data relating to these three options, where there is a difference between the options. It was therefore decided that there is no need to do further work on flood defence options 1,5 or 6, as there was either little or no interest in these by the community.

7.11 Decision reached at 1:30pm on 20th September 2018

Once the decision was made by the community as to which flood defence option best matched its vision for the future of the Waiōhine River, it was decided to undertake a series of more detailed studies on a number of topics around Option 2 (inland stopbanks). These included:

1 A flood sensitivity study to identify the impact of extraordinary events coinciding with a one-in-one-hundred-year flood (1%) as at both the 2050 and 2100 planning horizons,

2 Conceptual design – to see more clearly where, how high, how long, what profile and what cost was associated with each of the two new stopbanks, including an additional investigation was made into the impacts of re-aligning the Western Stopbank.

3 A more detailed study into modelling what would happen if the riverbed built up or was blocked near the end of Greytown Stopbank, to find out if or what extension or other defences might be needed there and

4 How much Freeboard (room for water velocity or wind action etc. pushed up the side of the stopbanks) should be planned for.

5 What the impact of re-aligning Fullers Bend might be.

Having obtained the results of further modelling work for detailed investigations the following observations were made:

7.11.1 Do Nothing

This additional study did not show any new information but clearly illustrated that there is a need to eliminate this option of "do nothing" in order to prevent extensive flooding to the northern end of Greytown.

7.11.2 Conceptual Design

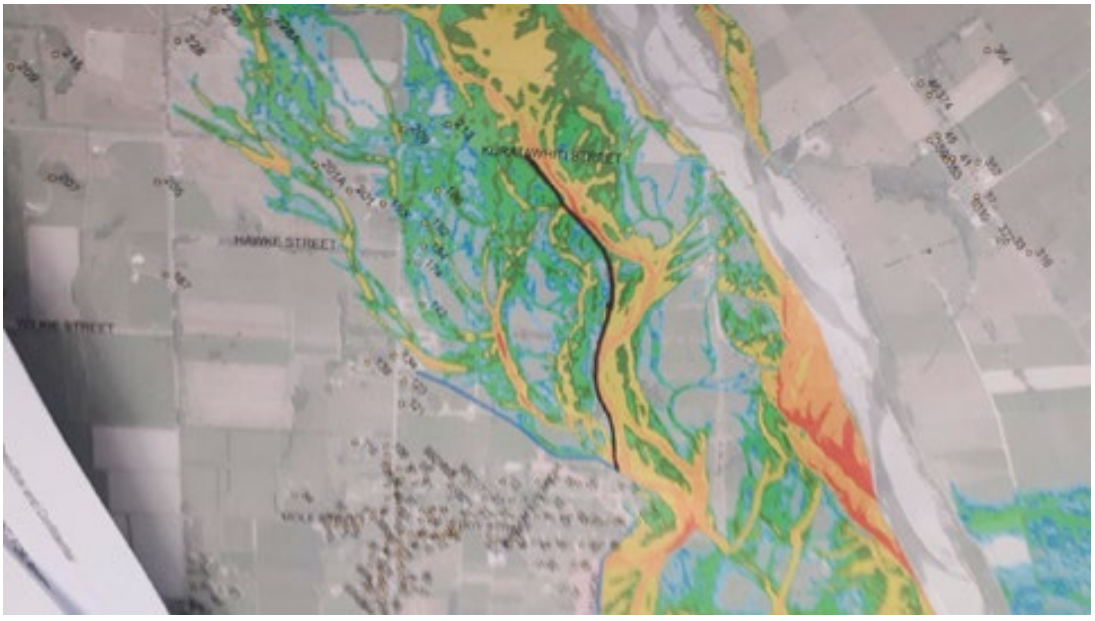


Figure 64: Investigation into possible alternative path for Western Stopbank - design path in blue, alternative path in black.

See Cameron Fauvel Report for conceptual design information.

As the result of a landowner consultation, an alternative path for the Western Stopbank (near Kuratawhiti Street) was investigated.

Unfortunately, indications are that this path would result in a stopbank of at least twice the length, far higher, with a much wider base. It was realised that this would present several challenges:

1 A far higher cost than the preferred path,

2 A greater impact on farm operations,

3 It still exposed an open flank to the West that would require considerable further work to ensure the flood defences were not outflanked, bringing further cost and issues.

Whilst the exercise had been informative, it was decided that further work on this possible alternative was unjustifiable for these reasons.

7.11.3 Greytown Stopbank

Following landowner consultation, work was undertaken to attempt to find a way to attempt to prove if there could be a need for the extension of Greytown Stopbank, directing flood water back towards the river. To achieve this, a substantial increase in bed roughness (to make it behave as if there were a major obstruction or increase in gravel build up in that area) above Greytown Stopbank, was simulated in the model. This allowed for 1:100-year (1%) flooding plus 16% climate change, plus the additional 20% of channel roughness. The resulting model could not prove the need for extension to the Greytown Stopbank.

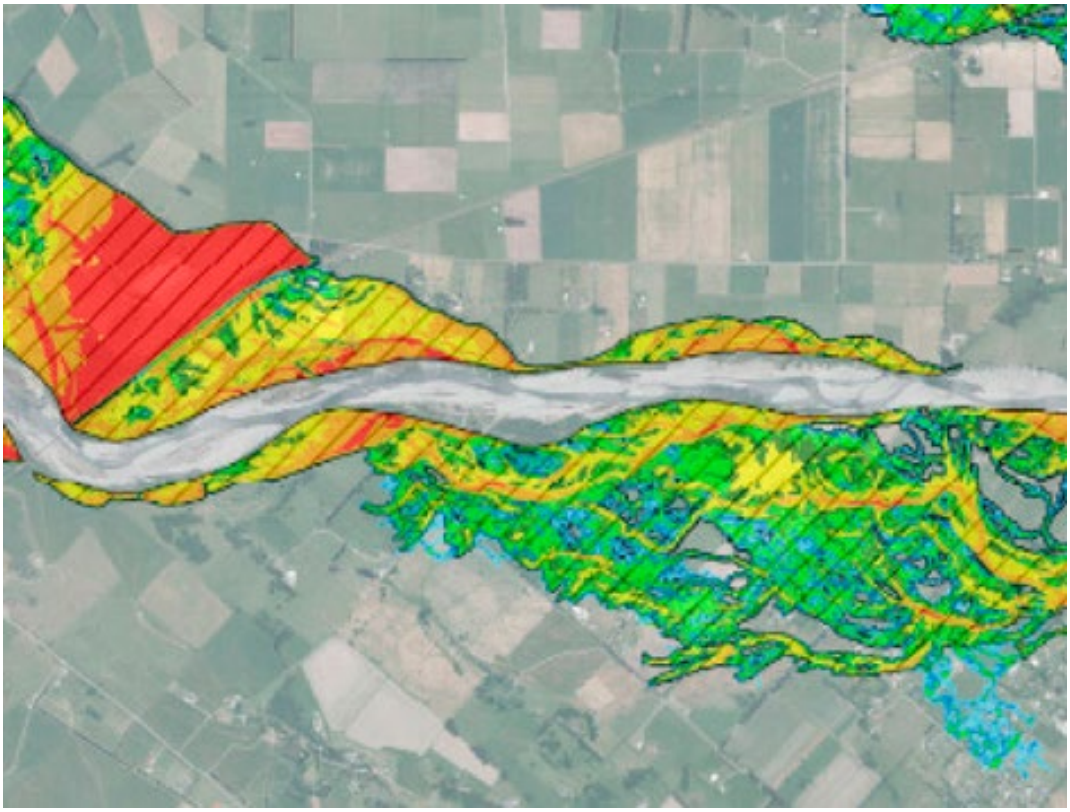


Figure 65: Attempt to force extra flood water at end of Greytown Stopbank (+20% bed roughness on top of 1:100 year plus climate change) makes little difference but has some negative downstream effects.

Regardless, as an extra precaution, in order to bolster flood defences here, it was decided, unless proven otherwise, to use trees to do the job of slowing any flood down. This can be done by planting along the toe of Greytown stopbank and to extend this planting along the base and face of the natural low bank that extends from Greytown Stopbank to support the existing tree line. Note that it is important that the existing trees are NOT cut down.

If evidence emerges that these defences become inadequate. Then the River Management/ Living Plan contains a Trigger that allows two further measures to be considered:

1 If observed effects of sheer stress on ground alongside of the Greytown stopbank or tree planting is unsuccessful due to the nature of the ground or substantial channel blockage of one of the two main river channels below the rail bridge (XS 37) occurs, then there should be a review of need for some protection here – for instance small spur banks, this has been accounted for in projected costs.

2 If future models indicate the need, the question of some form of extension to the Greytown Stopbank should be revisited. However, this should, if possible, not focus on forcing the flood back to the river but continue the strategy of spreading it out and slowing it down.

Subsequent modelling of increases in bed level of up to 1 metre in places show that the preferred option is quite tolerant of this with no significant increase to flood spread resulting in this location. Note that raising the bed level further downstream does have serious consequences, near the end of Kuratawhiti Street.

This was presented and supported at a public community meeting.

7.11.4 Freeboard

A definition of Freeboard in Civil Engineering: the height of the watertight portion of a building or other construction (in this case the stopbank) above a given level of water in a river, lake, etc.

Following advice from Ian Heslop during his review of the project it was agreed to build up a specific freeboard separately i.e. specific to the needs of each part of the system. This recognizes that 'not one size fits all'. The biggest components of Freeboard were recognized as:

- Velocity effects – how much power the flood waters exert as they collide with a stopbank
- Bed level changes – which could elevate the river level and increase flooding

Clearly this means that stopbanks set far back from the river will need a different approach to those close to the river. For instance, flood waters that have spread out and travelled far across the floodplain are likely to have a much lower velocity than those in or near the river channel.

Freeboard is distinguished from Flood Sensitivity. Flood Sensitivity is used to denote the extra area sometimes found on the edge of the floodplain that might in some unlikely combination of circumstances, be slightly prone to a relatively small amount of flooding. This area is defined to help advise local authorities on building platform height, specific location of dwellings and access.

Freeboard has been set for the two inland stopbanks:

1 North Street – 500mm but tapering off at the Westernmost end.

2 Inland Stopbank (near Kuratawhiti Street) is set at 100mm.

This was arrived at having discussed the following considerations:

1 Probability
2 Tolerance
3 Weightings
4 Cumulative effects
5 Allowance for increase close to SH2
6 Accounting for:
   a Ground survey error
   b Stopbank cross section accuracy tolerance
   c Velocity Head (blocking of flow)
   d Other uncertainty
   e Wave and wind set up

7.11.5 Fullers Bend

The third and final additional study was to try to prove a need for the re-alignment of the inside of Fuller's Bend (XS 20, True Left Bank). This was developed as an analysis by modelling, of the force applied to the existing Stopbank on the outside of Fuller's Bend (True Right Bank) both with and without the best shape of re-alignment of the inside of the bend. The result of this investigation was that no significant additional flooding occurred when the inside of the bend was realigned. However, the point of impact of the force of the flood was moved slightly further downstream, to where existing river defences are weaker and inadequate to the task. In addition, the force of the river would likely be deflected to the outside of the next bend (True Left Bank) where there would be a high risk of the river breaking its banks. The concept of realigning the inside of Fullers Bend was therefore abandoned.

8

Cost and funding implications

8.1 MfE guidance to communities on flood risk management

States: *"Lower-income areas and areas with a smaller rating base also experience difficulties in affording good flood risk management. Councils with better resources, including better information and funding, are more likely to achieve more robust flood risk management. This results in an equity issue, as some communities may not be able to afford an acceptable level of flood risk management. Reducing flood risk across the country requires that all councils are able to manage the flood risk effectively."*

As part of the Wairarapa, the Waiōhine Valley is part of a large area, with less than 10% of the population of the Greater Wellington Region and approximately 80% of the river and lake area of the region. Average incomes are also lower than the remainder of the region, with a relatively older demographic. The practicalities of this dictate a high degree of care for what kind of burden the overall cost of flood protection is to such a community.

8.2 Estimation of total capital cost of proposed works

It is estimated that the total capital cost of the proposed solution will be less than $2 million.

This includes an estimated cost of $1,131,431.85 has been provided by Cameron Fauvel Projects for the physical works to complete the new Western and Eastern inland stopbanks near North Street and Kuratawhiti Street respectively. Their Topographical Survey Report contains a conceptual design of the two proposed stopbanks, including the topographical survey of the subject site, coordination and consultation with local stakeholders and optimization of the stopbank alignments, heights and earthworks volumes.

The total of $1,131,431.85 for (both) the stopbanks construction costs therefore breaks down by location, as follows:

Preliminary & General	**$67,500**
Kuratawhiti Street (West) Stopbank:	**$304,805.64**
North Street (East) Stopbank:	**$759,126.21**
Total:	**$1,131,431.85**

Figure 66: Table of preliminary cost estimates – Project Team.

This cost is made up as follows (West Bank is near Kuratawhiti Street, East Bank is near North Street):

We investigated whether the build/cost of the Western stopbank, near Kuratawhiti Street, could be deferred until clear evidence of need emerges – this could be managed under the Living Plan process. However, some risk, if unlikely, would exist and might possibly have a potential impact on issues like minimum build heights, insurance etc. for many urban properties.

So, **it is recommended** that whilst the new stopbank near North Street is urgent and important, the new stopbank near Kuratawhiti Street is also needed and should be built as soon as is practical.

In addition the estimate of approximately $2 million includes estimates of structural and related works capital (one time) costs relating to improving flood defences at the Eastern end of Greytown Stopbank are:

- **$30,000** (+ or – 30%) for planting at the foot of and end of Greytown Stopbank. This cost is based upon a recent planting of natives.
- **Or alternatively: $45,000** (+ or -30%) for the construction of 3 spur banks for the Greytown Stopbank.

In addition, there will be other costs associated with the process, consents and related matters.

Item	Description	Unit	Quantity	Rate	Amount
1.00	PRELIMINARY AND GENERAL				
1.01	Construction Set Out Survey	LS	1.00	$ 10,000.00	$ 10,000.00
1.02	Mobilisation of Plant and Equipment	LS	1.00	$ 7,500.00	$ 7,500.00
1.03	Site Establishment	LS	2.00	$ 2,500.00	$ 5,000.00
1.04	Installation of Environmental Controls	LS	1.00	$ 15,000.00	$ 15,000.00
1.05	Compaction Testing	LS	1.00	$ 20,000.00	$ 20,000.00
1.06	As Built Survey and Documentation	LS	1.00	$ 10,000.00	$ 10,000.00
				Subtotal 1	$ 67,500.00
2.00	EARTHWORKS				
2.10	STOP BANK 1 - WEST BANK				
2.11	Top Soil - Strip 250mm to Stock Pile	m^3	2,327.00	$ 14.19	$ 33,020.13
2.12	Sub Grade Treatment	m^2	9,308.00	$ 1.56	$ 14,520.48
2.13	Imported Material (FOC) - Carted from 15 minute Radius	m^3	6,909.20	$ 9.90	$ 68,401.08
2.14	Place and Compact Imported Fill	m^3	6,909.20	$ 20.10	$ 138,874.92
2.15	Respread Top Soil on Bank	m^3	930.80	$ 20.38	$ 18,969.70
2.16	Respread Top Soil off Site	m^3	1,396.20	$ 10.19	$ 14,227.28
2.17	Undercut - Provisional Sum	m^3	690.92	$ 14.19	$ 9,804.15
2.20	STOP BANK 2 - EAST BANK				
2.21	Top Soil - Strip 250mm to Stock Pile	m^3	4,459.75	$ 14.19	$ 63,283.85
2.22	Sub Grade Treatment	m^2	17,839.00	$ 1.56	$ 27,828.84
2.23	Imported Material (FOC) - Carted from 15 minute Radius	m^3	17,811.00	$ 9.90	$ 176,328.90
2.24	Place and Compact Imported Fill	m^3	17,811.00	$ 20.10	$ 358,001.10
2.25	Respread Top Soil	m^3	4,459.75	$ 20.38	$ 90,889.71
2.26	Respread Top Soil off Site	m^3	-	$ 10.19	$ -
2.27	Undercut - Provisional Sum	m^3	1,781.10	$ 14.19	$ 25,273.81
				Subtotal 2	$ 1,039,423.95
7.00	MISCELLANEOUS				
7.10	STOP BANK 1 - WEST BANK				
7.11	Vehicle Crossing Surfacing (Farm Access) - AP40 Supply and Place	m^2	40.00	102.51	$ 4,100.40
7.12	Fencing Reinstatement Works	LM	165.00	17.50	$ 2,887.50
7.20	STOP BANK 2 - EAST BANK				
7.21	86 North Street Detailed Earthworks and Landscaping	LS	1.00	15,000.00	$ 15,000.00
7.22	Fencing Reinstatement Works	LM	144.00	17.50	$ 2,520.00
				Subtotal 7	$ 24,507.90

Figure 67: Table of preliminary cost estimates for stopbanks – Cameron Fauvel Design.

Therefore, at this stage we recommend that an estimated budgetary expectation of up to $2,000,000 (which includes contingencies, options etc.). It is noted that this does not include the purchase of any land as that is not considered to be necessary.

We recommend that all other work on the river be addressed through the existing operational (OPEX) maintenance annual budget.

8.3 Note to costing – parcels of land inside Fuller's Bend

As at 2021, ratepayers have been paying rates to cover loans taken out by GWRC to acquire three parcels of land. These properties were purchased by GWRC in recent years and set aside, in case the widening and re-alignment of the inside (true left bank) at Fuller's Bend should need to go ahead. The first two of these were purchased (utilising the Public Works Act), specifically for realignment of the inside of Fullers Bend:

1 The Land at 127A Mataroa Road/Swamp Road, purchased for $120,000 as at 2015.

2 The Land at 127C Mataroa Road/Swamp Road, purchased for $595,000 as at 2014.

3 A third parcel of adjacent land was also later purchased at 65 Mataroa Road/Swamp Road for $454,000 as at 2016.

Note that a small portion of this land, which lies between the river's edge and the existing stopbanks, would need to be retained by GWRC. Also, current access to the river buffer will need to be retained (a portion of this access is over mana whenua land and will continue to need ongoing permission for access to be kindly granted). This land is needed specifically for a) a slight re-alignment of the river buffer against the need for its defence and b) for rights of access for ongoing gravel extraction.

It is roughly estimated that the total burden to ratepayers of servicing these three interest-only loans is in the order of $65-70,000 per annum. Disposing of this land or at a minimum, shifting it out of the Floodplain Management aegis, would remove the annual burden of loan repayment from the ratepayer community and release it into the pool of funds set aside annually for river maintenance operations (OPEX). This would help speed stopbank strengthening of the outside of Fuller's Bend for instance and would be most beneficial to the river overall.

As retaining this land within the flood plain management portfolio is no longer necessary, the community and Project Team have been asking for some time for this land to be released back onto the market and sold, or moved to another cost centre, to remove this unnecessary financial burden. GWRC have advised that as at the end of the 2020/21 financial year, this land will be moved out of the scheme and any improvement in value since purchase will be granted back to the Waiōhine river scheme.

Finding:

We recommend that these parcels of land, (except for land between the river edge and back of stopbanks) are sold as soon as possible, that any residual profit, should be used to progress protection work on the outside of Fuller's Bend, which otherwise is funded from the annual river maintenance budget.

8.4 Further information and recommendations on costs

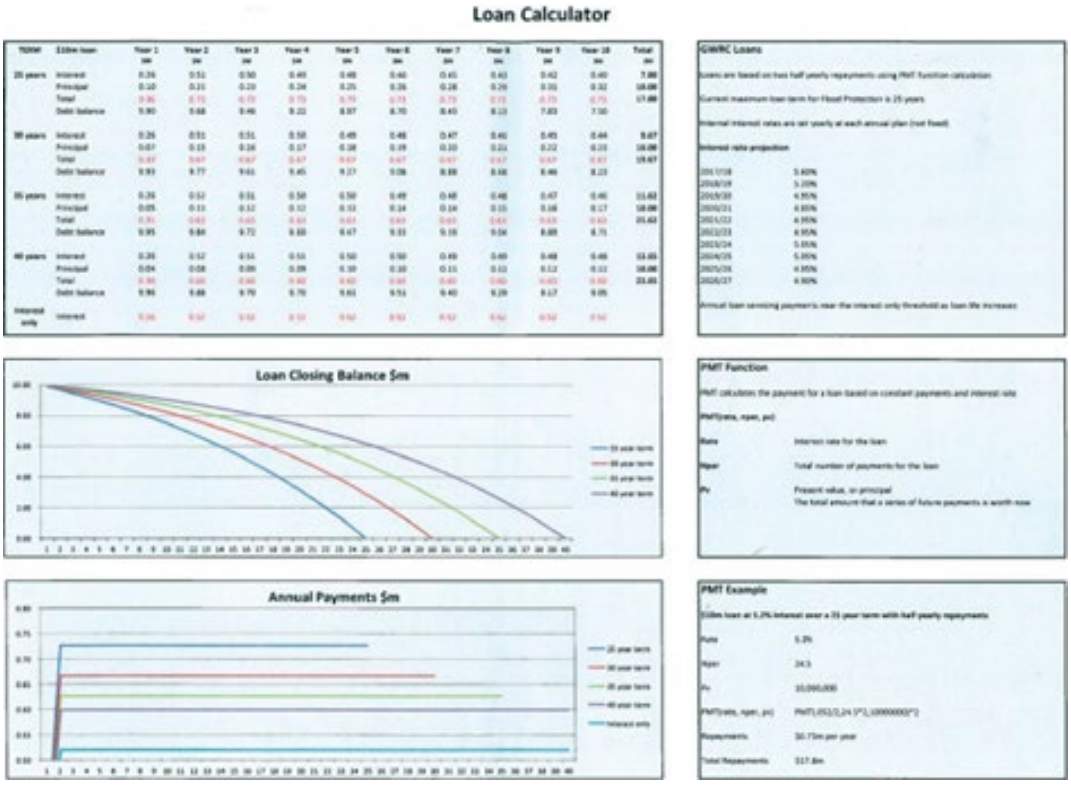


Figure 68: Loan Calculator – GWRC.

8.4.1 Term of Loan to fund Structural Works

The roughly estimated capital cost of works associated with this River Plan has to balance a range of factors, to find a way to meet the capital cost of structural solutions, needed to provide flood defences, added to cost effective ways to continue to manage the river.

Capital works can now be funded to a 25-year funding horizon if needed, or up to 30 years in some instances.

Different works can be phased and timed differently, therefore financed in different ways, that are the right fit for their use, cost and life.

It is recommended that capital costs are funded through a loan for a term of around 25 years. This will roughly align with the 2040-2050 first planning horizon, and proposed full review of the plan at that time, whilst minimising the impact on annual rates in the meantime.

All recommendations relating to finance and funding are subject to GWRC funding policy in place at time. This policy is consulted on in a separate document.

8.4.2 How did we arrive at this?

The capital works for new inland stopbanks to protect urban Greytown and a small proportion of rural zoned properties within the flood defences are relatively inexpensive. If spread over 25 years, including interest, split between pan regional and local rates (currently a 50/50 split), this will have a very small impact on urban ratepayers and others within the defences, who will be the major beneficiaries of a 1:100 defence of dwellings, facilities and businesses. It is roughly estimated that on average, this should work out at approximately $50-80 per ratepayer, per year.

It is recommended that the new inland (Western and Eastern) stopbanks and the minor work to build perpendicular snub groynes at the foot of Greytown Stopbank, should be funded from rates contributed by all urban dwellings and rural dwellings protected within the new (Western and Eastern) inland stopbanks.

Other rural dwellings along both sides of the whole river will continue to benefit from existing flood defences and river maintenance for flood protection to at least 1:20 year flooding (5% chance of occurring in any one year). New rural dwellings will be required to be built to the 1:100-year (1%) standard.

It is recommended that as those rural dwellings outside the new inland stopbanks, are not the major beneficiaries of the main new flood defences, they should not need to contribute above current levels to flood protection. As at present the maintenance projects and annual budget seems to be adequate to needs, this should continue as is but we recommend this should be subject to review if a significant Trigger event requires.

8.4.3 Target rating – clarifying new build versus maintenance

It is recommended that redistributed benefit should be recognised, and that the existing target rating classification remains for all river maintenance and operational management works. We see these as operational (Opex) in nature.

Therefore, we recommend that they should continue to be funded from annual rates, rather than capital expenditure, funded from long term borrowings identified for capital build.

Conversely, we recommend that new capital funding be raised for the construction of new stopbanks (such as Western (near North Street), Eastern (near Kuratawhiti Street) stopbanks and the perpendicular snub groynes at the toe of the Greytown Stopbank).

We recommend that a new targeted rate for this should be implemented, to be repaid over a term of 25 years, from a targeted rate on all urban and other properties behind (protected by) the new Inland Western and Eastern stopbanks.

Current policy is that up to 50% of the cost of flood defences are found from pan regional rates and the remainder is raised from the local share, based upon whatever is the current policy for that river.

8.4.3.1 Findings: Recommended Approach to Funding Structural Solutions:

Finding: It is Recommended that new capital works be Funded using a finance horizon of 25 years – fitting the horizons identified above.

These capital works include:

- Kuratawhiti Street (Western) Stopbank (new construction).
- North Street (Eastern) Stopbank (new construction).
- New perpendicular groynes, should they be required, on the toe of Greytown Stopbank.

This excludes:

- Completion of ongoing work to strengthen the major stopbank on the outside of Fuller's Bend (XS 20) to protect SH2.
- Other maintenance and operational works.

It is recommended that the excluded projects should be funded from operational funds allocated to river maintenance, which would be significantly boosted by the disposal of the three parcels of land on the inside of Fullers Bend and other means, see below.

8.4.3.2 Summary of the sources of funding for the ongoing project to rock line the outside of Fullers Bend

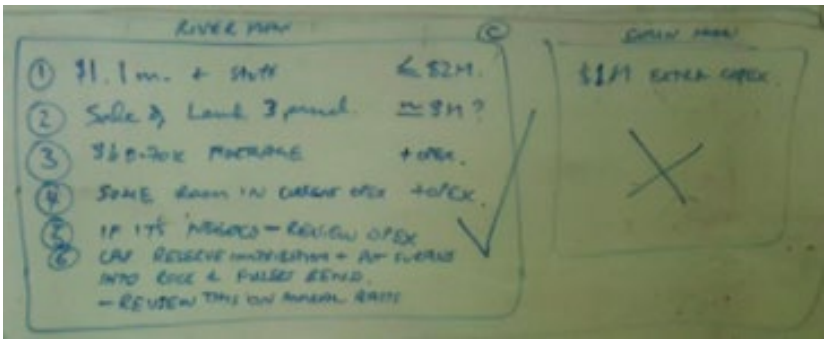


Figure 69: Summary of sources of funding – Project Team.

1 The remainder of the capital budget of $2 million, i.e. what is left after the capital build and related costs are completed (see above).

2 Any profit that accrues from the eventual sale, transfer to another purpose, or disposal of the three parcels of land inside Fullers Bend that were specifically purchased for straightening and widening the river, which is no longer required and have been paid for by the community, out of GWRC rating for this purpose.

3 The savings to the operating budget of the estimated $60-70,000 per annum servicing the mortgages on these three parcels of land should be redirected towards the rock lining project for Fullers Bend. Once completed, the savings should become part of the operating budget for river maintenance and restoration.

4 As some work has already been completed, it is evident that there is some continuing room for funding from the existing operating budget.

5 Capping the river scheme reserve for the Waiōhine at $750,000 and redirecting the excess now and in the future into the rock lining project. See Notes on Waiōhine River Scheme Reserves Treatment below.

6 If all these fail for good reason, then review whether a small increase in opex budget is needed. This is viewed as unlikely.

NOTE: This should be reviewed in each annual plan until this project is completed.

8.4.3.3 Waiōhine river scheme reserves treatment

There is, at the time of writing this plan, substantial financial reserves have accrued to the river scheme. These reserves are used to:

1 Provide go-to funding in the event of a major flood event on the river and the need to undertake extensive emergency repairs and maintenance to flood defences, or

2 Provide a "buffer" of funding that can be dipped into and replaced in the event that operating and maintenance budgets are stressed during any one year.

There are two reserve funds. As at early 2021, these would stand at approximately $750,000 and $55,000 respectively. If needed for emergency work after a major flood, these would be boosted by a contribution from the rest of the GWRC rating

base. They have been temporarily depleted but will be restored from the net residual when the bulk of the Fullers Bend land is removed from the scheme.

Ideally, reserves could accrue until a target of approximately 10% of river asset (stopbanks etc.) value has accumulated. However, an interim target of $750,000 is deemed adequate.

8.4.3.4 Benefits of this approach

1 Capital works will be fully amortised by the first planning horizon of up to 2050 this will leave the way clear to invest in further works then needed.

2 This fits to repay the loans within the span of one generation, leaving a much better-informed next generation to review the needs beyond the up-to-2050 horizon out to 2100 where climate change and new data might drive adjustments to the River Plan.

3 By 2050 strategies for river management, fuelled by new science, engineering and technology may well provide new opportunities for a new generation to adopt its own strategy for their river. We will, for instance, have a zero-carbon economy and hopefully have made steps in the vision of this plan, which will positively change the relationship between mana whenua, town, country, land, climate and river.

8.4.3.5 CAPEX, OPEX, and spend to date

Spend to Date on developing a Waiōhine Floodplain Management Plan has been approximately $1 million. This was funded through a consolidated loan over 15 years: Levied equally across GWRC in accordance with current GWRC policy (that Floodplain Management Plan Investigations and plan development is spread 100% across the regional funding base). These costs therefore have no impact on the costs associated with this, current, River Plan.

8.4.3.6 Reserves for emergency works

A strategy is in place of setting aside a small portion of the operational river management budget in quiet years and periods (see Waiōhine Hydrology) when no damaging floods occur to build up a financial reserve that can be drawn upon in the event of emergencies and damaging events (for instance major floods or earthquakes). We understand that **this reserve currently amounts to approximately $770,000**.

It is important, given the aggressive and unpredictable nature of the Waiōhine, the urban infrastructure and other assets at risk, that this reserve be exclusively retained for use as intended, on the Waiōhine, whose ratepayers have funded it.

Finding:

It is recommended that the reserve fund should be maintained at or near $750,000, allowing for it to be gradually replenished, in the event of its use in an emergency. This reserve should be clearly and distinctly reported separately and categorically earmarked for emergency use on the Waiōhine river. Funds accumulating in the reserve in excess of the $750,000 cap should be used to accelerate the rock lining of the outside of Fullers Bend and, once that is completed, other projects as agreed between stakeholders.

9

Non-Structural Solutions

Non-structural solutions keep people away from floods.

9.1 Interim maps, final maps, planning controls

Until the proposed new inland stopbanks can be built soon (≈ 2 years from approval of this plan), **we recommend** that we should retain the interim maps currently in use for planning and approvals, then publish new maps that can be adopted after the stopbanks are completed.

There are two major flood hazard zones identified through the mapping exercise and that we have agreed to, these are:

1 The Flood Hazard Area

2 The Flood Sensitive Area

Here is a description of these two hazard zones:

9.1.1 The flood hazard area

This relates to the area of flood hazard from the Q100 flood event in the river plus an increase in water to consider the increase in rainfall intensities from climate change. In this case the increases were 10% and 16% for the 2050- and 2100-year planning scenarios respectively. In this hazard area we were going to use the hazard categorization (H1 to H6) that is in the Australian Rainfall and Runoff (ARR) guidelines. Flood levels given out would be to the Q100 + 16% climate change + the top of the flood sensitive area. These rules are given in the following section 9.2.

9.1.2 The flood sensitive area

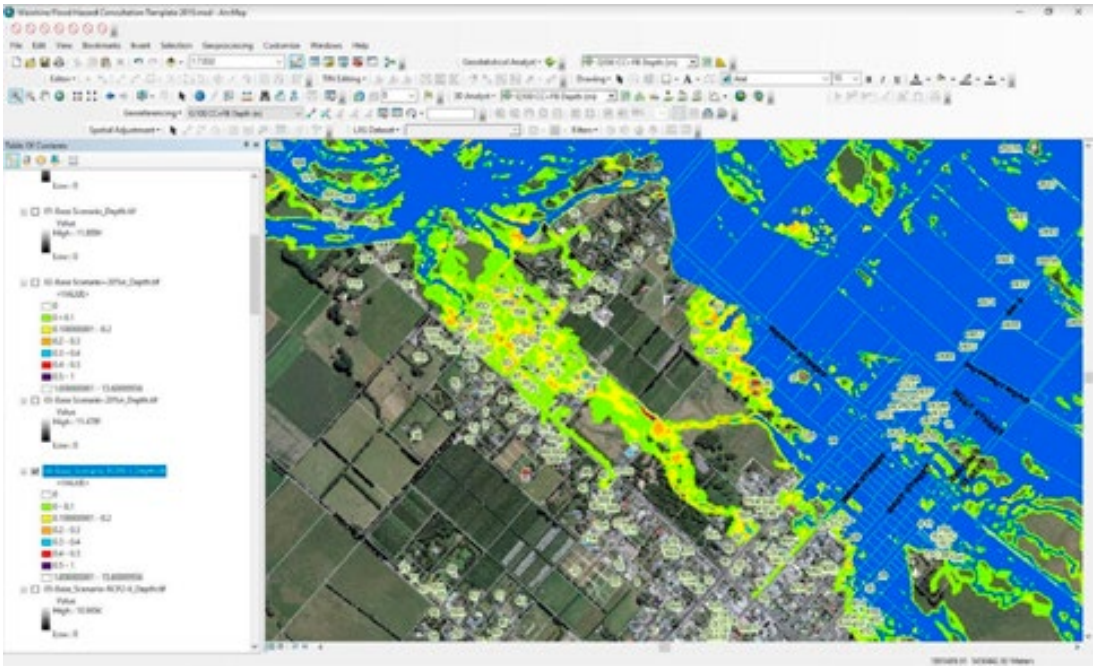


Figure 70: Flood Map – Detailed Study of Flood Sensitive Area 1 – landriversea Consulting.

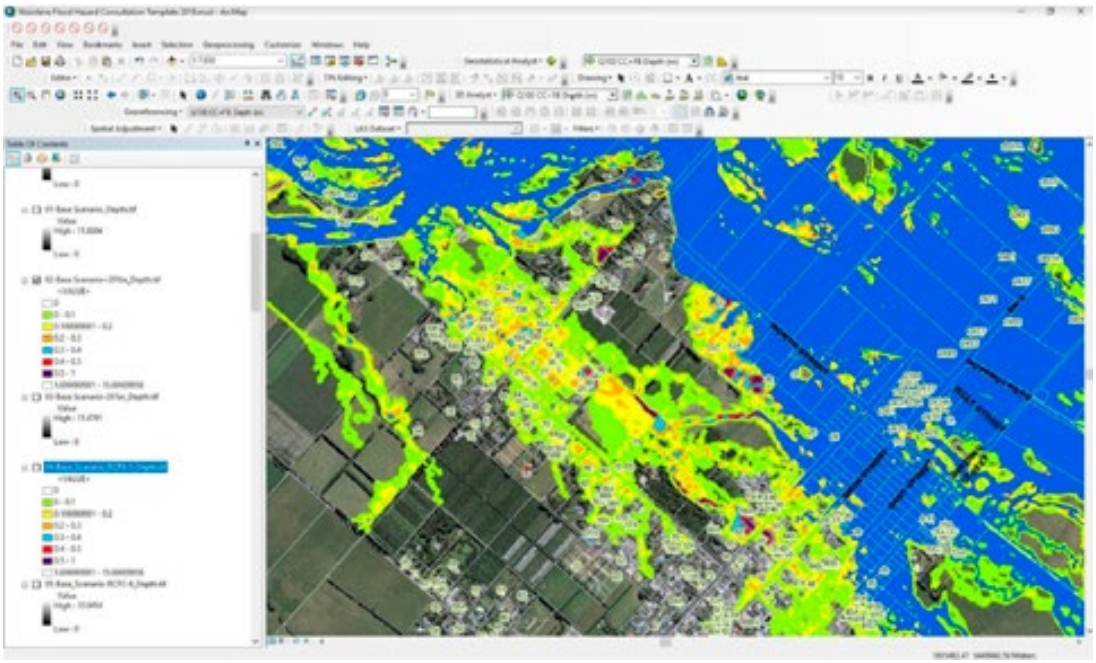


Figure 71: Flood Map – Detailed Study of Flood Sensitive Area 2 – landriversea Consulting.

We agreed that there should be recommended build levels in this area, but that these would be based on a blanket 300mm above ground level flood height requirement for the entire area. We subsequently learned when looking through this area in some detail, that there are quite a few locations where the sensitivity flood depths are greater than the 300mm (see detailed study images inset) we have chosen; so we needed to consider what to do to address this. It was agreed that it would be prudent and more informative, to use the actual flood depths in this flood sensitive area to recommend building levels.

9.2 What controls are we seeking on flood plain (between buffer zones and edge of flood risk zones) as a recommendation to territorial authorities?

The area outside the riverbanks but inside the greatest extent the river may flood to in a 1% (one-in-one-hundred-year flood) is the floodplain of the Waiōhine river.

It was decided to use the Australian Rainfall and Run-off method (ARR) for depicting the degrees and types of risk from flood waters in the floodplain. This was chosen in consultation with Planning Officers from SWDC and CDC. Using this method allows the Project Team to provide information that is most useful to both the community and territorial authorities.

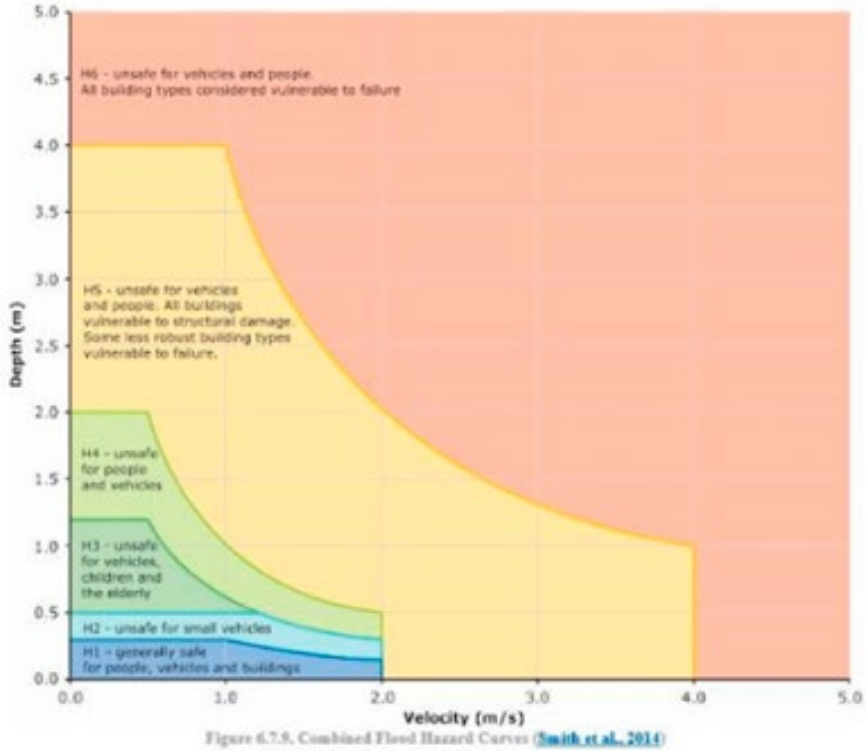


Figure 6.7.9. Combined Flood Hazard Curves (Smith et al., 2014)

Figure 72: Australian Rainfall Runoff Guidelines hazard classification – ARR.

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings
H2	Unsafe for small vehicles
H3	Unsafe for vehicles, children and the elderly
H4	Unsafe for vehicles and people
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

Figure 73: Table of Hazard Classifications – ARR.

The following recommendations are made:

- Land Information Memorandums (LIMs) will still be annotated for properties still in at-risk areas.
- A control on building floor levels at minimum height should be adopted.
- The planning principle that the town should intensify/spread away from the river.
- No filling/impeding of old flood channels also storm water channels should be allowed.
- Land in the flood plain will indicate the degree of hazard from major floods using the Australian Rainfall and Runoff Guidelines.
- That Land designated as Australian Rainfall and Runoff model High hazard (H5 & H6) has a high velocity multiplied by depth combination that should not be considered as fit for new building or access,

- That Medium Hazard (H3 & H4) may be used for building or access, subject to specific requirements,
- That Low Hazard (H1 & H2) does not mean no hazard, but includes the rest of the flood risk area and includes the flood sensitive area
- Recommendations relating to subdivision:
  a Maintain low density i.e. minimum 4-hectare sections
  b Must have suitable building site
  c Must have safe access
  d Must not impede flows
- That Territorial Authorities (T.A.s) adopt the implementation of control on vegetation we want protected in the flood risk zone because it does an important job of flood protection – and on areas that need to be kept cleared of large vegetation or other impediments
- That T.A.s adopt measures to protect critical landscaped features e.g. small bumps that may play any part in impeding flooding
- The Independent Peer review by Ian Heslop recommends considering the use of Protection Works Contracts on the titles of land on which existing features, such as banks, groups of trees and so on, need to be retained in order to protect the integrity of flood defences.
- That within the flood risk zone, shipping containers and other large objects that could be swept away by a major flood, should be somehow securely anchored. A shipping container or similar obstruction can cause serious blockage or damage when carried along on floodwater.

Findings:

To propose that local councils adopt a minimum height for a building in a flood sensitive zone based upon the use of High, Medium and Low Hazard classification labels for land within the floodplain. These are designated, considering both depth and velocity of flood water in any location on the floodplain.

9.3 Relating to State Highway 2

NZTA reseal this stretch of road, typically raising the height of the crown by 10-12 mm every 8-10 years. This gradual increase in height increases the effect of damming water behind the road crown and increases flood depth and risk to dwellings in a 1:20 plus climate change flood event, putting some adjacent properties at additional risk.

We recommend that NZTA maintain the height of the crown of SH2 in identified locations, within an envelope of heights (for the crown of the road surface).

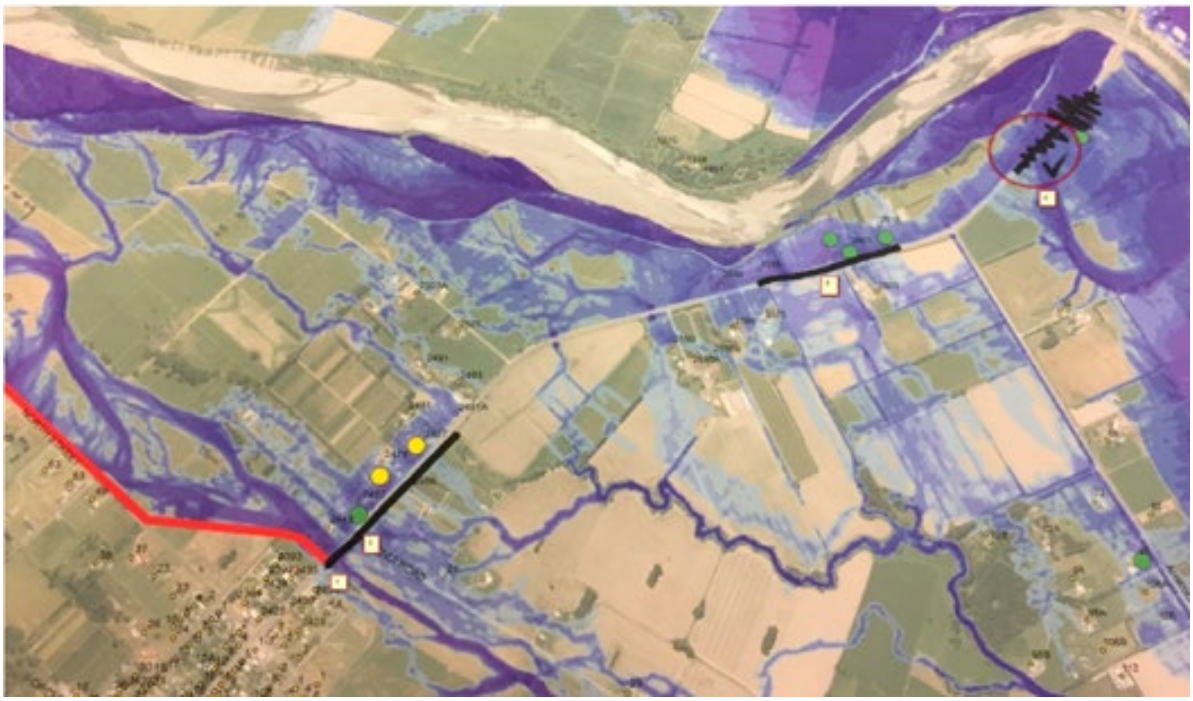


Figure 74: Flood Map – Detailed Study of need to raise crown of SH2 – landriversea Consulting.

There are 4 key locations for maintaining the road surface height:

1 To slightly raise the road south of the Apple Barrel shop (e.g. 100 mm), creating an improved barrier to the risk of flood water over spilling the Apple Barrel and entering the North end of Greytown.

2 To keep the Apple Barrel floodway at the current height.

3 To keep the road crown past Pinehaven retail outlet (2471 SH2), on the straight stretch, between current height and -100mm.

4 To keep the road crown at its current height, in the slight dip in the road near Clark's farm (XS 18).

NZTA have undertaken to consider these recommendations in their own planning.

NZTA advises that pavement heights are upgraded at 25-year intervals.

Computer information has been provided to NZTA by GWRC, depicting the locations of start and stop for surface heights, for each stretch of road.

Progress on this will be monitored under the Living Plan Process.

9.4 House Raising

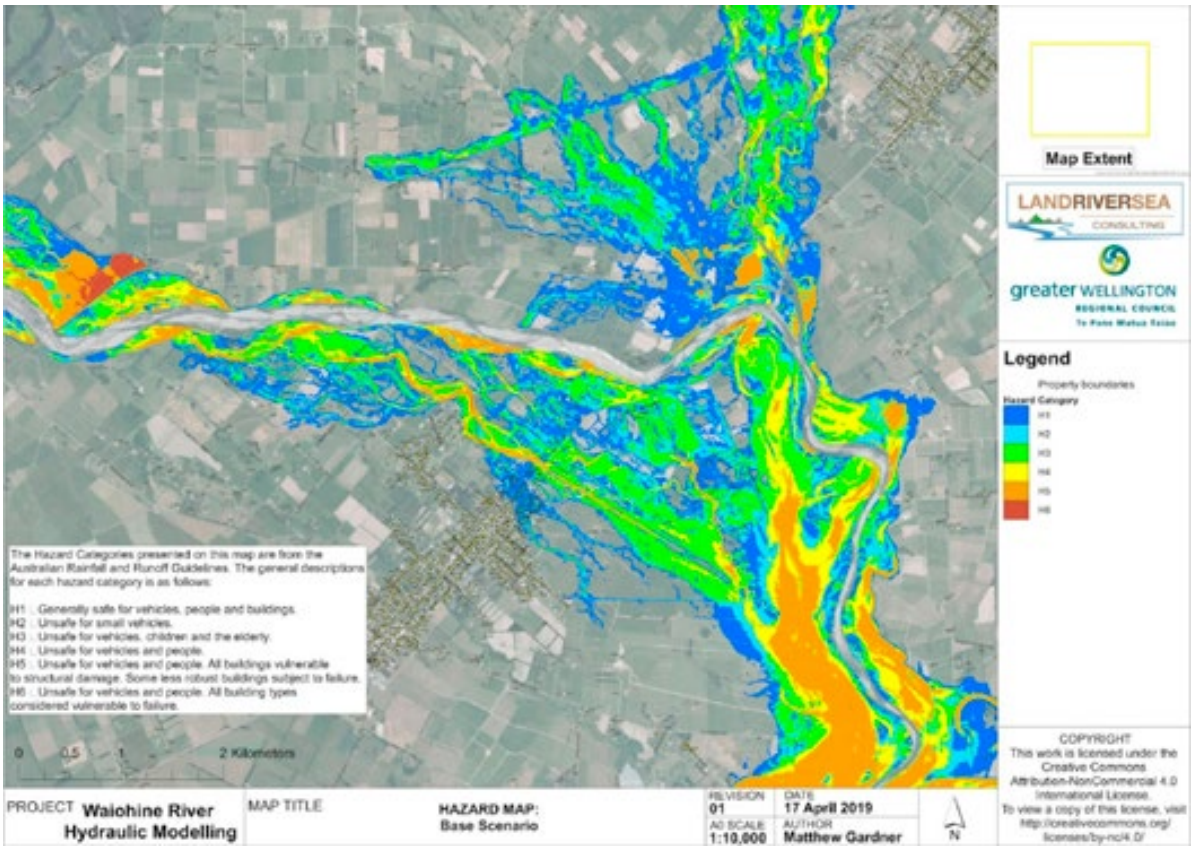


Figure 75: Hazard Map depicting types of risk from flood waters using the Australian Rainfall and Run-off Guidelines method. A map that can be expanded can be found here.

In some situations, the possibility of offering to part subsidise the raising of house foundations, where properties are seriously threatened by floodwaters, and other defences that fall within the plan have been considered. At the time of planning, there are no rural dwellings that we know will be inundated by up to a 1:20 year flood plus climate change and no urban dwellings will be inundated by 1:100 year river floods plus climate change (conditional upon the proposed stopbanks being constructed), as at 2050. However, if for some reason an event trigger in the Living Plan occurs to change this (e.g. a dramatic upswing in climate change forecasting, or the result of the forthcoming catchment planning of the Mangatārere), then this can be revisited within the River Maintenance Living Plan provisions of this plan. We also note that house raising options are rarely taken up for a variety of reasons, but feel this should be nevertheless held in reserve, as a tool that the Living Plan may call upon, if a good reason to do so emerges in the future.

Notes:

1 House raising is a possible tool that has been used elsewhere. For the Waiwhetu stream in 2013 the estimated cost of house raising was in the region of $170k – $300k per house, **this is not budgeted within this plan**.

2 There is no identified need for house raising for properties relating to the Waiōhine at present, although there might at some stage be a possible application on the true left bank (Carterton side) relating to the Mangatārere. This should be considered, following completion of the Catchment plan for that river and consequent review, if necessary, of the Waiōhine River Plan.

3 For these reasons, any consideration of need in the future is adequately covered by existing triggers.

10

Emergency management and flood warning

10.1 What do we know about the risks?

The nature of its remote catchment and its steep gradient make the Waiōhine prone to sudden flash floods that can be life threatening. It is necessary to install suitable signage to warn the public of the possible dangers of sudden flooding. These should be provided at the following major access points:

1 At Kuratawhiti Street end access.

2 At State Highway 2 access.

3 At the access area above the railway bridge (XS 37) known as the gooseneck.

4 At River Road access.

Flooding of the Waiōhine is rated as a "**Major**" risk by WREMO.

WREMO Coordinates Civil Defence and emergency management services on behalf of the nine councils across the Wellington Region.

10.2 What tools do we use to mitigate these risks?

Stopbanks are the main tool to protect urban Greytown.

Planning controls are the main tool to protect new development.

Emergency Management is the main tool for protecting residents of existing development in high hazard area. See hazard map.

Provide Warning: Flash flooding occurs so quickly that the current method of escalation and warning to the public cannot respond in time to prevent risk.

It is recommended that some form of automated flash flood warning system, as those in widespread use overseas, should be investigated under the Living Plan Process. Examples of such technologies are media tools e.g. phone alerts, sirens, text alerts.

As a minimum, we need to add Greytown and Carterton Civil Defence volunteers into alerts from the current flood telemetry system.

Utilizing the text-based emergency mobile alert service should also be investigated under the Living Plan.

Enable Evacuation: High hazard properties should have evacuation plans and warnings of one in twenty year or greater flood events. These should be maintained via an online portal and implemented and periodically reviewed under the Living Plan Process. It is likely that road closure at the Apple Barrel Floodway may occur and a practical system for this needs to be verified.

There is a system of notification of neighbours in rural flood risk areas where flooding above 1:20 year return period could pose a risk, with evacuation plans to go to "safe houses".

Maintain Awareness: SWDC, CDC and WREMO must be included in developing joint planning via the Living Plan Process.

Appropriate signage should be provided at the most popular access points to the river to help make users aware of the sudden danger flash flooding poses.

It is recommended to:

- Install suitable warning signs at popular access points to the river
- Investigate automated flash flood warning system within the Living Plan
- Add Greytown and Carterton area Civil Defence volunteers into the flood warning process
- Investigate using the text-based emergency mobile alert service in the Living Plan
- Keep emergency evacuation process up to date under Living Plan
- Include WREMO as stakeholder in Living plan process

11

The Living Plan

11.1 How the stakeholders can be partners

It would be folly to assume that a River Plan would be able to anticipate every eventuality that may arise for seventy years into the future. So, we must have an approach that allows the community to continue to work together with GWRC to keep on developing and adapting this plan, as the river, legislation, the community, climate and our society and economy evolve and interact.

Figure 76: A Living Plan – A holistic Approach – Project Team.

Finding:

It makes sense that the processes and models that have been successful in bringing everyone together to analyse and understand the issues, and to come up with solutions, based on broad consensus, should continue to deliver in a living plan form. This is what the Living Plan Model is built upon.

While developing the Waiōhine Floodplain Management Plan it was agreed that it should address all aspects of the river (and therefore became the Waiōhine River Plan).

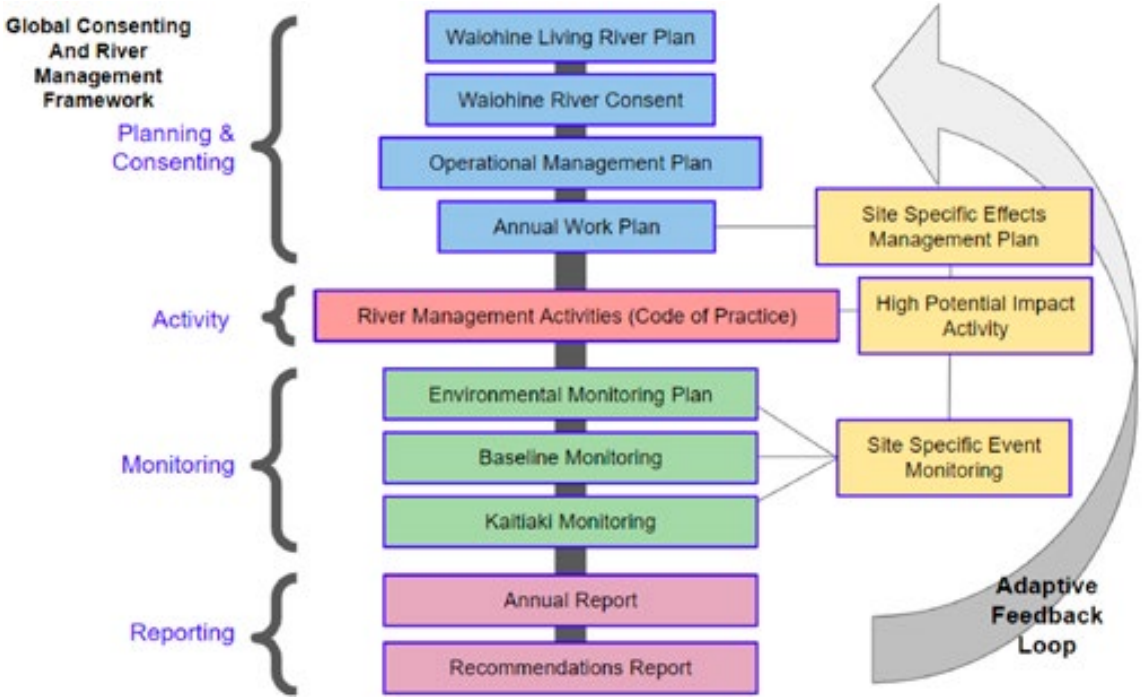


Figure 77: Global Consenting and River Management Framework Diagram – Project Team.

It was agreed that:

1 It must contain all the necessary processes, mechanisms, personnel, triggers and plans to continue the partnership of community and GWRC.

2 It must contain all the necessary processes, mechanisms, personnel, triggers and plans for the ongoing management and improvement of the river, for the timespan of the River Plan: this aspect of the Waiōhine River Plan is what makes it a Living Plan.

Finding:

The Living Plan: It is recommended that the Waiōhine River Plan can evolve as needed by consensus between the community represented by the Waiōhine Action Group Project Team in partnership with GWRC. Its job is to make decisions and recommendations on what the community conceives as the best model for engagement; to ensure the most likely success of the Living Plan. This will report formally as an advisory committee to the Wairarapa Committee of GWRC.

The Waiōhine River Plan as a Living Plan is subordinate to the law, and superordinate to operating manuals, annual and other GWRC operational plans, and other operational instruments. Any consent should embrace its intent and recommendations. It must address the needs of the whole river, not just floodplain management.

It is noted that different communities and different rivers have different needs and thus expect (GWRC to have) a flexible enough model to accommodate this – including the stakeholders combined needs for their shared vision of the Waiōhine.

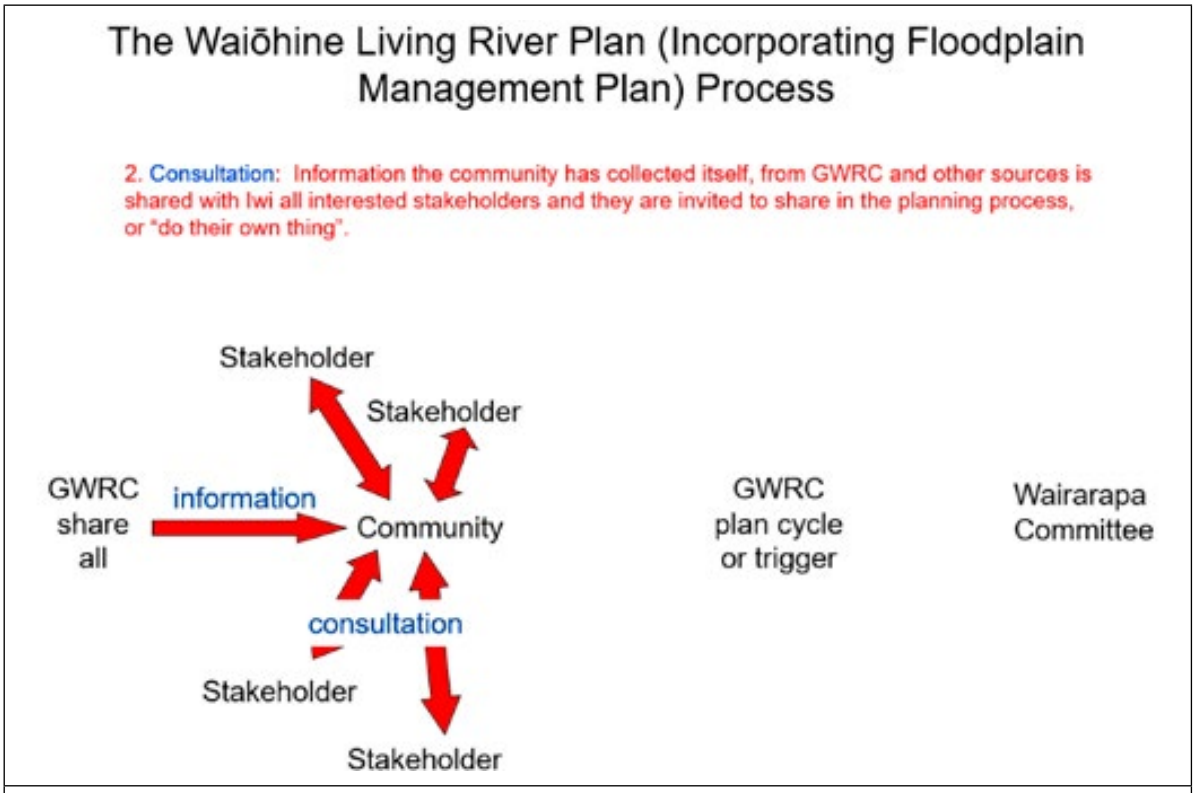
Monitoring of flood protection and other work by the community include Maori cultural consideration from research and monitoring. The possibilities for cultural enhancement of the environment, should be considered as an opportunity, when undertaking flood protection work in the Waiōhine Floodplain – see Cultural Impact Assessment.

The Terms of Reference and Operating Model for the Waiōhine River Living Plan and the Waiōhine WAG Project Team Committee are at Appendix C. This will be refined by WAG reporting to the Wairarapa Committee, as the Living Plan comes into effect, once this plan is ratified and adopted by GWRC in Council.

"The Living Plan model is very sound, and given continued ongoing strong community engagement and consultation, it is expected to produce a Floodplain Management Plan which aligns community and Council expectations." Review of Waiōhine River Floodplain Management Plan.

Figure 78: What Partnership Looks Like Diagram – Project Team.

ONE
GWRC will share in good time, with the WAG Project Team and community, all relevant trigger data, events and findings that might inform planning inputs or actions that might need to be taken in between GWRC annual planning cycles, or that fall within the aegis of this Waiōhine River Plan (Incorporating Floodplain Management Plan), such as, for instance, Living Plan trigger events or measurements and studies of the river, or that generally relate to the river and floodplain.
TWO
With that in hand, everything provided will be shared and reviewed by the community prior to each GWRC planning cycle (annual, operational or long term) commencing. New items and topics may be added to this with the agreement of the Wairarapa Committee.



THREE

GWRC, the WAG Project Team and community will share all planning inputs and discuss as needed, by both parties, prior to the start of each formal GWRC planning cycle that might affect the river and environs.

FOUR

GWRC will produce their draft plan and share this with the WAG Project Team and community in good time for the community to communicate with all stakeholders, meet, seek additional information if necessary, review it, and identify differing views or endorsements. It may be necessary to engage independent subject matter experts during this period.

FIVE

The Project Team will present these along with any proposed community initiatives to the Wairarapa Committee at which the GWRC plan is also presented.

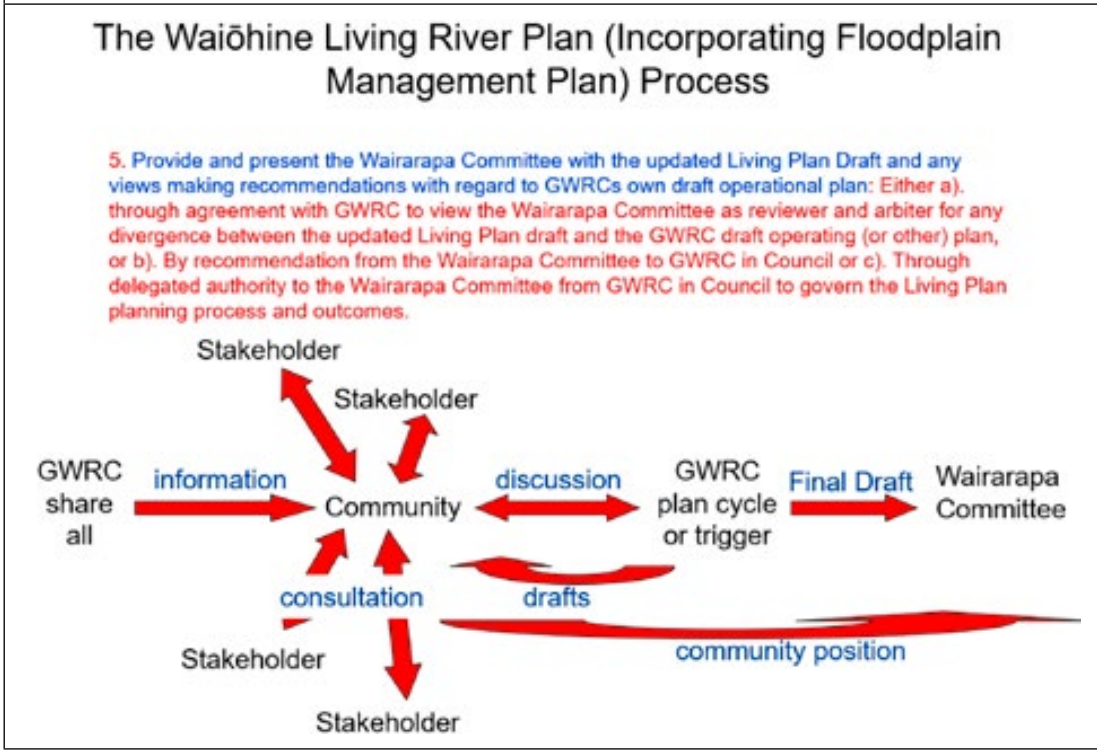


Figure 79: Four Steps of the Annual Planning Cycle – Project Team.

Notes:

1 This is not intended to displace any of the existing rights of iwi or community groups as per the consenting process.

2 GWRC will support the actual and reasonable day to day running costs of this process, budgeted annually, in keeping with the process for producing the River Plan.

3 GWRC Wairarapa Committee will decide what steps, if any, need to be taken where there are significant differences between what the community and GWRC wishes for the river, guided by this Waiōhine River Plan. Either a). Through agreement with GWRC to view the Wairarapa Committee as reviewer and arbiter for any divergence between the updated Living Plan draft and the GWRC draft operating (or other) plan, or b). By recommendation from the Wairarapa Committee to GWRC in Council or c). Through delegated authority to the Wairarapa Committee from GWRC in Council to govern the Living Plan planning process and outcomes. D) Any other model agreed to by the community and GWRC.

The principle of the Living Plan model is to create a collaborative partnership in which the community remains in a leadership position as keeper of the vision and overall plan for the river (the Waiōhine River Plan, Incorporating Floodplain Management Plan), with GWRC and there are checks and balances to make sure rifts cannot happen again, between the community and GWRC. It should in effect act as a tool for collaboration and therefore a "fence at the top of the cliff" rather than, as in times past, relying on an "ambulance at the bottom of the cliff".

Finding:

We recommend that the process incorporates the current planning cycles of GWRC: annual and Long-Term Plan, budgeting, planning around consented activities, other planning process current or future that relate to or impact on the Waiōhine River, incorporated data sharing and shared decision making for significant aspects of river management and development to eventually realise the vision and River Plan. This process can be updated as necessary by agreement between the community and GWRC, which may be delegated to the Wairarapa Committee.

11.2 Active management triggers for the Living Plan

These are events that compel the WAG Project Team to reconvene, compel GWRC in a timely fashion, to provide to the community with any information that it holds or that is required by WAG and for the Project Team to identify what actions need to be taken and how the River Plan should be improved upon, using the lessons provided by the trigger event. The WAG Project Team may learn about these from any source and choose to reconvene as they feel the need, but the general expectation is that the commitment by GWRC to quickly pass on any information that relates to any of these triggers, will be the main source. If in doubt about the relevance of any information, then GWRC should supply it and rely on the WAG Project Team to always advise if it is no longer necessary. It is expected that the WAG Project Team will engage closely with GWRC throughout the process and vice versa.

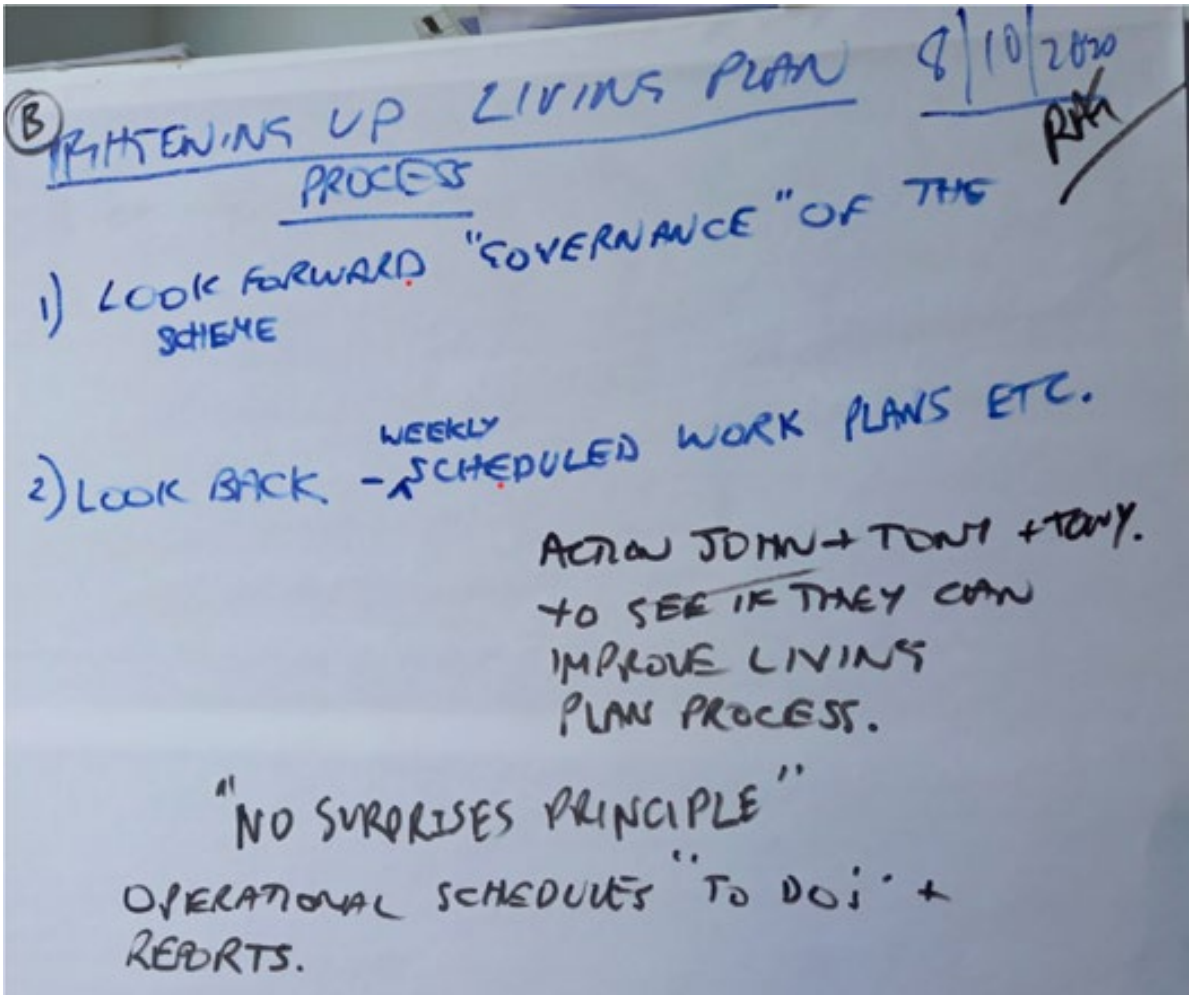


Figure 80: Tightening up the Living Plan Process involves adopting the "no surprises principle".

Trigger events may be added to in future but presently include:

1 2050 – The first of **two major planning horizons** for this River Plan. This review of the plan may occur earlier if significant new data comes to light.

2 Climate Change – any new information that changes our understanding of how **climate change** will affect flood or other risks to the Waiōhine catchment and valley,

3 **Earthquake** – an event that changes the geomorphology or creates a dam or other change that substantially affects the behaviour of the river, new LIDAR should be obtained.

4 A **Large flood** i.e. unforeseen consequences (for example major stopbank failure or damage to flood defence or other critical infrastructure, or the likelihood of this), new LIDAR and/or survey data should be obtained.

5 **Failure/dissolution of WAG**, it's Project Team or its successor as community catchment group/ organization such that (in their opinion) the community are no longer able to work in partnership with GWRC and other stakeholders, or of the Wairarapa Committee.

6 **Major change in insurance** protection conventions or community demand for change in flood protection level based on new societal expectations and norms.

7 Bed level maintenance, **river management**, habitat and gravel management not meeting targets

of preventing the river from changing course and threatening towns or Critical Areas (such as bridges, roads, stopbanks and dwellings), creating additional flood risk through the riverbed rising (aggradation) or bed level dropping (degradation), this includes any gravel formation that could risk avulsion or erosion of Critical Areas and river banks.

8 **Environmental** objectives (e.g. Whaitua) not met.

9 Significant **impacts on flora, fauna** and ecology.

10 Major change in **funding policy** or cost, affecting affordability, in the eyes of the community.

11 Major change in **flood hazard** information.

12 Major change in **land use**.

13 **Major change (of knowledge)** in relationship between river and catchment (including the discovery of relevant documentation).

14 Annual work programmes **cannot deliver Waiōhine River Plan** commitments.

15 Rapid **change in vegetation** in catchment (e.g. move away from grass paddocks to other forms of farming which will affect the way floods may behave).

16 Major **economic impact** (e.g. massive increase in interest rates).

17 Possible **future extension** of Greytown stopbank. This can be invoked if evidence emerges that the currently proposed measures will no longer be enough to protect vital assets (such as bridges), the town (from 1% floods) and rural dwellings (from 5% floods).

18 Any major influence from **Ruamahanga** or **Mangatārere** schemes.

19 If as a result of observing high velocity points, **issues are identified that threaten flood** defences or key assets.

20 Treaty settlement or other significant **cultural implications**.

21 Risk to the **oxidation ponds** bringing any heightened flood threat.

22 Any substantial risk to water quality improvement or it's measurement.

23 Any opportunity, such as the availability of **significant new knowledge**, techniques, data, methods, events, to improve the Waiōhine River Plan (such as enough data and science to implement a meaningful bed level envelope).

24 **Any issue that arises that is seen as critical** by iwi, landowners, or any other stakeholder group, including GWRC, that engages in the Living Plan process.

25 Any time there is a **new river related issue deemed important** enough for inclusion in this list by the community.

26 Any other issue or cause that WAG or its successor, mana whenua, Iwi, Fish & Game or other **stakeholder considers may impact** the success of the Waiōhine River Plan.

27 Identification by any stakeholder of possible new Critical Area or significant change to existing Critical Area.

28 When something occurs that makes it obvious that an aspect of these techniques is **failing to protect the banks and channels within the Critical Areas**, then these techniques may need tuning.

It is recommended that the WAG Project Team or its community nominated successor can, during the full term of this plan, convene as needed by the community to consider any issues relating to the river and floodplain management plan. Any statutory body or stakeholder group can ask WAG to convene but is not limited to any indication that a Trigger Event or threshold may have been reached, significant information has been shared from GWRC regarding the Waiōhine, planning information or inputs to planning information relating to the Waiōhine are available from GWRC, to prepare a report to the Wairarapa Committee or GWRC in Council, if the Wairarapa Committee is unavailable for any reason, to engage with GWRC regarding the river or their annual planning and budgeting cycle or any other planning or budgeting cycle (such as the three year revision of the ten year Long Term Plan) or one-time event of interest.

11.3 The annual cycle for the Living Plan process

"To ensure that GWRC management of activities remains appropriate and focused over the life of the new consents, while at the same time retaining the flexibility to change in response to new information over time; it is proposed that an adaptive management regime be approved as part of the resource consent conditions. This approach is integral to the success of the Code."

In this section of the Waiōhine River Plan, we cover how that adaptive management regime necessary for such a volatile, high risk and flood prone river as the Waiōhine needs to translate into a resource consent that draws together all the threads of this plan and puts them into action in an adaptive manner through a working partnership.

GWRC included within the Terms of Reference for this plan the need to address the operational management of the river. On 11th April 2019 the General Manager, Catchment Management Group wrote to the Project Team advising that resource consent should be the mechanism to address challenges in the operational management of the river. To do this, it is therefore necessary for this plan to describe what is needed, within any resource consent for the Waiōhine, to enact this Living Plan. The following sections to inform consenting are as far as practicable, based on the principles of:

1 To make this easy for GWRC to adopt and as consistent as practicable with current consenting practice.

2 As well as to be wholly consistent with this plan.

3 And to adopt tools and mechanisms already inherent in other recent GWRC river consents.

11.3.1 It is recommended that Resource Consents for the Waiōhine River and its environs should adopt the following in both specific content and intent:

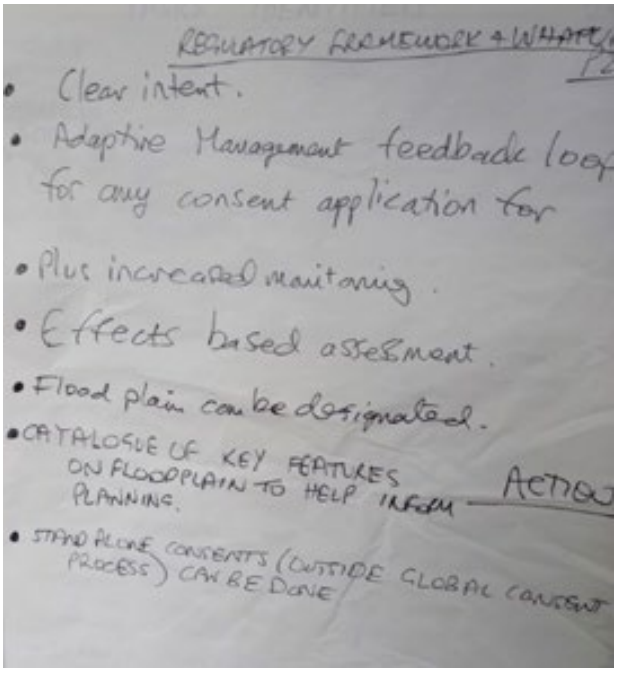


Figure 81: Regulatory Framework and Change chart – Project Team.

11.3.1.1 Regulatory Framework and Change

1 The Waiōhine River Plan shows a clear intent which should be reflected in any application for consent regarding ot's care and management.

2 A key principle of the Living Plan is Adaptive Management. For this large, steep, fast flowing, fast changing, major flood prone river, carried above the surrounding floodplain on a raised alluvial fan, with a string of adjacent critical assets – fast and constant change is the norm.

3 Given the above there is a greater than normal need for an increased level of monitoring and managing – making best use of collective stakeholder, local expert and independent subject matter expert wisdom to adapt to change based upon assessing risks and effects.

4 **There is a need to recommend** that Territorial Authorities (local councils) designate the extent of the floodplain as needing care in earthworks, tree felling and building that could impact or be impacted by the river in flood.

5 It is proposed that by designating certain areas along the river as Critical Areas, a pragmatic approach to maintenance and gravel extraction is able to be taken that allows the river to behave more naturalistically away from the Critical Areas that make up a small proportion of the approximately 66 kilometres of it's length.

6 **It is recommended** that initially seven stretches of the river are designated as Critical Areas:

Found Between Cross Section	And Cross Section	Brief Descriptor
XS 17	XS 18	Urupa and banks above SH2 Bridge
XS 20	XS 21	Fullers Bend, above and below
XS 21	XS 22	Platform Farm
XS 20	XS 26	True Left (Carterton Bank) stopbank protection
XS 27	XS 28	Kuratawhiti Street
XS 31	XS 32	Hallidays
XS 39	XS 40	Town water bore field

Figure 82: Table of Critical Areas – Project Team.

7 Where projects such as most carefully conducting controlled testing of new concepts, such as those proposed by Massey University subject matter experts for even lower impacts of works that have to be conducted in the river, from time to time, separate stand alone consents, strictly limited to those proofs of concept required.

11.3.1.2 Operational Management Plans

for the Waiōhine River must, within 12 months after the commencement of a consent:

1 Consent holder must invite Waiōhine Action Group (WAG), or it's community appointed successor, to facilitate and coordinate stakeholders including mana whenua (representing Papawai Marae), Ngati Kahungunu Ki Wairarapa, Rangitane o Wairarapa, Fish & Game, Department of Conservation and South Wairarapa District Council to be involved in the design and development of Operational Management Plans in accordance with The Waiōhine River Plan (incorporating the Waiōhine Floodplain Management Plan).

2 2. Submit each Operational Management Plan to GWRC Wairarapa Committee for review, then to the Manager, Environmental Regulation. Each Operational Management Plan for the Waiōhine River must be consistent with the The Waiōhine River Plan (Incorporating the Waiōhine Floodplain Management Plan).

11.3.1.3 Annual Work Plans

For the Waiōhine River, the consent holder must, by 1st July each year:-

1 Invite Waiōhine Action Group, or it's community appointed successor, to facilitate and coordinate stakeholders (see above) to be involved in the design and development of the Annual Work Plan in accordance with The Waiōhine River Plan (incorporating the Waiōhine Floodplain Management Plan).

2 Ensure any data, information or documentation, whether in note, draft or final form, is provided to Waiōhine Action Group (WAG) or its successor, as it comes to hand at GWRC in order that it can be shared with other stakeholders and used to inform them with regard to all matters pertaining to the river and its environs.

3 Submit each Annual Work Plan to GWRC Wairarapa Committee and WAG for review and also provide copies of the plan to each of the parties listed above.

When translating the Waiōhine River Living Plan into Resource Consents each Waiōhine River Annual Work Plan should also:

1 Be consistent with the vision, specifics and intent of the Waiōhine River Plan and supporting documents.

2 Identify opportunities for environmental enhancement in collaboration with the Waiōhine Action Group (WAG) and other stakeholders that contribute towards the vision for the river, and as identified by a suitably qualified, mutually agreed ecologist.

11.3.1.4 Site Specific Effects Management Plans and Monitoring

Each Operational Management Plan must be consistent with the Waiōhine River Plan (Incorporating Floodplain Management Plan). Before the consent holder commences one or more of the activities listed, it should consult Waiōhine Action Group (WAG), or it's community appointed successor, who will use the Living Plan Process, to attempt to facilitate responses from interested stakeholders. Additionally, Rangitane o Wairarapa, should be invited to appoint a kaitiaki to oversee the work permitted by the SSEMP on behalf of the Waiōhine River Plan, Waiōhine Action Group or its successor and other stakeholders if they wish.

11.3.1.5 Annual Reporting

The consent holder must, by 31st August each year also share each stage of the drafting of the Annual Report with Waiōhine Action Group (WAG) or its successor (See Waiōhine River Plan) along with contributory data, reports and documentation.

Annual reports should comment fully on the past year's actual contribution to realisation of the vision of the Waiōhine Living Plan, together with any actions, or their lack that has impacted negatively on the River Plan.

A copy of the Manger, Environmental Regulation's review document should also be shared with Waiōhine Action Group (WAG) or its successor and the Wairarapa Committee of GWRC.

11.3.1.6 Independent Review Panel

Independent experts appointed to the Independent Review Panel must be acceptable to mana whenua, Waiōhine Action Group (WAG) or its successor and Fish and Game; who must all also be able to submit information, make presentations, or make representation to the Independent Review Panel.

All parties should be provided with the report as should be the Wairarapa Committee of the GWRC. The Review Panel's report should thoroughly consider the consent holder's alignment against the vision and specifics of the Waiōhine River Plan and what might be done to better deliver against it in future.

11.3.1.7 Ecological Enhancement Fund

Should be used where it is mutually agreed with Waiōhine Action Group (WAG) or its successor, that the application advances the Waiōhine River Plan's vision for restoration and enhances the mauri of the river.

11.3.1.8 Walkovers (annual and other)

The consent holder should undertake at least two formal walkovers each year where river management activities may, in the opinion of any party, need to be undertaken pursuant to these consents at times mutually agreed with Waiōhine Action Group (WAG) or its successor, that will coordinate attendance of interested stakeholders.

The purposes of walkovers is:

1 To review new or known data and information relating to the river and environs.

2 To identify and agree on work needed in the maintenance and restoration of the river and environs.

3 To ensure completed and proposed work aligns with the vision and specifics of the Waiōhine River Plan (Incorporating Floodplain Management Plan).

4 To identify any new work required to be coordinated by Waiōhine Action Group (WAG) or its successor, to further develop the Waiōhine River Plan.

Additional walkovers may be necessary in the event of any trigger event occurring that is listed in the Waiōhine River Plan.

11.3.1.9 Critical Areas of the Waiōhine River

The size, steepness, speed, location, size and nature of tributaries, flood, slip and earthquake affected history, elevation above floodplain, gravel loading and proximity to sensitive and critical infrastructure and dwellings, make the Waiōhine a particularly complicated river to plan and manage safely.

Critical infrastructure includes bridges, town water supply bore fields, and the high risk to Greytown and SH 2 of avulsion or damage to key assets. The Flood Protection aspects of the River Plan rely on a point in time survey, model and mapping of the river. In taking an approach to new flood defences of stepping well back from the river and allowing it to spread out and slow down, it has been identified that channel alignment and bank protection must remain as it was in January 2019. This has been adapted by applying this only to Critica Areas, where risk of damage to Critical Assets must be prevented and avulsion or course change for the river must also be prevented for the flood protection part of the plan to be viable.

The Waiōhine River Plan identifies these high risk locations as Critical Areas and how they may be assessed as such. It is important that the river is managed in such a way as to minimise these risks within the context of such factors as long term weather and flood cycles, climate change and changes to gravel beaches that might force significant changes of river channel. In other stretches of the river, more latitude to spread out, slow down and assume a more naturalistic manner is achievable. In Critical Areas, decision making should seek a balance between protection and naturalistic outcomes with care to use techniques that create and maintain habitat. For guidance on this, see the Waiōhine River Plan, with particular reference to the subsidiary document "Ecological effects of flood management activities in Wairarapa Rivers'' 2013, authors Russell and Fiona Death of Massey University and Aquanet Consulting. See references within this plan relating to Critical Areas.

11.3.1.10 Site Specific Effects Management Plans and Monitoring (SSEMP)

Each Operational Management Plan should be consistent with the Waiōhine River Plan (Incorporating Floodplain Management Plan). Before the consent holder commences one or more of the activities listed, it should consult Waiōhine Action Group (WAG), or its community appointed successor, who will attempt to facilitate responses from mana whenua (representing Papawai Marae) who should be invited to appoint a kaitiaki to oversee the work permitted by the SSEMP on behalf of other stakeholders if they wish. If mana whenua do not wish to provide kaitiaki services, then WAG or another stakeholder may elect to provide oversight instead, that work carried out is in keeping with the Waiōhine River Plan.

11.3.1.11 Reviews

The consent holder when undertaking a review should consult with Waiōhine Action Group (WAG), who may make a submission to accompany the review, on what has not been achieved to progress the restoration of the river and environs, towards the vision and specifics of the Waiōhine River Plan (Incorporating Floodplain Management Plan).

11.3.1.12 Disagreement Resolution

In the event that consensus is not reached amongst the parties during a walkover or in WAG's subsequent work to enhance or implement the River Plan, then the issue is to be resolved by the next meeting of the Wairarapa Committee of GWRC, or if urgency dictates by a meeting attended by WAG, the interested stakeholders and the Wairarapa Councillor of GWRC, who will chair the meeting, in accordance with provisions in the Waiōhine River Plan.

This disagreement resolution mechanism should also be applied in any situation where consensus is not attained through reasonable efforts to find a consensus solution that can be added to the River Plan or for work to be done in the river and its environs.

In the event of disagreement, law and regulation, together with the Waiōhine River Plan (Incorporating Floodplain Management Plan), Whaitua Implementation Plan, Code of Practice, Management and Operational Plans (in that order of precedence) should be used to guide resolution. Mutually acceptable independent experts can be called upon where additional advice is wanted.

This disagreement resolution mechanism should also be applied in any situation where consensus is not attained through reasonable efforts to find a consensus solution that can be added to the River Plan or for work to be done in the river and its environs.

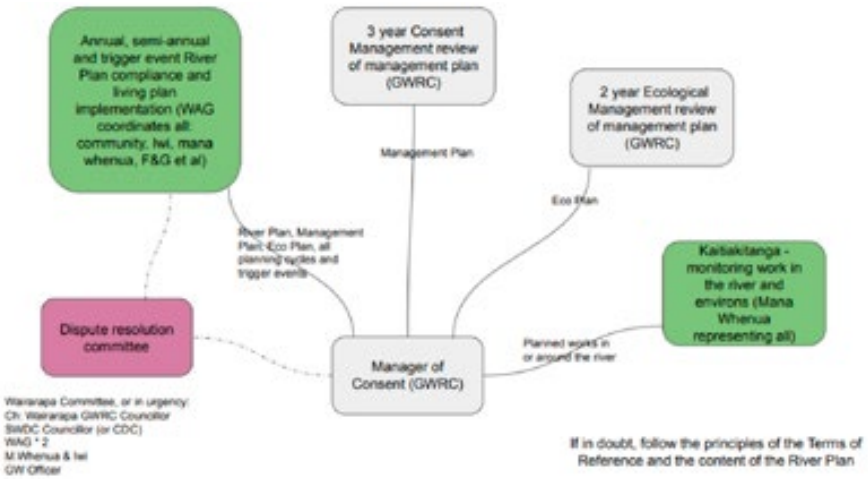


Figure 83: How the relationship between River Plan, stakeholders and the consent process should work (based on existing consent mechanisms)-Project Team.

11.4 Appropriate term of consent

The planning horizons for the Waiōhine River Plan are 2090, with a mandatory overall review and update of the consent no later than by 2050, and reviews and updates if judged necessary by stakeholders, or judged necessary whenever a Trigger event occurs.

There is a need for regular review of the Waiōhine consent for a number of reasons:

1 Its fast changing nature and issues with gravel banks building up rapidly.

2 It's size and the size of risk it poses to nearby towns, dwellings, state highway, bridges, water supplies and critical high banks, stopbanks and other assets.

3 The size and scale of flood events and the associated long range weather cycles.

4 Changing technologies are becoming available.

5 Changing legislation and understanding of the nature and behaviour of rivers.

6 Unfolding information about the impact of climate change.

7 Changes in land use.

8 The need to ensure the best care of the mauri, environment and ecosystems.

9 Changing recreational use.

For these reasons, clearly a 35 year consent term is inappropriate.

It is recommended that a much shorter term, such as ten years is set, or until a Trigger Event suggests there is a need for change to the consent and a new or modified consent should then be applied for.

11.5 What is done by who by when for the Waiōhine River Living Plan – and cost estimates

Notes:

1 As at November 2020

2 Needs to be updated annually and used as one of the inputs to inform the LTP and annual plan.

	Within how long after this plan is approved	Rough (RAG) Budget	Refer to page in this plan	Notes
Planning Controls in District Plan	2 years	<$200,000	9.1 Interim maps, final maps, planning controls on page 111	Synchronize to District Plan process, repeat
North Street Stopbank	2 years	<$800,000	Conceptual stopbank design on page 175	
Kuratawhiti Street Stopbank	2 years	<$330,000	Conceptual stopbank design on page 175	
Greytown Stopbank Spurs/groynes	2 years	<$45,000	7.11.3 Greytown Stopbank on page 99	Either this or the planting on next line
Greytown Stopbank Planting	2 years	<$30,000	7.11.3 Greytown Stopbank on page 99	See above
Gravel Extraction proof of concept testing	2 years	<$20,000	6.6 Proposed: rules for gravel extraction on page 66	Depends on expert from Massey or other
Improved warning of flood risk (@river access and homes)	2-5 years	$25,000	Emergency management and flood warning on page 118	Depends on 3rd parties e,g, Fire Service and WREMO
Additional Aerial Survey	2 years	<$20,000	8.4 Further information and recommendations on costs on page 105	Cost benefit may need to be better understood to set frequency
Bed Level Envelope	ASAP	C. $20,000 ?	12.7.2 Bed level and gravel on page 149	Depends upon when reliable and trusted data found
Design Line Review	ASAP	C. $2,000?	6.12 Setting the flood sensitive area on page 72	Tweaks and tidy ups but no major changes to size of buffers
Water quality monitoring	As required JFDI		Water quality management and other Whaitua programme obligations on page 162	Citizen science, stop waiting for GWRC

Figure 84: What is done by who and when – cost estimates – Project Team.

12

River Management

Where it joins the Ruamahanga, the Waiōhine is comparable in size to the Ruamahanga itself. As discussed above, it has a large catchment, deep in the Tuataras, a steep profile and runs atop a delta built up above the floodplain. It has a long history of sudden, major floods that endanger the adjacent towns.

For these reasons, careful and frequent maintenance of the river is vital to keep people and places safe and the banks must be maintained against erosion and avulsion (sudden changes of course) in the stretch of the river between the gorge and State Highway 2 Bridge. This must be done to protect the bridges, town water supply, Greytown and Carterton and State Highway 2.

The Independent Peer Review of this plan by Ian Heslop of ECAN, dated January 2019, states that:

"One key point that needs to be reinforced is that the bed level and channel management will need to continue, to maintain the current river alignment and both the rural and flood protection standards."

The feasibility of the flood protection scheme for the Waiōhine relies on this rule. Between 2019 and 2021 river management has changed considerably, gravel extraction was drastically reduced and the river allowed to deviate from it's existing channel alignment to attack it's banks. In most of the river this has not been problematic, however it has caused issues in the seven Critical Areas (see below) and a programme of remedial work and ongoing maintenance was agreed to in March 2021 to restore and maintain the river so as to ensure for critical areas, banks and channels tip towards the safety of community and cultural assets.

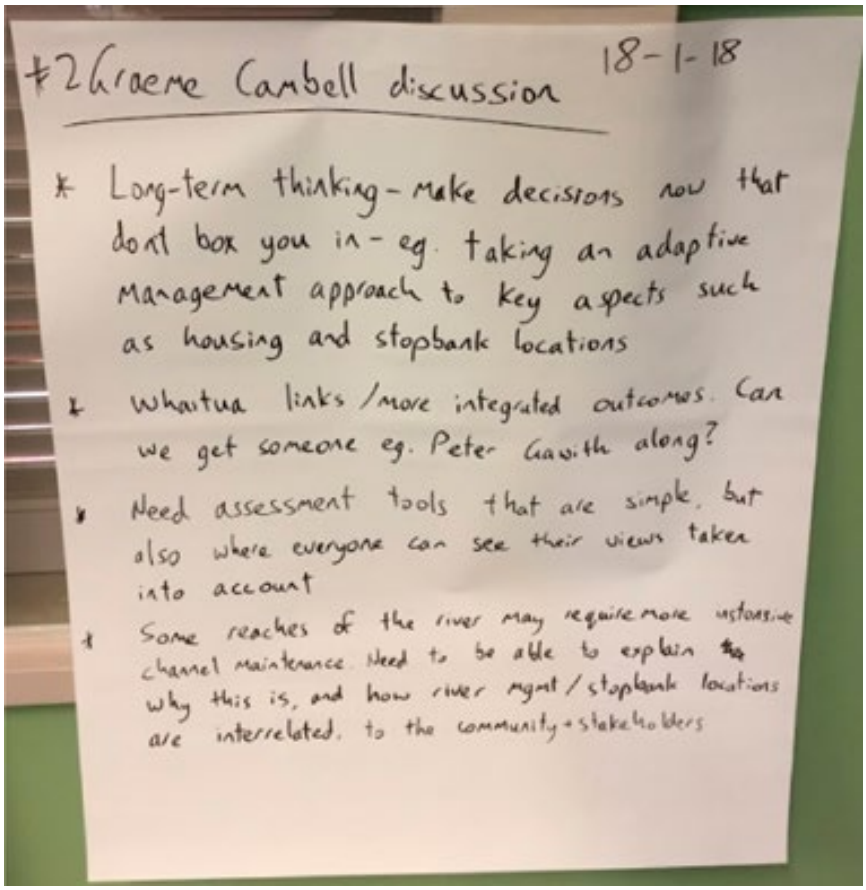


Figure 85: Graeme Campbell Discussion chart – Project Team.

12.1 Critical areas

Where there is a risk of an erosion weakened bank or the river being turned against a bank because of compacted gravel banks/beaches having built up, and that bank is in a Critical Area of the river – then important assets are endangered by either continued erosion causing a change of course, or the banks being too weak to withstand a major flood event – thus causing a major avulsion (change of course) or other event that endangers important assets. So it is important to distinguish what must be protected from flood and what must be protected from erosion:

	What Are We Protecting?	From flood	From Erosion
1	Towns	Yes	No
2	Stopbanks	Yes	Yes
3	Bridges (SH2, Rail)	Yes	Yes
4	Roads	Yes	Yes
5	Bore Field – towns water supply	No	Yes
6	Water Races	No	Yes
7	WasteWater Network	Yes	Yes
8	Private Dwellings	Yes	Yes
9	Papawai	Yes	Yes
10	Farmland	No	Yes
11	Urupa	Yes	Yes
12	Change of course	No	Yes

Figure 86: Critical Areas Table – What Are We Protecting? – Project Team.

This also means that maintenance of Critical Areas should be done early – on the principle that "a stitch in time saves nine" and nothing should be left until risk and cost mount up. Leaving maintenance until major works, such as lining the banks with massive rocks shipped down from the central north island, is necessary – would be an example of very poor river management. Extracting surplus gravel and protecting banks with appropriately designed boulder groynes, interplanted with trees that provide shade and shelter to ecosystems and help manage swirls and slow down water flows – would be an example of good river management.

12.2 Critical area planning parameters

12.2.1 Principles

The following management principles may be applied to all areas on the Waiōhine but must be applied to areas Critical Areas. Stakeholders and GWRC should work together on this in the spirit of a multi-disciplinary, cross functional team.

12.2.2 Remedial work

Initial remedial work (as at April-June 2021) needs to be undertaken in these areas to bring them back to complying with the channel alignment and bank protection requirements of the flood protection scheme and it's Independent Peer Review.

12.2.3 Introduction of principles

From 1st july 2021 the operational management principles of this plan will be adopted to continue to manage the river pending formal adoption of the entire Waihone River Plan.

12.2.4 "Tool box"

This has implications for the toolbox in regular use to manage the river, for instance, including gravel extraction.

12.2.5 Adoption of additional critical area planning parameters:

1 Balance Critical Area protection and environmental values

2 In Critical Areas the balance of consideration tips in favour of protection of critical assets and cultural values.

3 Plan channel alignment and bank protection maintenance out to five year horizon

4 Refresh plan at time of each three year revision of the Long Term Plan

5 Invoke review of plans if trigger events occur that affect relevant critical area(s)

12.2.6 Independent peer review compliance

Comply with Waiōhine River Plan Independent Peer Review January 2019) guides with regard to maintaining channel management and bank protection for Critical Areas.

12.3 Tools for critical area management

1 Extract Gravel to
   a Remove high beaches
   b Re-align channel

2 Maintain alignment of channel upstream of Critical Area – to keep from attack against bank in Critical Area

3 Well designed and constructed snub nosed groynes
   a Interplanted

4 Move gravel
   a Beach contouring
   b Batter banks

5 Rock lining of bank

6 Ripping/cross-blading

12.4 Overarching principles for managing channel alignment, beaches and banks in critical areas

12.4.1 This structured logic should be used to determine when to act:

1 IF it's a High-beach in the design alignment channel, OR

2 IF the river is in contact with the buffer zone THEN

3 Extract-or-move-gravel

Where:

1 A High-Beach occurs:

- a IF it's in or immediately above a flow less than ten cubic metres (>10M^3)
- b AND the High-beach is in the design alignment channel
- c AND it is more than 2 metres above water level
- d AND not Undermining-a-Structure (e.g. bank)

2 THEN Extract-or-move-Gravel OR

3 IF it's Undermining-a-structure then

- a Move enough gravel to protect the structure
- b AND extract the balance to resolve the High-Beach[1] OR

4 IF High-beach occurs in design alignment channel OR

5 IF in contact with the buffer zone

6 THEN extract gravel.

12.5 Specific five year plans (revised at each three year long term plan event)

12.5.1 Critical area – Urupa bank above SH2 bridge

1 Issue – loss of irreplaceable land

2 Cause – Alignment of channel

3 Solutions:

- a Well designed, snub nosed groynes at the Urupa bank and smart planting
- b Extract true left bank gravel beach around the corner upstream, maintain backchannel, keep beach low and flat. Initially remove 15,000 cubic metres of gravel from here to remove the high beach

4 Maintain extraction of true right bank opposite Urupa and above SH2 Bridge, to be low/flat

5 Keep possibility of re-contouring in mind

6 These will be needed to be kept up through the next five years.

12.5.2 Critical area – Fullers Bend

1 Complete rock lining "revetment" across rest of eroded "bay" at XS 20 to beyond halfway to XS 21 (or approximately 150 metres from access road

2 Complete detailed design of snub nosed groynes upstream of rock lining, to be okayed by Project Team, then built

3 At XS20 extraction may be necessary to maintain low and flat beaches (same principles as urupa Critical Area to be applied), this will be needed to be kept up through the next five years.

12.5.3 Critical area – Platform Farm

1 Plant planned natives to supplement remedial work done as at May 2021

2 Gravel Extraction to lower and clear high beaches

3 Bed Recontouring

4 Build snub nosed rock groynes if channel reaches bank again.

Figure 87: Critical Area Photograph – Platform Farm – GWRC.

12.5.4 Critical area – protect true left bank between cross sections 20-27 and channel alignment

1 Keep channel alignment away from buffer zone

2 Move or extract high beaches as they occur, where they impact channel alignment.

12.5.5 Critical Area – Kuratawhiti Street

1 As at 22nd May 2021 extract 10,000 cubic metres of gravel from the high beaches as remediation.

2 Construct 3 150 ton snub nosed rock groynes to protect the exposed True Right Bank (Greytown side) at 25 metre nominal spacing, using quarried rock.

3 Push over 2,000 cubic metres of river gravel to be battered in under the groynes.

4 Further groynes may be needed to be added at some later date above or below these.

5 Both science (LIDAR) and "art" (Observation and experience) are needed to manage these Critical Areas – these should be applied in good faith collaboration between stakeholders.

Figure 88: Critical Area Photograph – Kuratawhiti Street – GWRC.

12.5.6 Critical area – mature significant native tree stand and natural nursery

1 Use overarching principles for removing high beaches and protecting banks.

12.5.7 Critical Area – Borefields

1 Remedial action – push over gravel (big stones) – some thousands of cubic metres of material to fill deep cutting near borefield bank and batter that bank.

2 Extract beaches to be low and flat, this will be needed to be kept up through the next five years.

3 Restack and maintain existing rock groyne.

Figure 89: Critical Area Photograph – Mature Native Trees – GWRC.

12.6 Ecological care and considerations

We have taken overarching guidance from the excellent document: "Ecological effects of flood management activities in Wairarapa Rivers" Russell and Fiona Death, Massey University & Aquanet Consulting, December 2013, prepared for Greater Wellington Regional Council (see Appendix l); which documents detailed studies carried out on the Waiōhine River, amongst others. It is worth quoting its conclusions here:

1 "Weight of evidence from all 3 studies strongly indicates a less than minor effect on riverine ecology of the engineering activities we investigated. It would thus be reasonable to assume that similar works in other reaches of these types of Wairarapa rivers would have less than minor effects.

2 This can be attributed to a number of factors including the activities were relatively small (80 – 150m length of river works) and discrete (no consideration of cumulative effects was made), this type of activity (despite the increased turbidity and substrate movement) is not dramatically dissimilar to the physical effects of a fresh or flood, which are common in all three rivers, and that such activities have occurred in these rivers (along with other anthropogenic disturbances) for many years.

3 Effects scaled with the size of the engineering activity, so that the Waingawa River study which had the greatest length and severity of works, exhibited the biggest ecological effect. Although, even here the number of macroinvertebrates and trout were the only biological parameters that were still "affected" at the final sampling after the first major fresh.

4 The scale effect may be particularly important when the cumulative effects of these engineering activities are considered (which we did not do in this study) and it is thus important that although localised effects may not occur, a wider river perspective must be maintained. To that end activities, such as using boulder groynes, leaving and creating backwaters, and minimising the on-site vehicle activity footprint is extremely important.

5 Directly after the works biological communities changed, periphyton biomass was reduced and deposited sediment did accumulate. However, the first major fresh or flood reset the local habitat and biological communities, so that the ecological impact of the works essentially disappeared."

In addition to this, a range of principles, tools and hierarchies to help choose the best tools for each situation have been identified below.

The expertise shared by subject matter specialists Professor Ian Fuller, Professor Russell Death and Will Conley of Massey University, are the cornerstone of this aspect of the Waiōhine River Plan. The living plan depends upon continued access to those or similar skills from time to time to trial, measure and develop solid science around the techniques, tools and hierarchies discussed below.

We have also engaged with NZTA who have agreed to attempt to mesh the plan into their planning process for the maintaining of State Highway 2. This offers the opportunity to maintain the level of stretches of the highway in a way that reduces the impact of flooding on dwellings alongside the highway and helps to protect the Greytown urban area. For example, between the Apple Barrel and Waihakeke Road the level of SH2 should not be raised, otherwise it will reduce the capacity of the floodway.

We note that approximately 3% of the budget GWRC allocated to the annual River Management budget may be available for river enhancement and restoration.

We recommend that this practice should continue and where available, be used to promote native planting and the restoration of native ecosystems, in keeping with the Vision for the River.

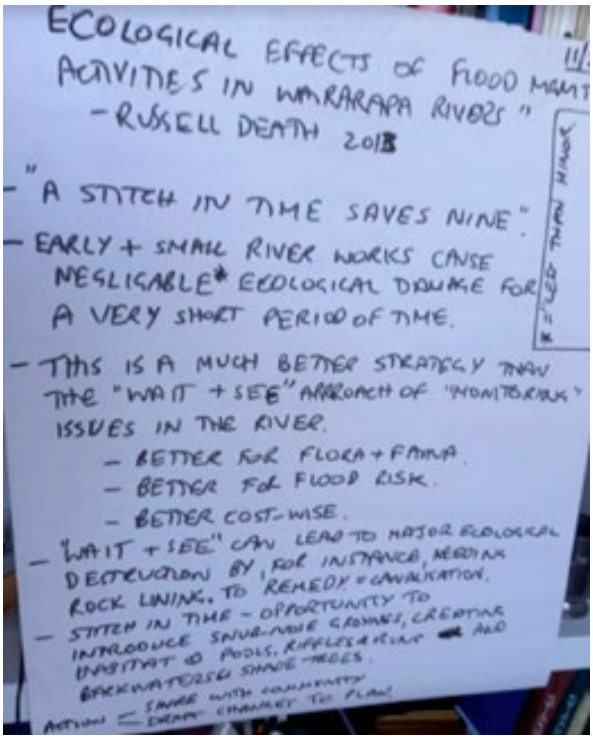


Figure 90: Ecological Care and Considerations chart – Project Team.

12.7 Other river management principles adopted

River management should be undertaken in compliance with statutes and regulations and in consultation with statutory authorities, such as Iwi, Fish and Game and the Department of Conservation. This is embraced in the Living Plan Process for the Waiōhine River and should also be reflected in the Code of Practice that is to be developed for the Waiōhine River (see Living Plan Process).

NOTE that all principles below should be in keeping with the conclusions of "Ecological effects of flood management activities in Wairarapa Rivers".

12.7.1 Shape and character

1 **We recommend** that the river, with the exception of works needed in Critical Areas, be aimed at achieving Natural Character, as distinct from returning the river to its original natural state. See Natural Character.

2 **We recommend** that giving the river room, wherever practical, is good and better supports the geomorphology, gives flexibility and future options and room for natural eco systems to develop.

3 Geomorphically, "working with the river" is better, where assets (such as in Critical Areas) are not threatened and the threat of the river adopting a whole new course, can be safely contained.

4 Maintaining wider margins reduces the need for intervention.

5 The distance between the banks doesn't necessarily have to be the same width all the way down. It is natural for a river to adopt an "hourglass" or "beaded" shape, alternating wider and narrower distances between banks. Whilst maintaining an "hourglass fairway" has no NZ precedent yet in practice: it is now recognized as the current best way to manage the river channel.

6 **We recommend** that structural work for prevention of flooding should be set back as far as practical from the river, where practical, and there is no immediate threat of a change in river course. Consequently, some erosion of high banks outside of Critical Areas may have to be tolerated pending more permanent repairs. If collapse does eventuate, then there is a need to quickly manage the eroded area (i.e. the beach from the collapsed bank) by planting vegetation to resist further erosion. This is the case in several locations outside Critical Areas, for instance, along the Beban (XS 30)/Vines(XS 28-30) /Fairbrother section of the true right bank and at points alongside Platform Farm, also on the true right bank.

7 **We recommend** to defend, where practical, areas where there might be high sheer stress (to prevent the erosive power of the river from causing it to break out and change course, threatening assets and dwellings) with riparian mosaics (planting along lines/ spaces that will slow and control the river in extreme events).

8 High beaches (in and alongside the river) are an effect of a constrained river: so, the more we attempt to constrain the riverbanks, the more we will be faced with high beaches that need to be reduced. High gravel beaches serve to constrain the river and so put banks at risk. Of course, Critical Areas may not offer this lattitude.

9 It is noted that the Matarawa area is ponding and creates potential gravel storage. Over time, the river is going to want to change direction there. We advise that Fuller's Bend

(XS 20) works would be an engineering, rather than geomorphic response, and will not usefully solve the problem.

10 **Where practical we recommend** that floods be allowed to spread and slow, this means more silt will be deposited across the flood plain and less will be carried downstream, to damage lower reaches of the river, Ruamahanga and Wairarapa Moana. We note that there is some benefit to aquifer recharge from allowing a flood to spread.

11 **We recommend** that it should be important to maintain dual river channels in the reach immediately below the rail bridge (XS 37), in order to ensure the river in flood does not block with debris easily, and force too much water onto the true right bank, alongside Greytown Stopbank, that could scour its toe and undermine the bank. Or create such a volume of water at the end of the Greytown Stopbank, that if rapid or otherwise unmanageable, would lead to greater flows on that berm. This is also an opportunity to maintain backwaters, pools, runs and riffles.

12 Velocity modelling results based on a substantial (+20% roughness) blockage of the existing channel have been used to generate significant sheer stress, at the toe and end of Greytown stopbank. **We recommend** that planting should be made (or if this is unsuccessful over time, spur banks) along the toe of the existing stopbank and in extension of the line of the stopbank. This needs to be done in a way that reinforces the existing bank and row of trees, so it will bolster existing defences here.

13 **We recommend disposal of the three Fullers Bend properties** that were specifically acquired to facilitate the repositioning of flood defences. These are no longer required for that purpose and should be freed from being an ongoing financial burden to ratepayers, releasing costs into the river maintenance budget to speed such work as the rock lining of the outside of Fullers Bend.

14 Bed levels have been monitored periodically since 1986. There is no clear evidence that the Waiōhine is degrading or aggrading significantly, or that gravel extraction or limits should be reduced at this time; but this should be monitored and is a Trigger for review under the Living Plan. In order to avoid increased risk of flooding and erosion, **we recommend that continued gravel extraction must be sustained**. Note other comments relating to triggers needed to manage effects of gravel extraction.

15 Bank erosion is the biggest maintenance issue at present (2020-2021) (between the Rail Bridge (XS 37) and State Highway 2 Bridge). There is some evidence of changed management (between 2019 and 2021) practices elevating flood risk and risk of significant bank erosion in this stretch.

16 **We recommend** that designate features on the floodplain that should not be altered without care and consultation, as they may affect flood management and safety. These should be listed and maintained as part of the Living Plan and will include:

- a Rows of trees and vegetation (for example the row of mature pine trees that run from the gate at the end of the Greytown Stopbank in an Easterly direction, towards the river buffer zone),
- b Old water channels and drains,
- c Existing road crossings and culverts,
- d Roads of any sort.

12.7.2 Bed level and gravel

1 An envelope to guide the upper and lower acceptable levels of the riverbed at each cross section (sometimes called a morphological or hydraulic envelope) is desirable. It will require a completed IPO cycle so that the full range of quantities of material brought down by high flows can be taken into account. Then the high and low marks can be set. Then these will guide the decision to extract gravel because the upper limit has been exceeded and the decision to stop extraction and/or replace gravel when the lower limit is exceeded.

We recommend that this should be safeguarded through the use of Trigger Events within this Living Plan, to ensure action is taken where any evidence emerges that there might be increased risk of flooding, bank instability that could lead to collapse, risk to assets, such as bridge abutments, or significant erosion in the view of a stakeholder.

2 Gravel extraction is a necessary part of river maintenance and **we recommend** that it is considered imperative to the success of flood defences that gravel extraction is continued by reasonable consensus, within the plan, especially for Critical Areas: see Gravel Extraction Tool Hierarchy.

3 There are a number of places where gravel can come from into the Waiōhine River:

- a Entering from the gorge into the top of the river below the gorge, this is caused by slips in the steep catchment tributaries, deep in the Tararuas that may be brought about by such actions as:
  - i Rainfall,
  - ii Earthquakes,
  - iii Erosion caused by wild animals grazing.
- b From the Maungataarere tributary below SH2 bridge.
- c From lateral erosion of the river banks caused by the river eroding it's banks where this can be allowed.
- d Bed erosion.
- e Minor tributaries, of which there are very few once the river emerges from it's gorge.

4 Removing large material higher up is not recommended unless dictated by the need to manage Critical Areas, as it will increase riverbed mobility and cause the river to move it's channel more.

5 Removing large material and leaving fines creates a pollutant problem, this is to be avoided wherever practical. The introduction of excessive fines into the river damages fauna and impacts the river and lakes downstream.

6 **It is recommended** that "Ecological effects of flood management activities in Wairarapa Rivers" at Appendix K for guidance and information on when moving or removing material in the river is acceptable and the significance of impacts and opportunity to create improved habitat (pools, runs, riffles and backwaters) that more than offsets downside.

7 **It is recommended** that where extraction takes place, techniques should be used that take the fines (sand and grit that is easily carried away in the river), and that minimise impact on the water and habitat quality. Extraction is all about balance, this can be

achieved by taking a range of material, rather than only one type. Only taking large stones must be avoided as, if this happens, fines can overwhelm invertebrates in the next flood event: stripping the river of life.

8 **Where possible, we recommend** increasing the number of points of access for machinery, to reduce the need to travel up and down the riverbed.

9 Beach extraction could create a sediment trap, encouraging more gravel to drop. Leaving a more hydraulically effective channel might be better; **it is recommended** to consider new techniques, even wet extraction in some carefully considered cases.

12.7.3 Ecology, habitat, flora and fauna

It is necessary to Identify an agreed toolbox for protection and eco zoning of the river to help manage the ongoing Living Plan, **we recommend to**:

1 Use appropriate plantings (see E&S).

2 Prioritise the establishment of buffers.

3 Protect plantings until they are established.

4 Create an amenity where there is an opportunity.

5 Create diversity of habitat wherever there is a choice.

6 Involve stakeholders where they have expressed interest.

7 Habitat diversity is better ecologically. A varied range of habitats is better. Keep up weed and pest control and where practical, the trimming of willows.

8 Where practical, use non-structural tools (vegetation, planning tools etc.) to manage the river,

9 If there is a fine sediment problem ripping should not be employed.

10 Ensure a supply of willow poles/sterile hybrid or equivalent and appropriate natives where practical.

11 Rock groynes are preferable to rock revetments (rock lining of the bank), as groynes create a better environment for flora, fauna, habitat diversity and slowing down the river, to recharge aquifers. Expert advice is that groynes may be more effective larger and further apart, work needs to be done to study and test this in controlled, measured conditions.

12 Allowing a "Crumple Zone" of vegetation. Provides large woody debris too, which helps to develop erosion and flood protection, natural habitat and ecosystems.

13 There has been the potential long-term loss of some floodplain habitat, e.g. former river channels that are now spring fed streams, as the river no longer floods the floodplain as frequently as it once did.

14 The stakeholders need to share a common set of objectives for weed and pest control (IWI/GWRC/WAG/DOC etc...), within the combined vision for the Living Plan.

15 Regular counts of pools, runs and riffles need to be conducted, recorded and published by reach, in consultation with the Department of Conservation, Wellington Fish and Game Council, mana whenua and other interested stakeholders as part of the Living Plan process.

16 The advice and guidance offered in "Ecological effects of flood management activities in Wairarapa Rivers" should be used as a guide in decision making where work in the wet will be needed. But always seek to create backwaters, pools, runs and riffles, so as to leave the river in a better condition for ecosystems and migrating fish.

12.8 River management toolbox

12.8.1 Including techniques that need proving

There is an opportunity to conduct well defined experiments to prove new management techniques in such areas as gravel management. These should be a partnership between GWRC, the community and an agreed body of independent experts such as Massey University. These would be best consented as standalone consents in the short term, rather than the less agile vehicle of global consenting.

12.8.2 Showing river management tool hierarchies where these can be used

Hierarchies are shown "best to worst" i.e. try to use the lowest numbered tool that works.

12.8.3 Gravel extraction tool hierarchy

1 **Trench close to the river technique**. This technique creates a dry trench to remove all material, close to the active channel of the river but not connected to the wet river. Only once all extraction is completed, can the river be allowed to enter the trench, thus minimising the transport of fines downstream. If this technique is to be considered, then either:

   a) Information on its successful use elsewhere is needed or

   b) A carefully managed trial should be conducted, and its effectiveness measured before determining whether to continue to use the tool. It would be useful to get the direct oversight of experts from Massey University or elsewhere for a trial.

2 **Remove the armour layer and then re-establish this**, once extraction is complete. Once removed, this fragile ecosystem is destroyed, and fine sediment is released into the river to interrupt downstream ecosystems. The concept of the "tool" of removing the armour layer and then attempting to restore it after gravel extraction, is intended to restore this environment in a way that encourages the protection and eco environment that the armour layer provides. It is agreed that the concept of armour layer restoration needs to be further investigated with the possibility of conducting trials, to measure actual effectiveness. It was also considered whether it was possible to remove stone, in such a way as to expose an earlier armour layer that might exist intact below. However, it was concluded this would be difficult and investigating restoration would probably be a better option.

   The Armour Layer is the surface of a gravel beach that has compacted naturally over time, with the finer sediment falling between bigger rocks and locking the surface layer together, whilst forming purchase for flora and eventually a habitat for fauna.

3 **"Scalp" Beaches**. This is the traditional approach to gravel extraction. It involves removing a layer off the top of a gravel beach, removing the armour layer and disrupting any eco systems, whilst exposing the loose fines to being washed into the river in the event of high water.

4 **Wet Channel Work**. This involves working in the river to remove material, releasing all the fines to be carried downstream. It is undesirable.

12.9 Possible alternatives to ripping (a hierarchy in order of preference from the perspective of river health)

1 **Widen the Channel.** This needs to be properly understood either through access to data from the technique being used elsewhere or through a managed and measured trial here on the Waiōhine, before being more widely adopted. The concept is to evaluate the practicality of widening the channel in selected problem sections. This may create the need for additional edge protection. Note that widening the channel does not increase the risk of avulsion. It creates lower energy in slower water. This needs data from a proven application elsewhere or a properly managed and measured trial to assess efficacy.

2 **Avoid ripping in the first place.** NOTE: This may not be possible in Critical Areas, where channel alignment and protection of key assets is at stake.

3 **Targeted gravel extraction** – see above

4 **"Ripping" after extraction**. It has limited effectiveness, is only ever a temporary solution and causes considerable damage to the environment. It is seen as a tool of last resort, because of damage to the armour layer and attendant eco-systems.

Beach "Ripping" or "Raking" is a process which involves the manual breakup of the Armour Layer using a tractor and custom-built "ripping" blades. It is done to encourage river "freshes" to carry away problem high beaches.

5 **Using rock-built groynes** should always be preferred to ripping beaches.

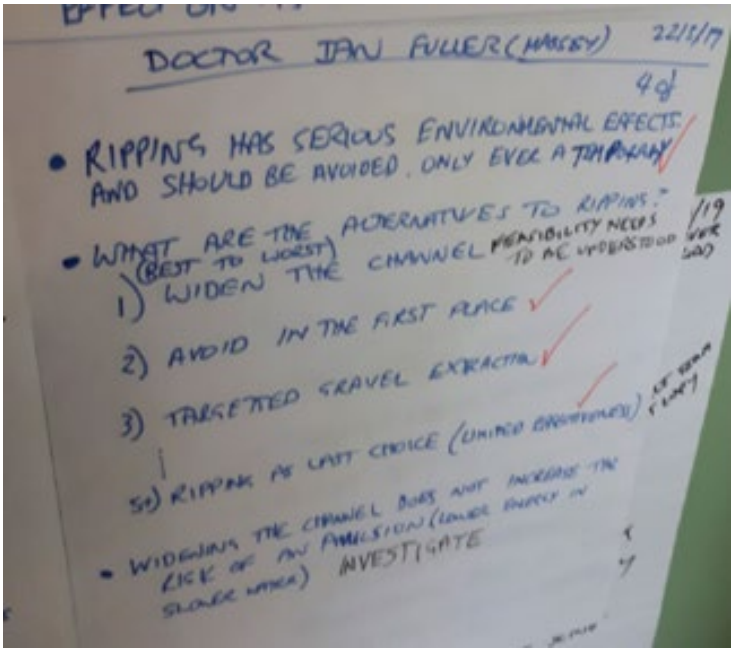


Figure 91: Finding the best way to manage gravel – workshop with Professor Ian Fuller (Massey University).

12.10 Possible Additional Tools

1 **Use of a Sediment Trap Further Upstream**. A sediment trap is created by scooping out a section of the riverbed to create a hollow into which sediment and gravel being transported will fall and remain. Clearly this is not a permanent solution and will require ongoing attention if it is to be maintained over any period. We do not yet have any clarity around its effectiveness or impacts, so an agreed approach to trialling and measuring the trial to investigate feasibility would be required, unless that data can be acquired from elsewhere.

2 **Use of groynes for bank protection**. Groynes are much better than rock revetments, offering better opportunities for flora, fauna, habitat diversity and slower water in the form of rock pools. For this purpose, Groynes are preferred to be larger and further apart. How large and how far apart should be the subject of a managed and measured trial, ideally under the guidance of Massey University subject matter experts. For guidance see "Ecological effects of flood management activities in Wairarapa Rivers" at Appendix K

12.11 River management design lines

River design lines are used as a planning, management and maintenance tool. They simply act as a guide to show, at the time of planning:

1 What care and maintenance are intended for each zone (Riverbed, buffer and floodplain)?

2 What agreement has been reached as to how each of these is to be treated,

12.11.1 Why and when to act

In reviewing River Design Lines and what job they need to do, it was asked:

1 Do we accept using River Management Lines as useful for the Waiōhine?

2 What do these lines represent to everyone?

3 Do site specific directions fit to River Management Lines?

4 How do we improve these lines to work better for the techniques we now use?

5 Can we evaluate the current river management width and/or make it better?

The diagram below shows the method devised for River Management Lines on the Waiōhine.

It is recommended this is adopted. NOTE this differs from previous approaches to meet the need for management of the flood plain out to the extent of the flood risk area and the planned stopbanks.

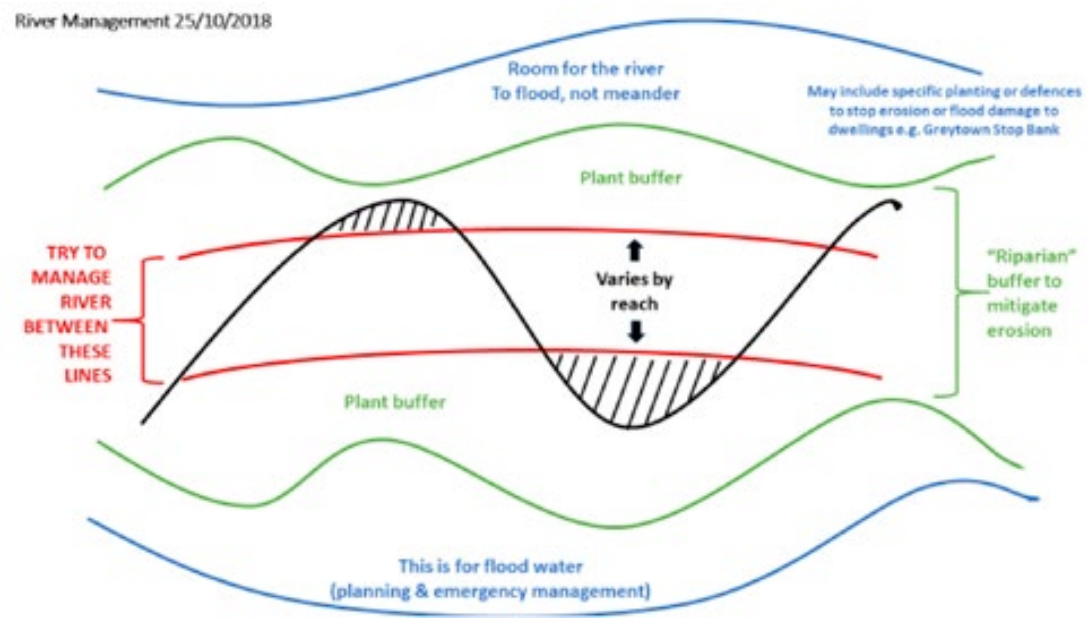


Figure 92: River Management Zones Diagram – Project Team.

The river design lines are provided as a guide, NOT set in stone and must be interpreted holistically.

Note that contrary to long standing expectation that river management lines should in the main be parallel, newer science calls for more of an hourglass shape. The Waiōhine is to be allowed to evolve to conform more to the hourglass shape, where practical (see Critical Areas). It is proposed to ask Massey University subject matter specialists to assist in redrawing this set of management lines in a way that makes most sense for the Waiōhine river management strategy.

It is recommended that this needs adjusting above the rail bridge (XS 37) to create an alignment that protects the pumps and wells for the Greytown water supply.

It is also desirable to allow the river to develop a combination of braiding and (without threatening the viability of defences, utilities, homes and farms) meandering, now known as "wandering" that allows the river, as much as is practical given Critical Areas, to obey its own dynamics and natural processes without endangering breaking down important banks or breaking through buffer zones.

12.11.2 This approach to river design lines answers several important questions

Q: In what circumstances would we be happy about the river being outside the red lines?
A: During major flooding.

Q: Are we happy with the river being entirely within the red lines?
A: No. See below.

Q: How much of the river should be expected to fall within the red lines at any time?
A: Approximately 80% should be relied on as a guideline.

Q: When should these lines be reviewed?
A: After a relevant trigger event and whenever the Waiōhine River Plan is fully reviewed.

Q: What would be relevant triggers for intervention for erosion into the buffers?

A: The risk of the river breaking through the buffer.

A: The risk of erosion on the opposite side, caused by the widening meander of the river as the result of it eating into a buffer zone.

A: Likely risk to existing assets, such as important banks or any stopbanks where maintenance is desirable.

A: In Critical Areas the river should be kept within its existing banks.

Q: What are the simple rules for management of the buffer?

A: We will use the principle of a 'stitch in time' to prioritize work that impacts the Buffer Zones in Critical Areas.

12.11.3 River management width. This varies by reach and location

1 Above rail bridge (XS 37) to upstream of Fullers Bend = 145 m. (steep bed)

2 Upstream Fullers Bend (XS 20) to SH2 bridge (XS 17) = transition down to 100 m

3 SH2 bridge (XS 17) to Mangatārere confluence = 80 m

4 Beyond the red lines on either bank is a buffer zone, delineated in green. The buffer zone does these jobs:

a Tolerates some river erosion (in non critical areas) and slows it.

b Forms an ecological corridor that can be sustained and improved as a reserve for environmental improvement projects.

c Provides a landscape and amenity value.

d Acts as a riparian filter to groundwater and run-off between adjacent farms and the river.

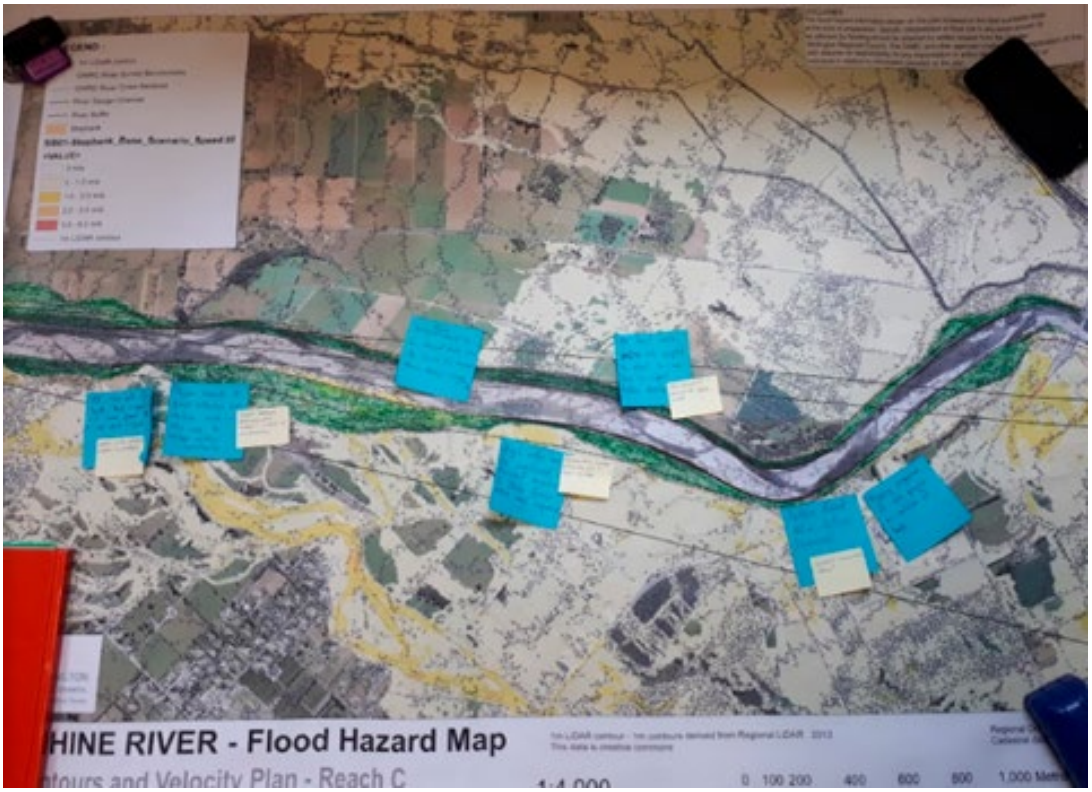


Figure 93: Example of tools used in developing an understanding of the needs of each stretch of river – Project Team.

5 **Beyond the Buffer zone on either bank is an area that depicts the expected maximum reach of a 1:100-year flood (delineated in blue)** with added contingency for climate change and for the flood sensitive area. The outer-blue lines are a new concept that we feel is necessary as our river plan has some things that should happen and shouldn't happen in that space. This area between the green and blue lines on the diagram should be designated as the floodplain in district and other plans. Some reasons for this are:

   a **Proposed stopbanks** will be out at the edge of the blue lines, protecting the limits of the urban area.

   b **Floodplain care:** There will be one or two places between the blue and green lines where for example, we'd suggest some trees be planted and gullies should not be filled in, without carefully considering planning the changes: as these things would affect the behaviour of flood waters in the event of a major flood.

   c **Building:** Obviously, there will have to be a care about where and how high off the ground new buildings and safe access to new buildings, might be allowed to be built in this zone.

6 Several locations have been identified as key for maintaining the river in its current course and to avoid unnecessary risk, to major flood protection assets and dwellings:

   a Platform Farm,

   b Vines Farm (XS 28-30),

   c Kuratawhiti Street.

Guide notes on following sections:
"XS" is an abbreviation of "Cross Section", "TLB" and "TRB" stand for "True Left Bank" (Carterton side) and "True Right Bank" (Greytown side) respectively.

12.12 River management needs vary by stretch of river

There are four distinct stretches of the Waiōhine River, each with a distinct character, each presenting different river management challenges and opportunities for the long term delivery of the community's vision for the river. Several approaches were taken to understanding these and developing strategies for each stretch. It was recognised that there was a need to balance a number of competing goals, including: the protection of Critical Areas, culturally sensitive sites, restoration and conservation of habitat to, for instance, preserve the high water quality, improve macro-invertebrate and fish environments, use "a stitch in time" touch to protect existing assets, manage flooding and erosion risks through river and gravel action, preserve important nesting sites and provide amenity. It is recognised that the job of effectively delivering against all these interests is difficult and complex but best achieved by partnership between Iwi, community, stakeholders and GWRC as proposed in the Living Plan process.

Of particular note are the seven Critical Areas, where gravel build up or constriction of the river may lead to erosion of high banks, attacks on critical assets (irrigation inlet, town water supplies, SH2, the Urupa) or weaken the river banks risking a change of river course in the event of a flood, running downhill into Greytown.

12.12.1 Reach A: Gooseneck to Rail Bridge

See full maps

1 This reach is steeper due to the fault line.

2 It features the sensitive "Critical Area" of the adjacent town water supply bore fields for Greytown and Featherston.

3 Wairarapa Fault: Water speed here is very fast at XS41:43 so a 140-metre width is not needed as overflows use Farmland Road.

4 Increase width of buffer areas to reflect existing vegetation.

5 XS 43-42 Carterton side (True Left Bank) replaces the training bank if destroyed, to protect from a river course change which could impact the water intake.

6 XS 42-40 TRB: Town water supply and bore field need care to maintain the bank to protect the bore field from river encroachment.

7 Just below and above the rail bridge (XS 37) – no mining of boulders is to be permitted e.g. near the water race intake (XS 42).

8 XS 38: Optimise design lines upstream and downstream of the Rail Bridge.

Figure 94: River management needs vary by stretch of river – photos – GWRC.

12.12.2 Reach B: Downstream of Rail Bridge to Wire Shed

1 This is a highly sensitive stretch as it is proven elsewhere in this plan that high gravel beaches in this stretch can cause the river to avulse (take a new course) in a flood and inundate Greytown. Management, including extraction of gravel build up is essential in this stretch.

2 XS 38 Optimise design lines upstream and downstream of the Rail Bridge.

3 XS 37-34: River to be kept wide to allow for a split channel below Rail Bridge to obviate risk to Greytown Stopbank and beyond.

4 XS 38-34: Maintain split channel downstream of Rail Bridge.

5 XS 36-35: Maintain stopbank bund as it is.

6 XS 36-33 (TRB): Design lines to follow groynes to prevent the river putting extra pressure on TLB downstream.

7 XS 33: Design lines can move closer to the river to prevent alignment issues downstream.

8 XS 29: The high riverbank on the TRB, if eroded, plant the resulting beach to counter further erosion.

9 XS 27 TRB: Move design lines to the north to avoid road end (River Road) and adjacent low ground.

Figure 95: River management needs vary by stretch of river – photos – GWRC.

12.12.3 Reach C: Wire Shed to SH2 Bridge

1 This is a highly sensitive stretch (containing Critical Areas) as it is proven elsewhere in this plan that high gravel beaches in this stretch can cause the river to avulse (take a new course) in a flood and threaten State Highway 2, the North end of Greytown and Udy Street. Management, including extraction of gravel build up is essential in this stretch. Constriction of flow by high gravel banks should also be avoided due to risk of destruction of high banks or assets.

2 XS 27: there is an unquantified risk that if the river gets above the true right bank here it could escape into lower ground beyond the car park and Kuratawhiti Street. Where practical, the existing riverbank should be hardened with rock groynes. If this should become non-viable and at risk of failure, then this will trigger a review within the Living Plan provisions. Note that this area is also the lower spill location to the start of the Apple Barrel floodway.

3 XS 27-26 Gravel extraction likely to be necessary in this area due to risk of avulsion (the river changing course) on the true right bank (Kuratawhiti Street side). We have also modelled the bed level to show it is sensitive to aggradation in this area, increasing some risk of flooding.

4 XS 27-21: True left bank high edge – rock groynes need to be keyed back into the bank to avoid them being outflanked.

5 XS 24-23 True right bank. Floodwater here may be already affecting State Highway 2. There is a need to plant and maintain the buffer zone. If a high bank erodes, plant on the resulting beach.

6 XS 27-21: Needs at least some rock groynes to extend to the inner line of buffer zone to protect buffer development. These would be big groynes – around 40 metres long. For reasons of practicality the chosen strategy is to harden the river edges with groynes but to maintain a trigger that if this ceases to be viable, then a new management strategy is needed.

7 XS21-19: At Fullers Bend maintain the 100-metre active channel. Fuller's Bend true right bank (Greytown side) stopbank: Whilst ongoing scouring out of the toe of stopbank is a problem, it does not require a true left bank (Carterton side) stopbank retreat. Repairs in this area to work towards a consistent design with ability to draw on Capex if agreed with the community, or flood reserves under the Living Plan process. Focus on improving standard of protection in stages, in response to erosion. Preference is for a programme of rock groynes on the outside of Fullers Bend (true right bank) upstream of new rock lining as this potentially offers the most cost-effective solution – to be undertaken as maintenance funds permit.

8 XS 21-17 Options for the long-term vision for the stretch of the true left bank (Carterton side) River Road and SH2 bridge could follow this decision hierarchy:

   a Harden the edge with groynes,

   b Push stopbank back from the river,

   c Surrender land on the true right bank (Greytown side) to create more room.

   For reasons of practicality the chosen strategy is to harden the river edges with groynes but to maintain a trigger that if this ceases to be viable, then a new management strategy is needed.

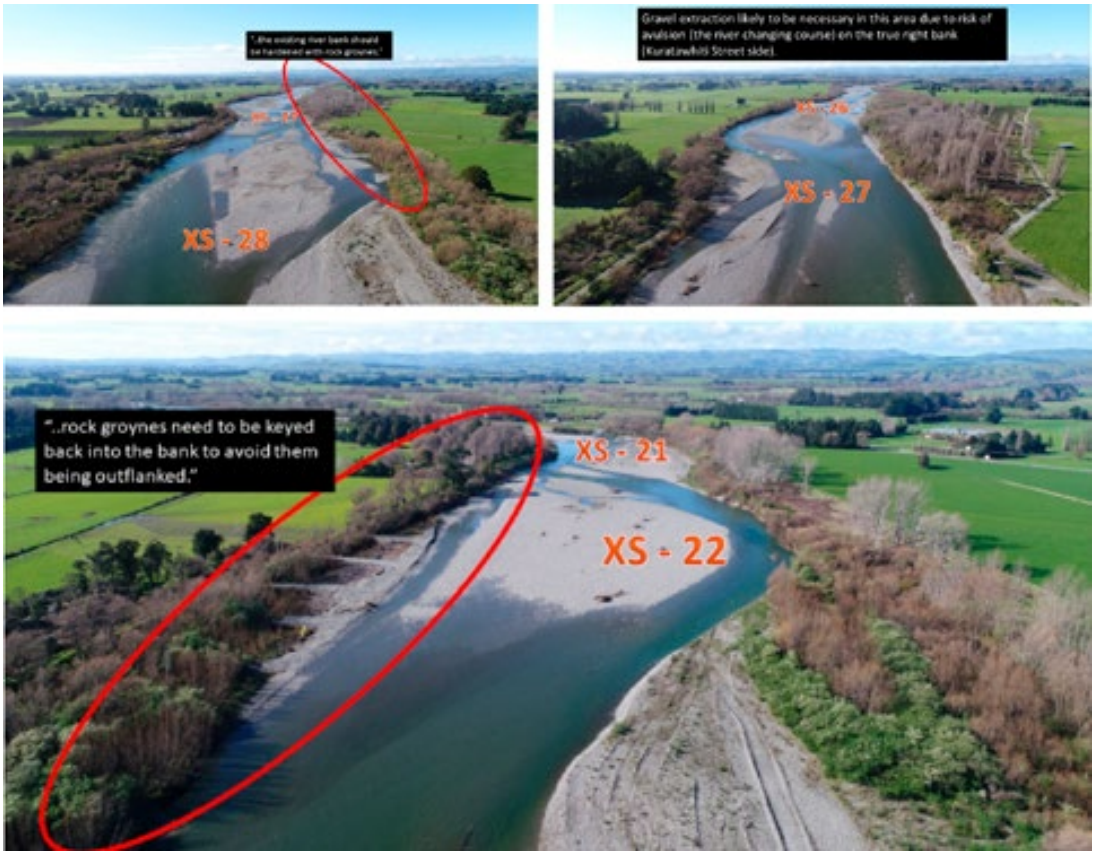


Figure 96: River management needs vary by stretch of river – photos – GWRC.

Figure 97: River management needs vary by stretch of river – photos – GWRC.

12.12.4 Reach D: Below State Highway 2 Bridge

All banks below the State Highway 2 Bridge are training banks, rather than stopbanks (they do the job of helping the river stay within design lines in normal situations but will not prevent major flooding). They will be managed based on the principle of maintenance and replacement, if the need arises.

Shingle aggrades on this reach and by its nature, can be less attractive to contractors to quarry. So, extraction may not be able to keep pace with aggradation in the long term and there is an acceptance that flood risk may gradually increase here.

1 XS 14: True right bank (Greytown side). Maintain a rock line at the property known as "Wong's".

2 XS 5-6: Design Line to follow line of groynes.

3 XS 17-1: Maintain channel width and channel by periodic vegetation removal.

4 XS 4-2: Bicknell Lower Gravel Bank. We confirm the need for the Bicknell lower gravel bank to protect SWDC wastewater.

5 XS 2: True left bank.

We recommend the retirement of the damaged Herrick bank and the need for a new training bank to deal with regular flooding at that location. Important note, this is a site of cultural significance – several Maori burials are located here.

12.12.5 Gravel extraction and management fees

The steep nature of the river and its catchment mean that large amounts of gravel have been washed down onto the floodplain historically. The amounts of gravel have been significant after large earthquakes (e.g. 1855 and 1942) and major floods in the area (which coincide with the Interdecadal Pacific Oscillation). Experience has shown that during these times gravel extraction was crucial in controlling flood and erosion risk. Since then gravel extraction has been found to also be essential during the quiet times in the river. In particular when used to manage bed levels and the related flood risk.

We understand that there are a great number of constraints on gravel extraction, but we consider it important and recommend that it continue into the future. The main reason for this is to constrain and limit flood risk. There are management fees collected for gravel extraction from the Waiōhine River. **It is recommended** that the monies obtained as management fees for gravel extraction in the Waiōhine River and all the other rivers in the Wairarapa continue to remain set aside for the Wairarapa catchment.

13

Water quality management and other Whaitua programme obligations

We recognize that GWRC has not yet conceived or implemented an overall solution to the urgent and important need for water testing and quality improvement yet.

In support of GWRC, the community see a shared opportunity to proactively engage in being part of the solution, until and unless something better comes along:

1 We will seek help from subject matter experts within GWRC, such as Amanda Death, and experts within the community, such as mana whenua, or other independent experts.

2 We will develop a community led, collaborative solution, under the Living Plan process.

3 We will incorporate whatever exists that is useful.

4 We want access to any test results, materials and methods etc. that exist in the public or GWRC domain.

5 We need to know on an ongoing basis what, if any, resources exist to help.

A trigger exists in the Living Plan to adapt and adjust the process and model as new knowledge and resources come to light.

The Whaitua Implementation Plan document concerns itself with the long-term improvement of the natural character of rivers and lakes. This includes water quality, in-stream ecosystems, riverbank ecosystems of flora and fauna and the attendant control of pests and weeds. Although not yet a regulatory document, it must form an integral part of any river plan and set some specific targets and target dates for things like water quality improvement. The community and GWRC should work in our own way, within the general direction set by Whaitua, to meet or exceed water quality commitments.

The Waiōhine River provides town water supply and serves a water race (XS 42). Past flood management regimes and gravel extraction may have had a significant impact on macroinvertebrate health. The Waiōhine River has good water quality and ecological health in its forested headwaters, contrasting with macroinvertebrate (MCI) scores at the very bottom of the "fair" grade farther down in the catchment, where the river has been subject to ongoing mechanical disturbance but principally, the influx of polluted water from the Mangatārere and Beef Creek tributaries.

The Waiōhine River has very good water quality above the confluence with the Mangataarere. Whilst MCI outcomes are at the very bottom of the "fair" band according to the Whaitua research, this appears to be arrived at by interpolation – i.e. without the benefit of actual measurement. Advice from Doctor Russell Death of Massey University suggests this should be checked and based upon actual measurement.

To fulfil obligations under the Whaitua programme to improve the natural character of the river, water measurement and observation will need to be regularly conducted in three key locations:

1 The Gooseneck (access off Waiōhine Valley Road) (XS 43).

2 At the State Highway 2 Road overbridge.

3 At the end of Tilsons Road, upstream of the confluence of the Ruamahanga (identified in the Ruamahanga Whaitua document as "Bicknells" XS 1).

Water quality goals (at the end of Tilsons Road below the confluence of the Mangatārere) are as follows:

- Ammonia (toxicity) needs to remain as quality "A", with a median (average) concentration of no more than 0.05 milligrams per litre and no more than 0.015 milligrams per litre at the 95th percentile.
- Nitrate (toxicity) needs to remain as quality "A", with a median (average) concentration of no more than 0.34 milligrams per litre and no more than 0.85 milligrams per litre at the 95th percentile.

Periphyton and Macroinvertebrate Community Index (MCI) need to remain as quality "A", with a count of less than or equal to 50 per cubic metre. This holds a current rating of "Fair" and the goal should be to lift this to a rating of "Good" with a count of between 110 and 130 per cubic metre by 2040. It should be noted that this is largely dependent on water quality improvement in the Mangatārere.

13.1 Current state vs targets for water quality improvement

	E. coli		Periphyton		Ammonia toxicity		Nitrate toxicity		MCI		Achieve by
	Now	Target	Now	Target	Now	Target	Now	Target	Now	Target	
Waiōhine River	A	A	A	A	A	A	A	A	Fair	Good	2080

Figure 98: Targets for Water Quality Improvement – Whaitua/PNRP.

13.2 In-stream nutrient criteria for the management of periphyton

	Nutrient criteria (concentrations)			
	Dissolved inorganic nitrogen (DIN) (mg/L)		Dissolved reactive phosphorus (DRP) (mg/L)	
	Median	95th percentile	Median	95th percentile
Waiōhine River	0.35	0.87	0.006	0.023

Figure 99: In-stream nutrient criteria – Whaitua/PNRP.

13.3 Nutrient limits and targets for diffuse sources of nitrogen and phosphorus, to be achieved by 2040

NB. "Limit" = current load. Loads are un-attenuated. t/yr = tonnes per year

	Nitrate (NO3-N)			Total phosphorus (TP)		
	Limit load (t/yr)	Target load (t/yr)	% load reduction	Limit load (t/yr)	Target load (t/yr)	% load reduction
Waiōhine River	122	121	1	9.0	8.6	5

Figure 100: Nutrient limits and targets – Whaitua/PNRP.

13.4 Sediment load limits and targets to be achieved by 2050

Notes: 1. Current total FMU sediment load = current annual sediment load from all "non-native" and all "native" land. 2. Sediment limit = current annual sediment load from all "non-native" land. 3. Load reduction required by 2050 = reduction in sediment load from "non-native" land only, as annual load. 4. Sediment target = change in annual sediment load from all "non-native" land as % reduction from sediment limit. 5. Figures derived from modelling of sediment loss from net bank and hill-slope erosion processes for land uses in 2017.

Freshwater management unit	Current total FMU sediment load	Sediment limit	Load reduction required by 2050	Sediment target
	t/yr	t/yr	t/yr	% reduction from limit
Waiōhine River	137,200	22,200	6,400	26

Figure 101: Sediment load limits and targets – Whaitua/PNRP.

13.5 Water Quantity Management under the Whaitua Programme

The Waiōhine River supports large town supply and water race takes (XS 42). A proportion of these large takes continues below the minimum flows in order to provide water for domestic and stock drinking needs. Two minimum flow thresholds are prescribed in the Proposed Natural Resources Plan (PNRP) (3,040L/s and 2,300L/s) to ensure that takes for other purposes are progressively reduced as river flow drops.

Figure 102: Water Management Wheel – Whaitua/PNRP.

The Whaitua dictates the higher minimum flow of 3,040L/s (litres per second) and considers that this threshold represents an appropriate balance between giving effect to the habitat objective and largely maintaining existing reliability of supply for users. However, the lower PNRP minimum flow (2,300L/s) is to be removed. This minimum flow is well below that which would provide for the habitat objective (2,990L/s). The Committee considers that all reasonable efforts to reduce takes in the catchment should have been made before 2,300L/s is reached.

Currently the 2,300L/s threshold is used to manage the town supply and water race takes (XS 42), with some amount of reduction required at this flow. The town supply and water race will have to further reduce their takes from current levels at the 3,040L/s minimum flow to just those volumes necessary for the health needs of people and stock drinking needs.

Whaitua recommends: Greater Wellington includes in the PNRP the following water allocation limits for the Waiōhine River:

1 Remove the existing PNRP "lower" minimum flow of 2,300L/s.

2 Retain the "higher" minimum flow level of 3,040L/s.

3 Cap the amount of water available to be allocated through consents at the existing consented use. (Existing consented use at June 2018 is 950L/s).

The total existing allocation from the catchment (950L/s) is moderate but below the default allocation amount in the PNRP (1,590L/s).

The PNRP allocation amount is seen as too generous and **recommends** capping the allocation at the existing level of use.

The reasoning for this is similar to that for the other rivers in which there is potentially some allocation headroom on paper: further allocation would be incompatible with the Committee's view that more resilience needs to be built in to the river management regime to counteract the likely future impacts of climate change.

14

Planting for River Management, Biodiversity and Cultural Resource

We would like to acknowledge the great expertise brought to this aspect of the plan by tangata whenua.

We recommend that this rich vein of knowledge be sought out at every future stage of the restoration of the river corridor to a naturalistic state.

It is recommended that the cultural impact on the connected places and the indigenous flora in these places can be restored as a part of the river and floodplain management.

It is recommended that: Buffer zones in the floodplain area include managed planting of indigenous flora and the opportunity for larger scale wetlands be researched in line with the biodiversity regional strategy and the mana whenua and community vision for the river.

There is a question as to how to make best use of traditional river management planting tools, such as willow in combination with native varieties. This is complicated by possible reductions in willow condition through pests such as giant willow aphid and willow sawfly and natural stand aging could limit their effectiveness in maintaining design lines and reducing bank erosion.

It is recommended that existing plantings should be complemented with suitable indigenous species that will have a long-term benefit for managing river widths, maintaining bank stability if mass wasting occurs, and improving wet and dry habitats.

The Cultural Impact Assessment makes an excellent point that the original natural environment cannot be fully restored as a revolution, but the scope for establishing indigenous flora in buffer zones behind protective exotics as plants like kahikatea establish themselves, is part of the evolution. The Papawai Marae project for riparian planting of the Papawai stream is an example of planting that Wairarapa Maori expect in the Waiōhine River Living Plan.

The Living Plan Process should ensure that community driven projects and local government plans and budgets are coordinated and in agreement. We can learn together the best way to restore the river to a naturalistic state that will benefit the entire community.

Several approaches to slowing or preventing bank erosion, using a variety of vegetative tools, have been developed internationally, including vegetated groynes, linear willow plantings with indigenous plantings in between, or timber pile training fields with vegetated buffers. See Tonkin and Taylor.

Supporting existing features on the floodplain, with willow and indigenous plantings, would reduce maintenance costs in the long term, and potentially alleviate some of the concerns around flooding of neighbouring properties. An example of this would be the opportunity to plant additional trees to bolster existing trees in line with the end of Greytown Stopbank.

Another location of cultural significance is the junction or confluence of the Waiōhine and other rivers, the Mangatārere and Ruamahanga. The cultural impact of protecting the junctions of rivers in the flood protection work can ensure a place for sacred rituals to be repeated.

Finding:

It is recommended to highlight these river junctions and other significant areas through targeted planting with indigenous flora to fit the significance of the area.

14.1 Restoration and Conservation of the Riverside

Restoration and conservation of the riverside is a huge task, so to address this in a way which can be easily understood, thorough, and be able to be handed on to the next generation, the following method has been adopted –

Starting with the map having the cross sections of the river, (Appendix J in the plan), it is envisaged that we will make two passes of detailed planning of the area, review and improve these with stakeholders and refine:

14.1.1 First pass

1 Identify culturally sensitive areas,

2 Identify the 'no-go' areas for GWRC, TA's, landowners, etc.

3 Identify areas of riverbank requiring/not requiring restoration.

This leaves us with the extent of our potential work area.

From this we should be able to build a list of people to contact for permission to do restoration work

14.1.2 Second pass

1 Label the type of habitat at each cross section.

2 Identify what's currently there.

3 If restoration is required, agree suggested plantings at each, using Iwi knowledge, the GWRC Central Wairarapa Plains planting guide, and Akura's restoration planting guide, and all our local knowledge.

This should give us the skeleton of a plan which can be taken onwards by the next generation(s), and a fair indication of the sheer size of the task to be broken down into manageable chunks and approached one at a time, with its own appropriate strategy.

A complete pass down the river needs to be done at this stage to capture the wealth of local knowledge about the river we have available to us now, which can be added to this plan to help future generations.

Once this is done, **it is recommended** that this information can be included in an annotated map which can be distributed, added to, amended, zoomed in on, or expanded and printed for display purposes. This can then be submitted to the community and stakeholders for their input before becoming part of this Living Plan.

14.1.3 Detailed plans for individual stretches

Prioritise the work areas.

Break these areas down into doable chunks for a working bee,

Produce a timeline for the first few areas, to include –

Preparation work required –

1 Weed and pest control
2 Watering
3 Plant protection and support
4 Fencing and shelter if required
5 Access ways for volunteers
6 Design of paths through the plantings for public access, where appropriate.

Phases of planting -

1 Pioneers and nurse plants
2 maintenance
3 2nd phase
4 Heritage trees

We will then have -

1 A long term overall plan
2 A detailed plan for the next few years
3 A shopping list
4 A list of requirements for funding and GWRC assistance
5 Something specific to take to the community for volunteers
6 Bite size chunks to take to schools for their involvement.

There is a lot of expertise in this locality, and if done well, this plan could generate a lot of positive feedback from the submissions process at the start of this Living Plan journey.

It will also allow the forward ordering of plants a few years in advance, plant from seed, justify a nursery.

There are many other things to be taken into consideration – e.g.

1 Edible and medicinal native plants
2 Material for weavers
3 Integration with flood control plantings
4 Cooperation with other restoration bodies
5 Funding
6 Organisation of working days
7 Keeping a close working relationship with GWRC,
8 All the flora and fauna items already incorporated in this Living Plan.

At the time of writing this plan (2021) the first pass has been done, such as identifying owners of the riverside properties who should be approached for permission to embark upon restoration. In many cases this is GWRC, whose sites are the best-fit initial sites for work.

Local knowledge has also identified private sites where the owners have expressed interest in restoration/conservation, and these first two categories of site should account for many years of work.

It is hoped that landowners who may be less enthusiastic at the moment will see progress being made and be more open to joining in. There is ample time ahead for this.

A series of river "walks" have identified the current state of the riverbank vegetation in a number of target sites, requiring actions varying from heavy duty clearance of the land eg at Kuratawhiti Street, to areas further upstream where natives are coming up underneath tree lucernes, gorse and willows, and will require little attention.

This data has been collated onto a spreadsheet, then overlaid on aerial photographs of the riverside.

This annotated map currently shows ownership, habitat, culturally sensitive areas, current and proposed vegetation and other features of interest. It can also now be used to record proposed work areas and schedule, progress, problems etc. and is scalable down to 'working bee area' size.

See maps at Appendix M Maps of Restoration Strategy

14.1.4 How to proceed

1 Local volunteers prepare and plant easily accessible areas with a variety of natives suited to each microhabitat, and locally sourced, to give the young plants the best chance of success. These areas are likely to include amenity areas like parkland, pathways, walking and cycling tracks etc.

2 As budget permits, GWRC planting teams to include natives e.g. flaxes and cabbage trees interspersed with their annual willow pole planting programs. These are typically on less accessible parts of the riverbank and planted in bulk.

With the volume of young plants required and the expected shortages due to so many current planting schemes, it is proposed to eco-source some seedlings from unwanted natives self-seeded in local people's gardens. This ensures that local varieties are used. A careful process for this will be developed. As the project progresses there may be a need for nurseries at various places along the river.

Help and ideas from the GWRC local operations team have been offered, including the idea of engaging a GWRC landscape designer in mapping out the block at Kuratawhiti Street.

GWRC Land Management have been very helpful in offering planning for plant sourcing and wetland restoration / enhancement, and info on eco sourcing.

As well as trees, native plantings should include as many varieties of flaxes as possible, advised by the local weavers group. Maori knowledge and expertise will guide the planting plans as we seek to include heritage trees, edible plants and medicinal plants over time.

Plantings should be planned to enhance the existing bird corridor along the river with food source plants for birds, for instance, harakeke and kowhai for Tuis, and berry producing trees and shrubs, which will self propagate with the help of the birds over time.

Some sites may have to be "no-go" areas for the public, for instance to establish nesting sites for birds along the tree corridor. Other areas may require long term exclusion to improve the chances for trees in their junior forms. Pest control will have to be rigorous here.

The creation and conservation of wetlands will be beneficial to the river in terms of water quality and biodiversity. A number of places along the river, especially on the true left bank, look to be ideal for this. We look forward to working with GWRC Land Management on this. In addition to habitat, wetlands offer a number of benefits in terms of water quality, flood management and natural water storage that helps river levels be maintained.

14.1.5 Habitat – a matrix of the right plant in the right place

Habitats		
Terrain	Nurse/pioneer	2nd Phase
Very Stony	Tree Lucerne	Mahoe
	Chatham Is. Akeake	
Soil/stones	Tree Lucerne	Beeches
	Manuka	Matai
	Kanuka	Black Maire
	Totara	Broadleaf
		Lancewood
Deep Soil	Cabbage Tree	Black Maire
	Manuka	Lemonwood
	Kanuka	Rewarewa
		Makomako
Boggy/wetland	Cabbage Tree	Kahikatea
	Flaxes	Totara
	Swamp Manuka	Miro
	Raupo	Fivefinger
	Akeake	Mahoe
	Swamp flax	

Figure 103: Habitat Matrix Table – Project Team

14.1.6 Matching plants to phase of planting: Establishment

Pioneer/Nurse Plants

Ti Kouka or Cabbage Tree: Favours open places in or near swamps or hill slopes near seepages. Up to 12m in height with a trunk of up to 2m. Pollinated by moths, bees and other insects. Abundant flowers in spring, fruiting from mid-summer to autumn. Leaves are used in weaving and plaiting.

Kanuka: First colonisers of cleared land and will occupy landslips. Prefers well drained soils. Up to 20m high and with a trunk up to 600mm. Densely covered with flowers. Flowers spring to summer, fruiting through late spring to autumn. Will not regenerate in its own shade, so will slowly be replaced by more shade tolerant species.

Flax. Whararikí: Grows in wetland and stream sides up to 1.5m high. Produces large yellow flowers. A source of nectar for Tuis and bellbirds. The leaves are a source of material for weavers.

Flax. Harakeke: Larger than the Whararikí. Many different varieties. Used for many different purposes by weavers from cordage, fishing nets to rain capes. A source of nectar for Tuis bellbirds and other nectar feeding birds. Note – main and local varieties need to be listed individually.

Manuka: Tolerant of low fertility soils. Likes open ground, not good in shade. Grows up to 10m high, trunk up to 150mm. Pioneer in forest regeneration or cleared ground. Flowering from spring to autumn

Toetoe: Native Grass growing to 2m tall forming large tussocks or clumps The flowering stems rise to 4m high with showy flower plumes. Will grow in swamps, stream banks, bush clearings etc Already found growing along the river bank above the rail bridge Has medicinal properties.

14.1.7 Aids to identifying trees

14.1.7.1 Resources

1 DOC

2 www.doc.govt.nz/get-involved/conservation-activities/let-nature-in/

14.1.7.2 Eco sourcing info

1 New Zealand Plant Conservation Network – nzpcn.org.nz

2 "How to identify native seedlings" – nzpcn.org.nz/flora/plant-identification/

3 Select "Written Descriptions", hit the hyperlink "flora search engine", use the "Search Flora" box to search on scientific name or common name

4 Bushmansfriend – leaves and foliage. Great pictures but mainly scientific names

5 NZtree. Free app. Put together by Len Gillman of AUT, can be accessed via rnz. Takes you through a series of pictures relating to the foliage you're looking at. Then gives you a list of trees with that type of foliage, and several pictures of the one you select. Unfortunately only 98 species are listed so far.

6 Wellington regional native plant guide. GWRC "What to plant at your place"

14.1.7.3 Waohine – Proposed Plantings

True Right Bank

Bore Field. Cross section 40

1 Toetoe

2 Karamu

3 Koromiko

4 Ponga (fern)

Rail Bridge. (above and below). Cross sections 39 – 35

1 Flaxes

2 Cabbage Trees

3 Kanuka

4 Some natives already established,

5 Spot planting heritage trees:

6 Kahikatea

7 Totara

8 Tawa

Cross sections 31 – 28

1 Flaxes
2 Cabbage Trees
3 Kanuka
4 Ferns

Kuratawhiti Street. Cross sections 27-25

1 Extend existing planting of
2 Manuka
3 Kanuka
4 Cabbage Trees
5 Totara
6 Kowhai
7 Flaxes

Notes:

1 Plan mixed use of the cleared area with grassed areas, native trees, amenity areas, pathways, signage.
2 Spot plant bigger tree seedlings amongst the established vegetation e.g. Totara, Matai, Black Beech, Broadleaf, Lemonwood, Tawa, Black Maire, etc.
3 Pest control for rabbits, possums etc.

True Left Bank

Rail Bridge. (above and below) cross sections 39 – 31

1 Planting opportunities with Hank Van Den Bosch possibly including wetlands

Bassets. Cross sections 24 – 22

1 Kanuka
2 Flaxes
3 Cabbage Trees
4 Kowhai

Fullers Bend. (GWRC) cross section 21

1 Kanuka
2 Cabbage Trees
3 Flaxes

Note: clear blackberry and convolvulus

Cross sections 20 – 18

1 Options for planting between the willows
2 Flaxes,
3 Cabbage Trees to help stabilize the bank.
4 Larger trees where there is already established cover which is not under threat from the river.

15

Conceptual stopbank design

15.1 Introduction

This section provides more detailed information on the work done by the Project Team and Cameron Fauvel Projects Limited in developing a greater understanding for the path, location, shape, length and costs for the proposed two new inland stopbanks required for the recommended (Option 2) solution.

Costs for these can be found here.

The Cameron Fauvel Projects Design documentation can be found here. This includes a series of detailed annotated aerial maps, showing the possible path of the stopbanks in large scale, as well as detailed profile diagrams illustrating the height and profile of the proposed stopbanks.

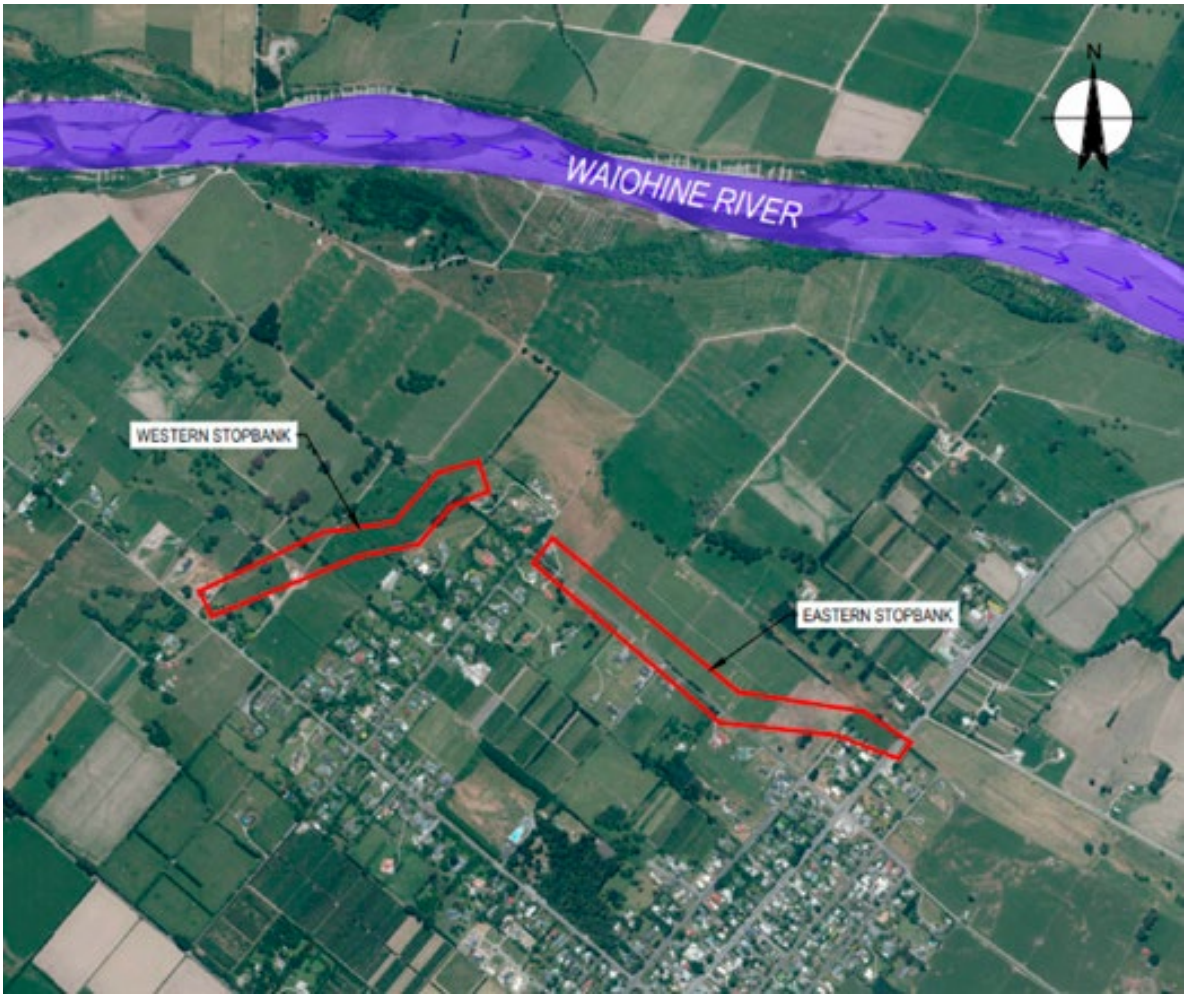


Figure 104: Conceptual Stopbank Design – CF Projects Limited.

It is important to note that these form a preliminary conceptual design. This is further into the design process than traditional river plans have gone, however, there is a wish to provide the community, stakeholders and landowners, with as full a set of information as practical, prior to the detailed design and associated discussions and procedures.

Ideally material resulting from the removal of unnecessary banks near the State Highway 2 Bridges over the Mangatārere and Beef Creek could become available to assist in the construction of the inland stopbanks. This may be complicated by discussions between GWRC and the Urupa Trust, so it may become necessary to source material from elsewhere. The size of the inland stopbanks also suggests that that material alone may not be enough for the whole construction.

Figure 105: Example of Mapped Path of Stopbank – CF Projects Limited.

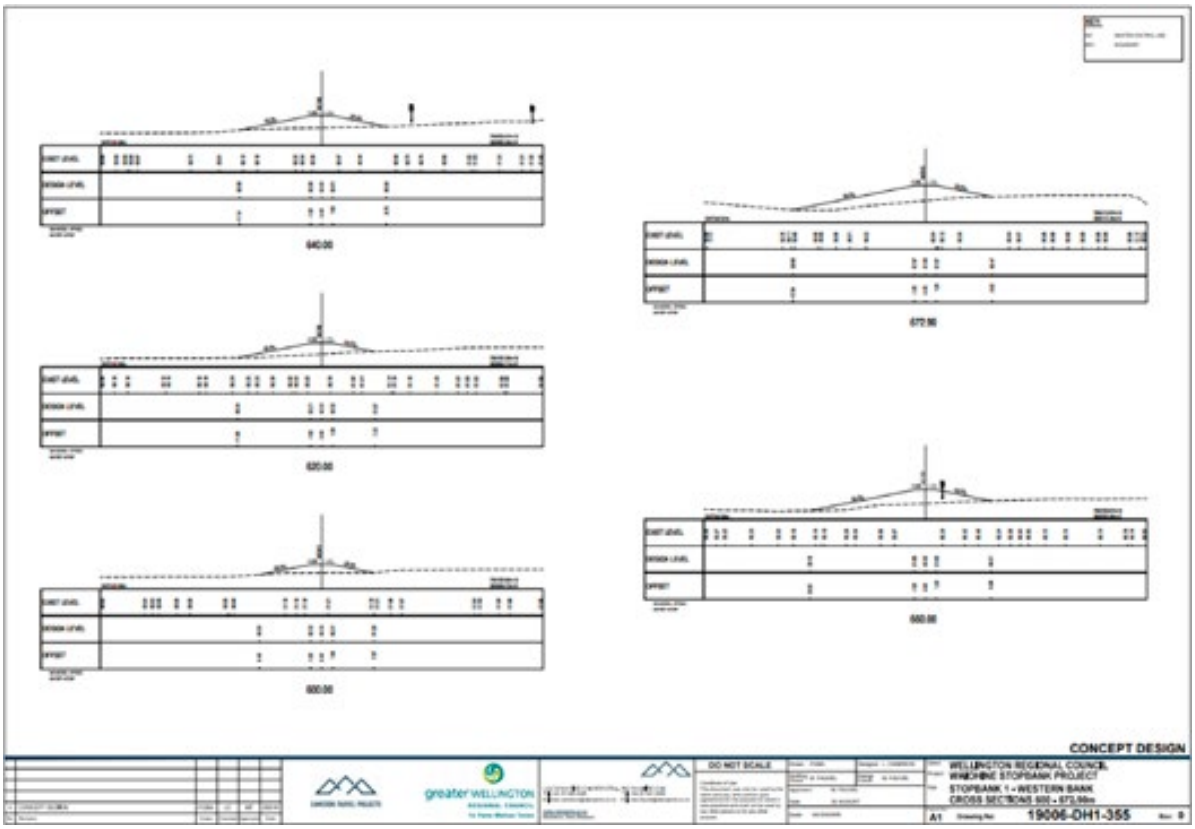


Figure 106: Example of Profiles of Stopbanks – CF Projects Limited.

15.2 Investigation of alternative western (Kuratawhiti Street) stopbank alignment

In response to a suggestion of a possible alternative stopbank alignment for the upstream Western (Kuratawhiti Street) stopbank, a first level investigation was carried out to assess the viability of this by comparison to the proposed path and design. It revealed the following information illustrated in the following diagrams:

Yellow line, the proposed stopbank alignment chosen by the community, approximately 650m in length and 3000m3 in volume, this bank effectively blocks all the flood waters coming across the floodplain towards Udy street;

Red line, the possible alternative stopbank alignment suggested by landowner, approximately 1400m in length and 14,000m3 in volume. Unfortunately, this bank does not effectively block all the flood water coming across the floodplain towards Udy Street so additional works, cost and impact on farm operations would be implied, in addition to the figures in section 8.

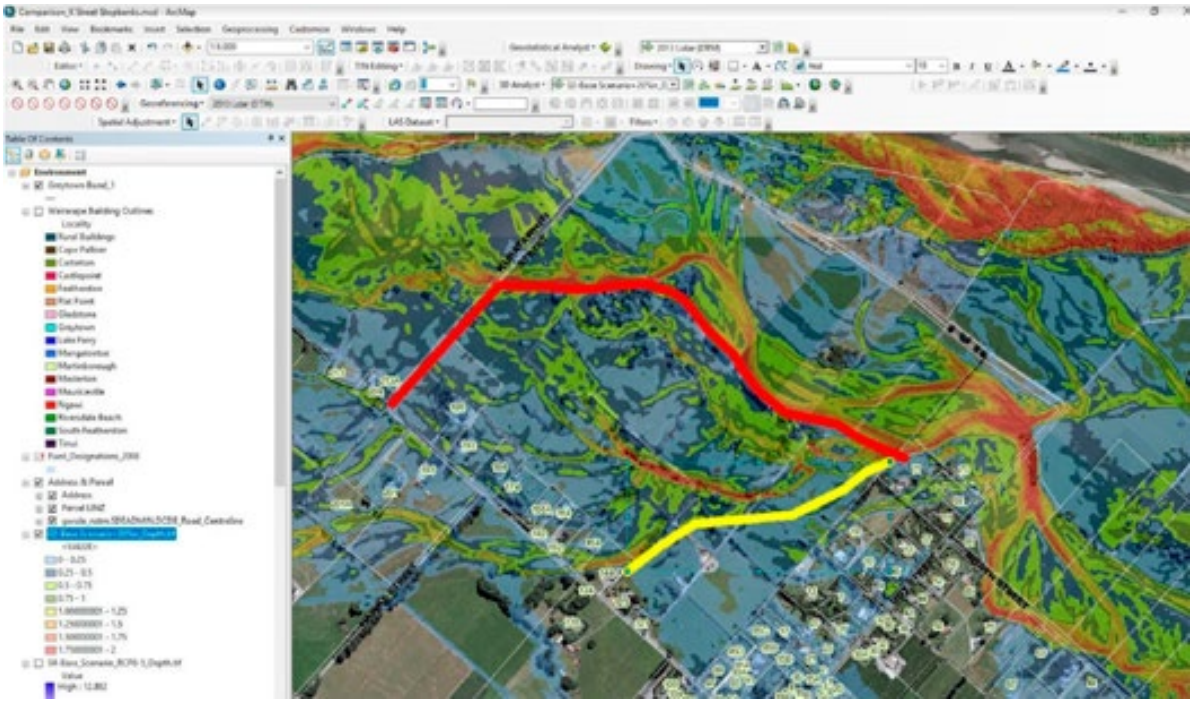


Figure 107: Investigation of Alternative Western Suburbs Stopbank Alignment – GWRC.

It is recommended not to proceed with further investigation of this possible stopbank alignment as there would be a very substantial additional cost (at least 4 times higher). Based on the design guidelines set out at the start of the project no discernible benefit can be identified against the design goals.

16 Appendices

Appendix A

Waiōhine floodplain management plan initiation

A record of the slides from the public meeting forming the WAG Project Team

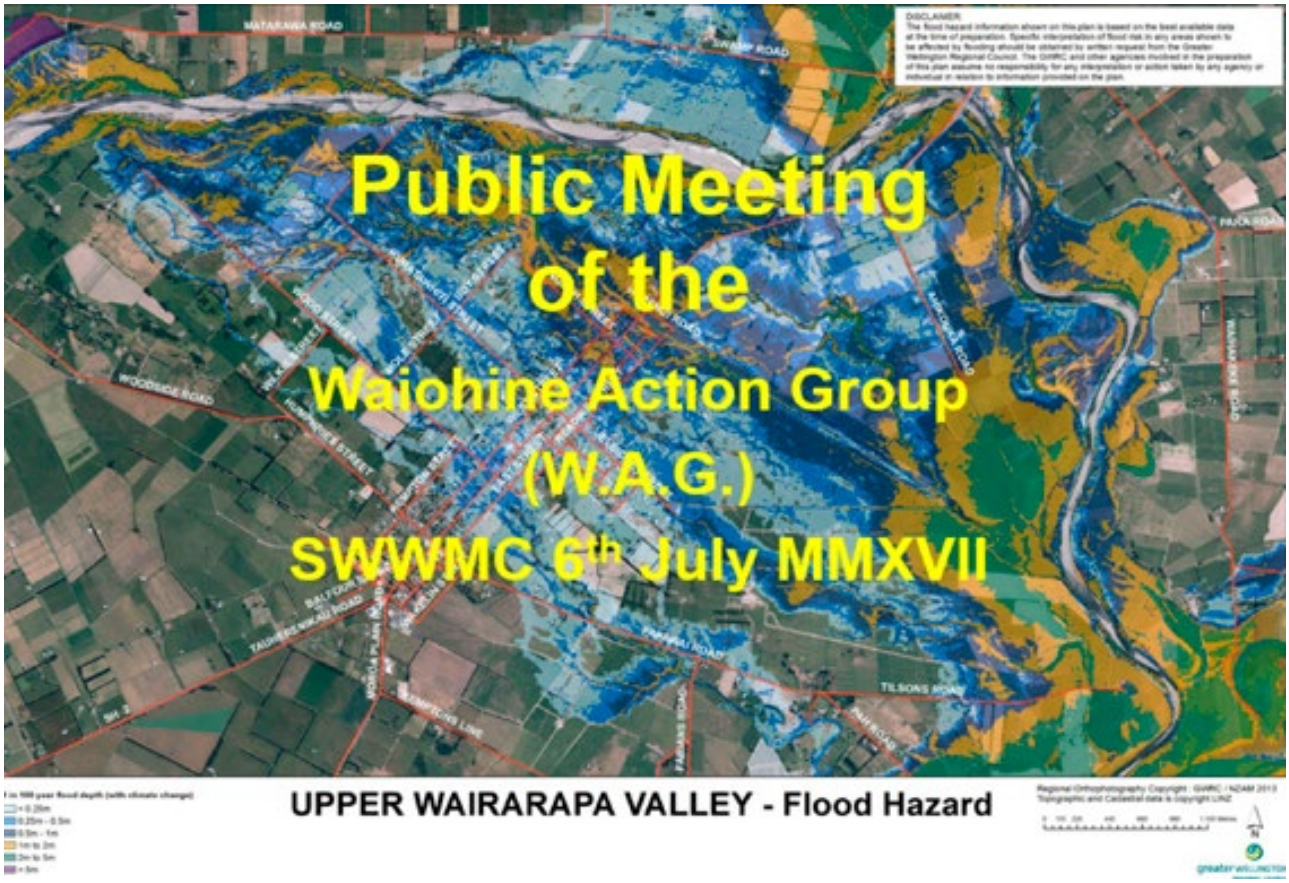


Figure 108: Public Meeting – 6th July 2017.

Welcome – Colin Wright

- Recap on last year's public meeting
- The Public Submissions "process"
- Fire Station Group = Waiōhine Action Group
  - What we've been doing

The Waiōhine – Bruce Slater

- The River and its Flood History:
  - Impact of past Waiōhine floods
  - Why nothing for over 60 years?
  - Why the river has more capacity now

The GWRC FMP – Mike Hewison

- The BECA report, survey and flood map
  - What was excluded
  - What was included
  - What was the real message
  - Why the flood map is no use

GWRC and Local Government Involvement – Colin Wright and Mike Ashby

- SWDC (South Wairarapa Council)
- CDC (Carterton Council)
- GWRC (Greater Wellington Regional Council)
- Impact on property owners
- The latest approach to our community & WAG

What we know – John Boon

- GWRC ads: after 9 years GWRC FMP process has not worked
- GWRC Flood Management Plan has multiple flaws
- GWRC FMP GWRC FMP is overkill
- GWRC FMP is insanely expensive for a rural community
- GWRC has conceded they will not proceed until community supports an FMP
- GWRC councillors and our councils have come to WAG
- They suggested a new, project team approach working to steering group of Wairarapa Committee to GWRC

A way forwards – John Boon

- WAG Picking up the ball from GWRC
- Taking the initiative on the Project Team strategy
- A core Project Team of local experts
- Affordable, practical, adequate flood protection
- Continuous consultation with community
- Invitation to GWRC to participate in community driven project team
- Questions
- Consider draft resolution

The community of Greytown and of the Carterton side of the Waiōhine resolve to:

Approve the establishment of a project team and facilitators drawn from the WAG speakers and such other expertise as may from time to time be required. The Project Group will, as far as is practicable, engage constructively and collaboratively with the GWRC and its staff to determine the parameters of sensible flood protection for the Waiōhine River, establish an accurate cost; keeping the WAG and Waiōhine Ratepayers continuously informed of progress.

Passed unanimously by circa 200 present.

Wrap up and questions – Colin Wright

- Spot WAGers you know
- Where you can get more information and stay informed – website or Facebook coming
- Trust fund at WCM Legal
- How to get involved and keep having your say
- Invite to cup of tea
- Thanks to everyone and close

Figure 109: Public Meeting – 6th July 2017.

Appendix B

Terms of Reference (TORs) for the Project Team

Origins – A Community Led Process in Partnership with GWRC and Stakeholders – Establishment by the Waiōhine community in July 2017 following two years of community discussion and opposition to the preceding draft floodplain management plan which had taken ten years to develop.

Terms of Reference – WFMP Project Team

Version: 1.0
Authors Boon, Wright, Ashby, Hayes, Hewison, Slater et al
Date: 4th May 2017

Purpose and introduction: What does success look like?

GWRC wish to complete a new FMP for the Waiōhine River. The background and history of this project is well documented elsewhere.

It is recognised by all parties that the process to date, whilst accumulating much valuable data, -has failed to bring about a plan that is credible and meets the needs of all stakeholders – GWRC, SWDC, CDC and importantly, the community to be served by and pay for, a flood management plan.

There is an opportunity to put aside unsuccessful practices and start afresh, using a facilitation process and team trusted by the community to review and pull together a trusted, acceptable to all, plan under the aegis of a WFMP Steering Group (Steering Group) appointed by the new Waiōhine Committee.

Once lost for whatever reason, rebuilding trust is hard. So to succeed in this and deliver to the Greater Wellington Regional Councillors and District Councillors a completed outcome that is technically viable, low risk and trusted: a WFMP Project Team (Project Team) must be facilitated by and made up of individuals who possess appropriate skills and the confidence of the community. It requires a departure from the past, according to Einstein: "The definition of insanity is doing the same thing over and over again but expecting different results".

The process, method and techniques employed will review existing data and wherever it is trustworthy, validate this consensually. It will identify what can be readily done to as many remaining issues as practical in the time available to come to a consensus on these and through analysis make recommendations on the remainder based upon pre-defined guides from the Steering Group. In this way the process will build upon consensus and positive step by step outcomes.

This approach therefore proposes a low-risk, win-win path to delivering a successful FMP. It also serves as a Terms Of Reference (TOR) for the formation of a facilitated project team charged with delivering on this, quickly and inexpensively. Obviously, it assumes easy, timely access to GWRC WFMP information and a positively oriented participation by willing officers, who can work in a new paradigm to share in a successful outcome. It also relies upon modern facilitation techniques, together with simple, immediate sharing of the workings of the team, to grow and demonstrate transparency and trust by all stakeholders. It must therefore be immediate, open and transparent for all. It is specifically designed to build trust and support whilst meeting the tenets of government and regulatory frameworks.

Time matters. This approach will speed up outcomes. Until the FMP is resolved, council planning and consenting and community subdivision and building work, amongst other things, are trapped in a nightmare of wasted time and money.

This is the approach that will be acceptable to the community and local councils. It represents the lowest risk in the circumstances. By following this course GWRC at the highest levels, can once again plan for a successful outcome to the WFMP and focus it's time and energy on other, pressing issues.

How will we know when we are there?

Three tests are to be pre-ordained by the Steering Group that can be used to guide investigation and decision making by the project team on a day to day basis and used by the Steering Group when reviewing whether the practice and recommendations of the Project Team are fit for purpose. In this way everyone can be guided to build consensus and be confident of when issues are resolved.

For the purposes of preparing the Terms of Reference we have proposed three "straw man" examples of such tests:

e.g. Does this meet the minimum requirements of the law?

e.g. Does this provide adequate protection in the eyes of the community in a way that is affordable and pragmatic (risk vs. cost)?

e.g. Has there been transparency of communication and information with all stakeholders so that they can understand, comment if needed and agree?

Chosen by the Steering Group

1 That the draft FMP be implementable

2 That it provides adequate protection in the eyes of the community and other affected parties that is affordable, pragmatic and sustainable.

3 That there has been transparency of communication and information with all affected parties so that they could understand and comment if needed

The Three Tests must come under the aegis of the Steering Group, handed down and regarded as mandated to the Project Team (past experience of this technique shows that more than three will become cumbersome, hard to remember in context and reference without unduly complicating process and delaying outcomes: less than three tends not to provide a firm enough framework).

Once every issue is resolved through consensus or acceptance of recommendation by the Steering Group, the project should be ready to be represented as-a-whole to the community (see below). After that, the work of the project Team is done.

Terms of Reference Outputs

What is to be delivered by the end of the project?

1 **FIRST DELIVERABLE:** engagement of the community to build trust
2 Convene project team
3 Familiarisation with TORs, inputs, methods, housekeeping
4 Settle in – forming/storming/norming/performing curve starts
5 Meet GWRC Steering Group
6 Receive Three Tests and other guidance
7 Set up community communication channels, inform and engage public

SECOND DELIVERABLE: common basis for understanding

All existing assumptions, data, inputs and outputs are to be shared and common understanding reached on their virtue.

Target subjects should cover

1 Assumptions and inputs
2 Survey efficacy
3 Engineering design
4 Contingencies
5 Funding/staging/timing
6 Costs vs Risks
7 Options
8 Mitigations
9 Other subjects as needed by Steering Group to meet deliverables

Terms of Reference Approach

How will subjects be evaluated, consensus reached, or recommendations made?

THIRD DELIVERABLE: It is anticipated that in the first workshop priorities, dependencies and completeness of this list will be addressed and passed to Steering Group for ratification.

All deliverables should be shared with the community as delivered and community feedback, questions and comments should be responded to by the project team via facilitator. An immediate and simple mechanism is required for this. All findings and notes of the workshops will be initially written onto flip charts during the workshops. At the close of each workshop these will be digitally photographed and posted up online, where all stakeholders can see, question and comment on them. This meets the need for immediacy, transparency and full communication with everybody – instilling confidence, sharing findings and showing progress. This offers a degree of probity that engenders trust and encourages progress.

FOURTH DELIVERABLE: Recommendations to Steering Group on each target subject and how to modify draft FMP to pass each test. It is expected that in some instances later findings will result in review of earlier recommendations where previously unknown material exists. If significant, these will be re-presented to the Steering Group, otherwise presented to them when the project ends, and the completed solution is presented for final review and approval.

To deliver these regular workshops will be conducted by a project team comprising:

Facilitator

1 Convenes and runs workshops

2 Drive for consensus wherever possible, or an agreed process to resolve differences, or failing that note positions and arguments and make recommendation that is best known fit to Three Tests

3 Deliver recommendations that pass the Three Tests

4 Lead a positive and constructive process, free of past politics and break down any entrenched positions using modern tools, processes and techniques fit for purpose

5 Captures outputs and posts online or delegates this

6 Drives timeline and delegates offline tasks

7 The Facilitator reports to Steering Group on:

8 Consensuses, recommendations (and rationale) on non-consensual issues,

9 Recommendations relating to opportunities and roadblocks

10 Progress and forecasts for completion including dependencies

11 Manages process, drives outcomes, facilitates understanding and consensus, resolves conflict, keeps things moving

12 Ensures transparency of process, information, recommendations and outcomes to all interested parties

Members

1 At least 5 Core Members: Greytown and Carterton community representatives with essential knowledge of the river and it's maintenance, floodplain management, surveying and engineering, economics and local government,

2 Additionally at least 2 further Core Members: GWRC staff able to share FMP information and advice, liaison and continuity as determined appropriate by Steering Group,

3 As needed representative landowners from both sides of the river,

4 Others as needed, invited by the Facilitator such as GWRC specialists and civil works experts based upon subjects under consideration.

The task of core members is to share assumptions, inputs and data, identify all items that are consensual, isolate the delta of non-consensual items and under the guidance of the facilitator find the best solution that passes the three tests and delivers outcomes.

Sending alternates is subject to Facilitator's agreement and requires full delegated authority of alternate

It is anticipated that more than one member of the Project Team may also be present in the Steering Group, ensuring good governance, communication and liaison with local councils.

FIFTH DELIVERABLE: Completed WFMP acceptable to Steering Group and community, final presentation and dissemination to community, followed by final review and sign-off by Steering Group as being complete, accepted by the community and passing the Three Tests.

Time Constraints: By when should it start and finish?

The project team could convene and hold it's first workshop within three weeks of being agreed by the Steering Group. It is envisaged that workshops will be weekly for a minimum of half a day each, with background work being carried out between. This is fairly intense by the standards of past approaches but it is believed that it is in the interest of all stakeholders to work expeditiously to minimise the impact of current issues on planning and consent within the community.

The first task is to inform the wider community of the process, how they can come up to speed (if not already involved) and how they can stay informed and have input if desired. This will be done via public meeting, flyers, news media and a Facebook site (or equivalent). By involving the wider community from day 1 we work in a way that will serve to restore confidence in the process and therefore outcomes. The importance of this cannot be overstated.

The first Project Team workshop will establish the team, it's culture and collective way of doing things (form/storm/norm), deal with housekeeping, digest TORs and absorb direction from the Steering Group, such as Three Tests.

Then no more than three months to complete tasks and deliver outputs ready for final presentation to the community and sign-off. Beyond three months if the project is not completed, the Facilitator must recommend changes to rapidly complete the project and seek Steering Group approval for these.

Assumptions

1 Prioritisation of time by participants.

2 All information is made available and ready when needed.

3 Team members available to complete "homework" off-line.

4 No interference. No redirection. No change. No information from the draft FMP and contributory processes withheld, incomplete, incomprehensible or redacted – but fittest for use.

5 Facilitator can replace unavailable or non-contributing members if necessary (with Steering Group agreement) .

Method: What is to be determined?

1 Ratify and extend if necessary, the Target Facts list,

2 Dig down to find the facts,

3 Analyse and understand these, where they have not been previously shared

4 Share assumptions and model inputs,

5 Share all background documents and data,

6 Identify items that have consensus (Consensus),

7 Categorise remainder as either able to be resolved (Resolve) and how to reach consensus or needing recommendation (Recommend),

Recommend items should be explored (with other subject matter experts and contributors as necessary), positions noted and a recommendation developed by the chair that must pass the three tests, then that recommendation presented to the Steering Group for them to cross examine and ratify as resolved, or push back for further work.

When all subjects are resolved the project team will prepare an easy to understand summary and information for all stakeholders that can be presented by well publicised website, mail shot, media and public meeting, ensuring the community and all other stakeholders are fully informed and supportive. Project Team to propose coms. pack to Steering Group.

Once all these tasks are completed the Project Team should be dissolved by the WFMP Steering Group, but all the documents produced should remain in the public domain to assure probity during the implementation and operation of the WFMP.

Added by the Steering Group

The Steering Group also wished to stress that a Flood Management Plan encompasses a much broader range of options than just stopbanks and that the Project Group must be able to demonstrate that all these options have been considered in the course of its work. This would include but is not limited to:

1 Values of the river environment
2 Iwi values
3 Flood mapping
4 Climate Change
5 River management
6 Emergency management
7 Structural river control
8 Non-structural river control

Paper to the Environmental Committee of GWRC to Establish the Project Team Waiōhine Floodplain Management Plan governance and project delivery structure

1 Purpose

To propose a governance and project delivery structure for completing the development of the Waiōhine Floodplain Management Plan (Waiōhine FMP).

2 Background

Draft Waiōhine FMP – development

1 The intended purpose of the Waiōhine FMP is to manage the risk of flooding and erosion from the Waiōhine River.
2 In 2016 a draft Waiōhine FMP (Draft FMP) was developed by the Waiōhine Floodplain Management Plan Advisory Committee (Advisory Committee).
3 On 10 May 2016 the Environment Committee approved the Draft FMP for public consultation.

Draft Waiōhine FMP – consultation

1 On 21 June 2016, the Environment Committee (on recommendation of the Advisory Committee) established the Waiōhine River Draft FMP Hearing Subcommittee (Hearing Subcommittee) to hear and consider submissions on the Draft FMP.
2 The hearing that was to have been held on the Draft Waiōhine FMP never took place due to the unavailability of Hearing Subcommittee members.
3 The Draft FMP did not achieve community support.
4 Submitters on the Draft FMP have not been heard.

Waiōhine Action Group

The Waiōhine Action Group is a large, diverse and growing number of ratepayers, including three serving Councillors. It works for the ratepayers and communities of Greytown and those who live near the Waiōhine river on its Carterton side. Amongst the members are deep skills including expertise and experience in managing the Waiōhine River issues, relevant engineering and surveying Greytown and the area, actually maintaining the riverbanks and bed, running local District Council and so on. Some members have a heritage of three or more generations of knowledge of the community and river. The group have completed many thousands of hours of reading, research and contribution of findings relating to the draft FMP project and the draft plan. Through consensus and genuine consultation, the group fosters openness and transparency to help the community investigate the good, bad and other work done on the draft FMP by GWRC, understand the costs and implications and participate in a better outcome than the failed approaches of the last nine years.

3 Review of the Draft FMP

Due to feedback on the 2016 Draft FMP, officers consider that Draft FMP should be set aside and reconsidered.

3.1 Proposed approach to review the draft FMP

Following discussions with Carterton District Council (CDC) and South Wairarapa District Council (SWDC), and in response to their approach, a proposed TORs and Project Team from WAG have been elected by a public meeting attended by over 180 ratepayers for a community led, open, consultative and consensus driven model, using a range of local experts to carry out due diligence throughout the draft FMP and make recommendations for a pragmatic, affordable solution that fits within the law and re-established trust between the community and GWRC.

This proposed delivery model will be subject to a steering group to oversee the completion of a Waiōhine FMP.

3.2 Proposed Waiōhine FMP steering group

Officers recommend the establishment of a Waiōhine FMP Steering Group (Steering Group).

A copy of proposed terms of reference for the Steering Group is attached as Attachment 1 to this report.

A summary of the Steering Group's proposed membership, roles and Responsibilities is set out below.

3.2.1 Steering group – purpose

The purpose of the Steering Group is to make recommendations to the Wairarapa Committee on areas of practical improvement identified and recommended by the Project Team of the Draft FMP that are preferred by the community, including local IWI and council representatives.

The management of the existing river scheme and the implementation will sit outside the remit of this Steering Group unless directed by the Waiōhine Committee to review areas of overlap with implications for the draft FMP. An example would be the ongoing maintenance implications and costs of FMP design options.

The draft terms of reference (see Attachment 1 to this report) propose that the recommendations of the Steering Group, if endorsed by the Wairarapa Committee, would be submitted directly to Council for approval without the need for consideration by the Environment Committee.

3.2.2 Steering group – membership

The following membership is proposed:

- Two members, being elected members of the Carterton District Council
- Two members, being elected members of the South Wairarapa District Council
- Two members, being elected members of the Wellington Regional Council
- Two members to represent the Waiōhine Action Group (one of whom will be the Waiōhine Project Team chair)
- One member to represent Kahungunu ki Wairarapa
- One member to represent Rangitane o Wairarapa

3.2.3 Steering group – role/responsibilities

The final decision on the adoption or otherwise of a draft or final Waiōhine FMP is retained by the Wellington Regional Council.

To deliver on its purpose, the range of suggested responsibilities to be assumed by the Steering Group includes the following:

Guide and support the Project Team and its Facilitator to deliver on its Terms of Reference as adopted by the public meeting of 7th July of the ratepayers of the Waiōhine valley

Familiarisation with the work that has been undertaken on the Waiōhine

FMP to date as well as the views of community, including IWI, conservation authorities, CDC and SWDC

Oversee the scoping of viable options for the project and ensure strong support within the affected communities for recommendations

Review recommendations received from the Project Team, and set and oversee the three guiding rules for the Project Team

Ensure the work of the Project Team delivers a comprehensive, long term and sustainable solution for the Waiōhine River and the people who occupy its floodplain

Develop and implement a communication strategy to facilitate effective engagement with WAG, the wider Greytown/Carterton communities and the general public in the work of the Project Team and its oversight

Identify and manage potential and relevant project risks.

4 Waiōhine FMP Project Team

Ratifying a Project Team is a matter for the Steering Group. Attachment 2 to this report contains Terms of Reference for this team. At its public meeting of 7th July, the ratepayers of the Waiōhine valley adopted these TORs and appointed five members of the community as its Core Team members, with one being chosen as it's Facilitator/Chair. The Steering Group will select and appoint one or more core team members from GWRC. The Project Team will bring in members from time to time with skills appropriate to the aspects of the FMP being worked on.

5 Wairarapa committee's functions

The terms of reference for this Committee set out that it may consider and make recommendations to Council on any issues relevant to the Wairarapa, including but not limited to flood protection.

The terms of reference for the Council's Environment Committee sets out that one of its responsibilities is to monitor/oversee the development and implementation of floodplain management plans, including the Waiōhine River Plan, Incorporating Floodplain Management Plan.

As both Committees have responsibility for flood protection matters, it is considered appropriate at this stage in the process that this matter being presented to the Wairarapa Committee is also presented to the Environment Committee for information before being sent to Council for decision.

6 Communication

The Committee's decisions will be presented to the Environment Committee and Council.

7 Recommendations

That the Committee

1 **Receives** the report.

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

3 **Notes** that a report advising the Environment Committee on the proposed establishment of a Waiōhine FMP Steering Group and Project Team will be presented to the Environment Committee on 9 August 2017.

4 **Recommends to Council:**

a that it establishes a Waiōhine FMP Steering Group; and

b that it adopts terms of reference for the Waiōhine FMP Steering Group as set out in Attachment 1 of this Report.

How the Project Team work together – "housekeeping"

- One out, all out – the entire team must be in the room in order to be familiar with all material and make sound decisions by consensus.
- Write up, not down – in this way there is immediate consensus about every word that is recorded from conclusions regarding data and analysis and from interviews of subject matter experts and stakeholders. These cannot be misconstrued or misinterpreted and become a permanent record at source.
- One conversation – to avoid missing information and ensure consensus
- All opinions are equal – ensuring equal input and weight in decision making
- Play the ball, not the person – making it possible to build consensus
- Park it – if the team do not know the answer to any question asked by any party, do not lose the question, save it in the parking lot to ensure it is addressed and not lost.
- Does it make a better flood management plan? – of course, this is now, does it make a better river plan?
- Tests – test all decisions against the three tests set by the Steering Group to guide the Project Team:
- Can we get resource consent?
- Can our community afford it?
- Will it work?

- Silent – setting for mobile phones etc.
- GWRC values –recognizing the cultural values set by GWRC as being pertinent to the River Plan
- **For People By People** – ensures we are thinking about the community and stakeholders and can walk a mile in their shoes
- **No sacred cows** – we should not be afraid to challenge anything within the law if it doesn't make common sense anymore.
- **Own it** – if there's something that needs doing, we shouldn't just wait for someone else to do it.
- **All on the same side** – everyone wants a River Plan that works and therefore we are on the same side.

Declarations of interest

A register of interests for the Project Team and people who worked closely with the Project Team was created at the outset and maintained throughout the project.

How were the community and other stakeholders involved?

- To consult with and keep everyone informed and involved in decision making in an open and transparent way, a range of channels were used:
- Via Facebook, as each working day or other event concluded, outputs (mainly the flip charts that reflect the structure of the mind map above and underpin this plan) were photographed and those photos posted, together with links to maps etc. on Facebook,
- Links to this material and a commentary were distributed by email to all interested people,
- Project Team members met with and briefed Waiōhine Action Group members of the community whenever anything of significance needed to be shared and to gain advice, feedback, guidance and major decisions,
- Public drop-in sessions, group and sometimes one-on-one briefings and input to decisions were conducted at key points, usually in the project room, where there was best access to project materials,
- At other key times public meetings were called, information shared, and key decisions made, and important motions put to the vote,
- Feedback received from all these channels was either addressed straight away, or captured on a "Parking Lot" to be addressed once the relevant piece of analysis had been completed,
- A Steering Group met regularly, chaired by a GWRC Councillor and attended by representatives of Iwi, CDC, SWDC and the Project Team. The job of the Steering Group was to challenge and test the Facilitation and Project Management, give guidance and direction to the project and assure probity and good governance within the process. The Facilitator/Project Manager presented a simple progress report to each meeting, which was also shared publicly via Facebook (an example can be found at Appendix A)
- An example of an action by the Project Steering Group is the decision to take a recommendation to the Wairarapa Committee of GWRC to take the unique step of GWRC publishing an Interim Flood Map for the Greytown side of the Waiōhine, this offered an effective interim solution to many planning issues and largely correcting flaws in the extant flood maps. Here is the record of this:

Steering Group recommendation of 2nd February 2018

To: "Release for use, the Interim Flood Map approved by the Project Team and satisfying the outcome of the peer review" to the Wairarapa Committee. All agreed and happy that concerns will be addressed by doing this.

Why was an interim flood map developed?

Early on the project team identified better data and had access to better tools to create a more accurate base model and set of flood maps. As a result of this a far more useful interim flood map was able to be developed. At this point a simple set of questions were posed to decide what needed to be done with the new, more accurate map:

Question: Does it benefit the community to recommend it be promulgated?
Answer: Yes

Question: If so, then what notes, and caveats would be necessary to ensure that it is used wisely?
Answer: Explain context of overall process

Question: How long before we get a set of final flood maps? What's our best guess?
Answer: Possibly by end of April 2018

Question: Are there any other intermediate steps?
Answer: No"

Appendix C

Intent of the Living Plan and it's Terms of Reference

The Living Plan model is predicated on the concept of what has come to be called co-governance

Ra Smith of Ngati Kahungunu ki Wairarapa proposed the idea that, to be useful, this plan needed to be a living plan. If the river is a living entity, so must it's plan be.

- A traditional, static plan is characterised by being useful as a:
- Point in time analysis,
- A level set that offers a chance to think about everything once,
- A fixed flood defence that enables a short-term programme of building structures but cannot adapt to constant change.

A living plan is characterised by adaptability and learning that enables:

- Long term vision – setting horizons out to 2050 and 2090,
- Interdependency – being able to keep on adjusting for climate change, better flood and map data, improved cultural understanding and much more,
- Triggers – that enable adaptive management and updating of the plan cooperatively between the community and GWRC,
- Iwi and Community partnership in gradually restoring the river to a more "naturalistic" state.
- River Management that respects the changing needs of the land, mana whenua, ratepayers, users and landowners,
- River Projects that everyone can get behind.

A living plan allows flexibility in the year by year operational management of the river in partnership with iwi and the community. This could lead to better on the ground decisions about cultural aspects, pest and weed control, restoration, gravel extraction, setting up a meaningful bed level envelope (once sufficient data becomes available to identify high and low points), flood mapping, safety and emergency management as technology evolves, water quality measurement and goal setting and many other valuable improvements.

A living plan allows the River Plan to avoid having to fix everything at one point in time, only to immediately be overtaken by events.

A living plan allows improvements to measures, goals, additions to scope to, for example, adapt to legislative change, technology, better science or the addition of other important aspects of the catchment's needs.

So, having settled on the need for the plan to be a living Waiōhine River Plan (Incorporating FloodPlain Management Plan), the question then was, how would the Living Plan continue to bring together everyone to make the best decisions, in the way the Project Team, iwi, community and stakeholders have throughout the project itself. The project team developed a simple, pragmatic working model and then sought the advice of the community.

To adapt the flood plain management plan to become a whole of river plan and a living plan, the mana whenua, community and stakeholders of the Waiōhine valley adopted Ra's concept and resolved to: "Approve the continuation of The Project Team, embracing Iwi, Friends of the Waiōhine, Ratepayers, Landowners and all other stakeholders, to engage constructively with GWRC to prepare and implement the Waiōhine River Plan, represent our interests and continue to keep everyone openly and transparently, informed of progress." This was passed unanimously at a public meeting, at a Waiōhine Action Group meeting and subsequently added to the Terms of Reference for the project by the Steering Group and thence the Wairarapa Committee.

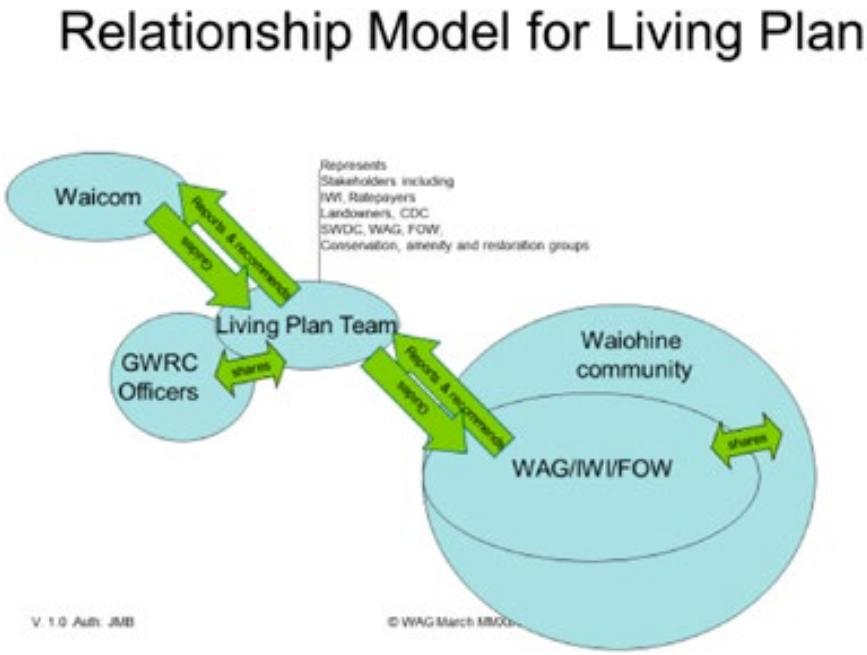


Figure 110: Intent of the Living Plan and TORs – Relationship model.

The Project Team will continue to meet and work as needed to support the Living plan process. It is envisaged that this would be far less often than for the development of the initial plan but would synchronise with GWRC planning cycles. At the start of each annual planning cycle or other planning cycle e.g. three year review of the Long Term Plan.

The Living Plan comes into effect as soon as the Waiōhine River Plan (incorporating Floodplain Management Plan) is enacted. At this point the Terms of Reference below is combined with the Project Team Terms of Reference so that it carries on in an operational mode under the revised Relationship model. See above.

The process will ensure that there is joint planning and management of the river and opportunities are taken to gradually implement the Vision for The River. It will ensure principles of adaptive management are followed, that there is governance and buy-in by iwi, community and all other stakeholders, that there is good understanding of what GWRC need to do to manage the river on their behalf and in return, GWRC can engage the help and resources of the community to deliver the vision and make good decisions together.

Terms of Reference (TORs) Extensions for the whole of river plan and Living Plan process

The ongoing Role of the Community (WAG) in Partnering GWRC to Oversee Implementation and Operation of the Waiōhine River Plan, both through the building of the proposed new stopbanks and flood defences and until the plan expires in 2100. This allows time for the vision to be realised for our river and to adapt and improve this plan as new data, science and events make possible, a fuller explanation of the intent process of the Living Plan can be found here.

Figure 111: What Partnership Looks Like

1 GWRC will share in good time, with the WAG Project Team and community, all relevant trigger data, events and findings that might inform planning inputs or actions that might need to be taken in between GWRC annual planning cycles, or that fall within the aegis of this Waiōhine River Plan (Incorporating Floodplain Management Plan), or that generally relate to the river and floodplain.

2 With that in hand, everything provided will be shared to and reviewed by the community, including tangata whenua and all other interested stakeholders, prior to each GWRC planning cycle (annual, operational or long term) commencing. New items and topics may be added to this with the agreement of the Wairarapa Committee.

3 GWRC and the WAG Project Team and community will share all planning inputs that might affect the river and environs for discussion, as needed prior to the start of each formal GWRC planning cycle.

4 GWRC will produce its draft plans and budgets that relate in some way to the Waiōhine and share this with the WAG Project Team and community in good time for the community to communicate with all stakeholders, meet, seek additional information if necessary, review it, identify differing views or endorsements and present these along with any proposed community initiatives to the Wairarapa Committee at which the GWRC plan is also presented.

5 GWRC will support the day to day running costs budgeted annually.

6 GWRC Wairarapa Committee will decide what steps, if any, need to be taken where there are significant differences between what the community and GWRC wishes for the river.

Above is the model for how the relationship between the community (including stakeholders) and GWRC will operate once the River Plan is ratified and the project moves into an operational mode to implement the plan, keep it relevant and oversee maintenance of the river in partnership with GWRC. The principle is to create a collaborative partnership in which the community remains in a leadership position as keeper of the vision and overall plan for the river, with GWRC and there are checks and balances to make sure rifts cannot happen again, between the community and GWRC. The process incorporates the current planning cycles of GWRC: annual and Long-Term Plan, incorporating data sharing and shared decision making for significant aspects of river management and development to eventually realise the vision and plan. This process is to be overseen by the Wairarapa Committee of GWRC who will also act as a "circuit breaker" in the event the Community Position presented to them differs from that of GWRC in some regard.

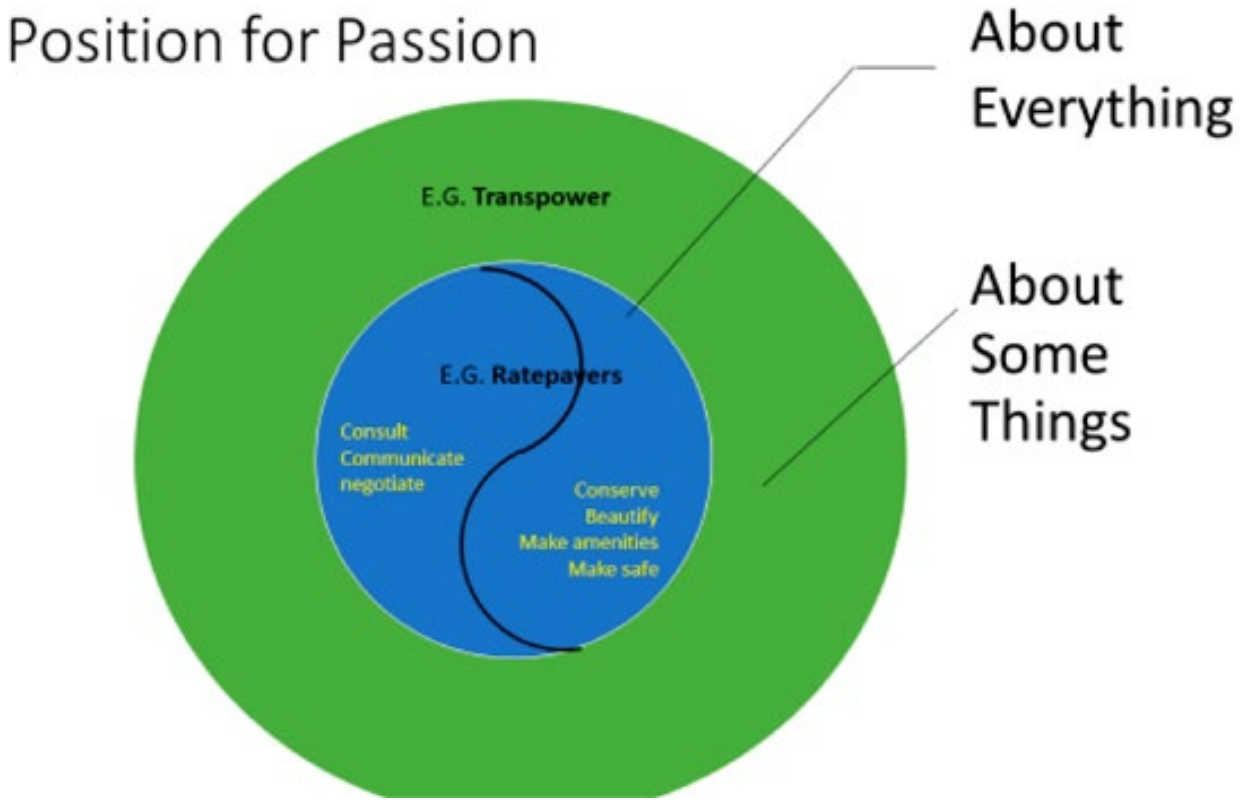


Figure 112: Position for Passion – some stakeholders are interested in all topics and some in specific topics.

The assumption at this stage is that folks in the middle need to participate in every cycle of input into GWRC, caused by either GWRC planning cycles, or event triggers (see list). Whereas the stakeholders outside the middle are probably only interested in some topics, relating to the river, and should elect which those topics are, and be always invited to participate when those topics come up. This model will be refined by WAG as a foundation task under the Living Plan Process.

The Waiōhine catchment has roughly:

1 2,200 ratepayers

2 1,800 urban ratepayers

3 400 rural ratepayers

Ideally the ongoing team should represent all types of stakeholders as much as possible by optimising the number of "hats" people wear at the table.

Optimum team size is no more than nine regular members, ideally with a similar distribution amongst stakeholders as the following example of representative 'Hats' (or stakeholder groupings):

1 IWI (1 "hat" on current project team)
2 Urban ratepayers (1 "hat" on Project Team)
3 Rural landowners (5 "hats" on current project team)
4 FOW/sustainability advocates (1 "hat" on current project team)
5 River expertise(5 "hats" on current project team)
6 District Councils (2 "hats" on current project team)
7 GWRC (2 "hats" on current project team)
8 Conservation and restoration friends of the Waiōhine (WAG) (2 "hats")

Much of the input data needed from GWRC would be as prepared for annual operations reporting, to be collected for Whaitua, from a joint walkover and as currently used in the delivery against conditions of river management consents.

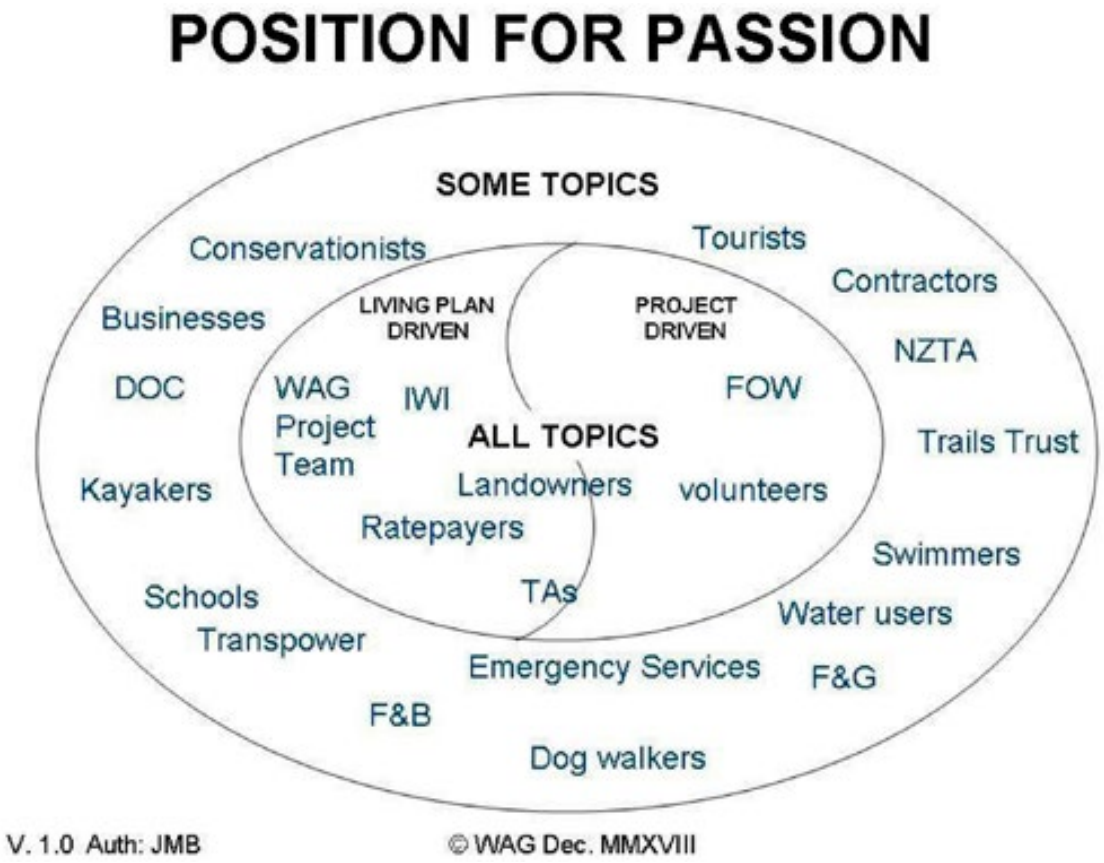


Figure 113: Position for Passion.

Appendix D

Relevant standards and guidelines

The Waiōhine River Plan considers the following laws, policies and regulations:

1 Relevant GWRC Flood Management Policies include:

2 Where practical avoid flood risk (See GWRC policies 50 & 51),

3 Protect existing flood protection assets,

4 Incorporate allowances for climate change,

5 New stopbank heights should be designed for:

a Urban areas: 100-year flood plus climate change,

b Rural areas: 20-year flood plus climate change.

6 It is necessary to distinguish strategy between existing versus new development

7 Legislation that must be complied with includes:

a The Building Act 2004 about land and buildings

b The Resource Management Act 2017 about consents for work and district plans

c NZS 4404 2010 about land development and subdivision infrastructure. E.g. rural subdivisions will affect all flood defence works

8 Public Works Act 1981 Soils, Conservation, & River Control Act 1941

Relevant legislation regarding climate change

The two main pieces of legislation relevant to climate change and flood risk management are the Resource Management Act 1991 (RMA) and the Civil Defence Emergency Management Act (CDEM) 2002.

The RMA requires regional authorities to control the use of land for the avoidance or mitigation of natural hazards. Territorial authorities are required to control the actual or potential effects of the use, development or protection of land, including for the purpose of avoiding or remedying natural hazards. The Resource Management (Energy and Climate Change) Amendment Act 2004 further requires local authorities to have regard to the effects of climate change.

The CDEM Act is another key piece of legislation for flood risk management. The Act primarily focuses on the sustainable management of hazards, resilient communities and on ensuring the safety of people, property and infrastructure in an emergency. The CDEM Act recommends an approach based on risk reduction, readiness, response and recovery.

Although risk reduction is primarily achieved through proactive planning as required by the RMA and the CDEM Act, other relevant legislation for climate change and flood risk management includes the Building Act 2004, the Local Government Act 2002 and the Soil Conservation and Rivers Control Act 1941.

Appendix E

Example of easement agreement

Easement instrument to grant easement or *profit à prendre* Section 109 Land Transfer Act 2017	
Land registration district	
Wellington	

Grantor *Surname(s) must be underlined.*

Grantee *Surname(s) must be underlined.*

WELLINGTON REGIONAL COUNCIL

Grant* of easement or *profit à prendre* or creation of covenant

The Grantor, being the registered owner of the burdened land set out in Schedule A, grants to the Grantee (and, if so stated, in gross) the easement(s) or profit(s) à prendre set out in Schedule A, with the rights and powers or provisions set out in the Annexure Schedule(s).

Schedule A Continue in additional Annexure Schedule if required.

Purpose of easement, or profit	Shown (plan reference)	Burdened land (Record of Title)	Benefited land (Record of Title) or in gross)
Stopbank Easement	?? on Deposited ??	Insert CT reference	Wellington Regional Council in gross

Easements or profits à prendre rights and powers (including terms, covenants, and conditions)

Delete phrases in [ ] and insert memorandum number as required.
Continue in additional Annexure Schedule if required.

Unless otherwise provided below, the rights and powers implied in specific classes of easement are those prescribed by the Land Transfer Regulations 2018 and/or Schedule 5 of the Property Law Act 2007. The implied rights and powers are ~~varied/negatived/added to~~ or substituted by: ~~Memorandum number , registered under section 209 of the Land Transfer Act 2017.~~ The provisions set out in the Annexure Schedule.

Covenant provisions	Delete phrases in [ ] and insert memorandum number as required. Continue in additional Annexure Schedule if required.
~~The provisions applying to the specified covenants are those set out in:~~ ~~Memorandum number , registered under section 209 of the Land Transfer Act 2017.~~ ~~Annexure Schedule 2.~~	

Figure 114: Example of easement.

Appendix F

Original diagrams and flip charts

These are images of the flip charts and whiteboard photographs from the Project Team Working Days which are the direct source of everything within this river plan. All these charts and photos were shared with the community within days – ensuring complete openness and transparency of every aspect of every decision ("Professor RAG" or final) and any subsequent revision as new expertise or data came to hand. By including these here we ensure probity and auditability between the agreed positions of the community, including GWRC and this complete river plan. It also serves as a complete record of discovery and decision making, sometimes involving the direct decision making by the wisdom of the crowd i.e. community.

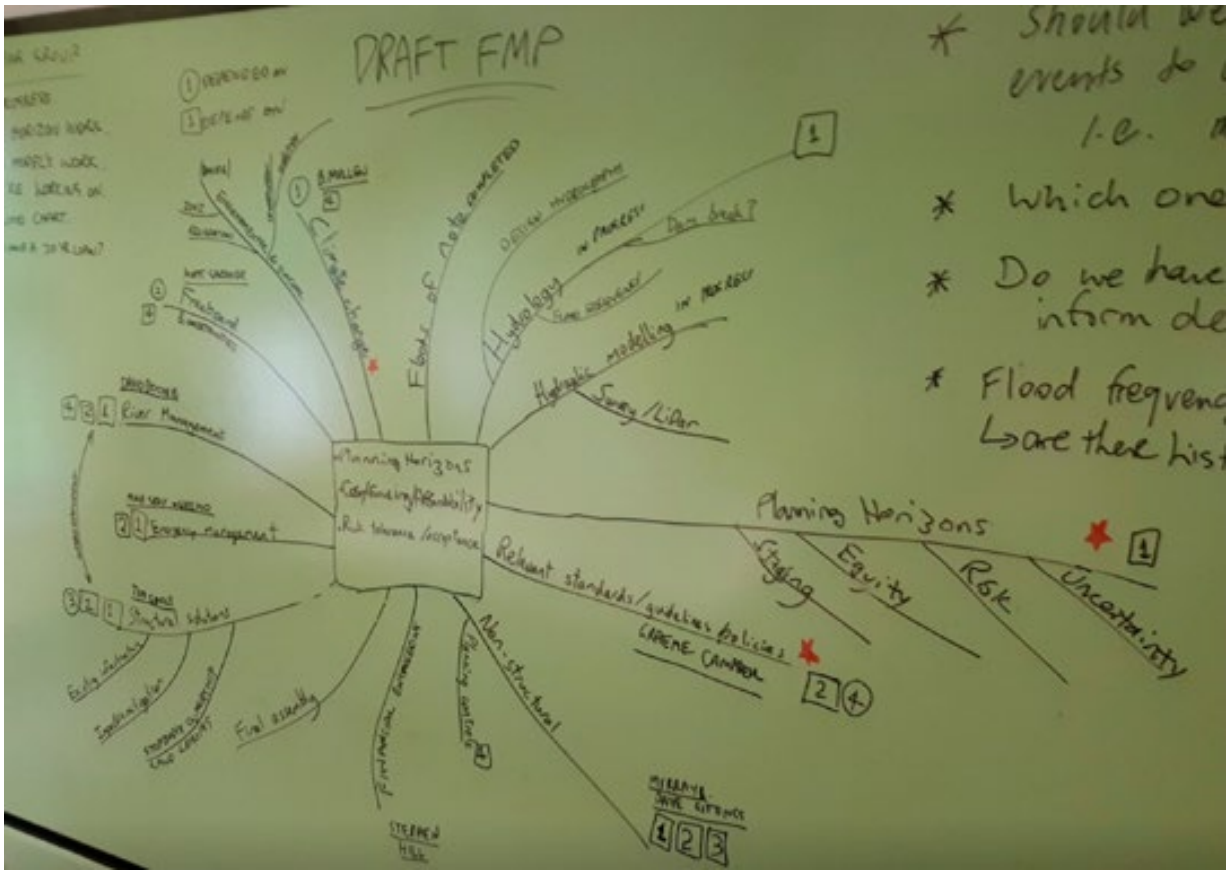


Figure 115: The Mind Map with linkages – an example of techniques used.

A directory of flip chart photographs, showing the day to day work of the Project Team, as published on Facebook with links and summaries of progress emailed to a wide range of interested people – can be found here.

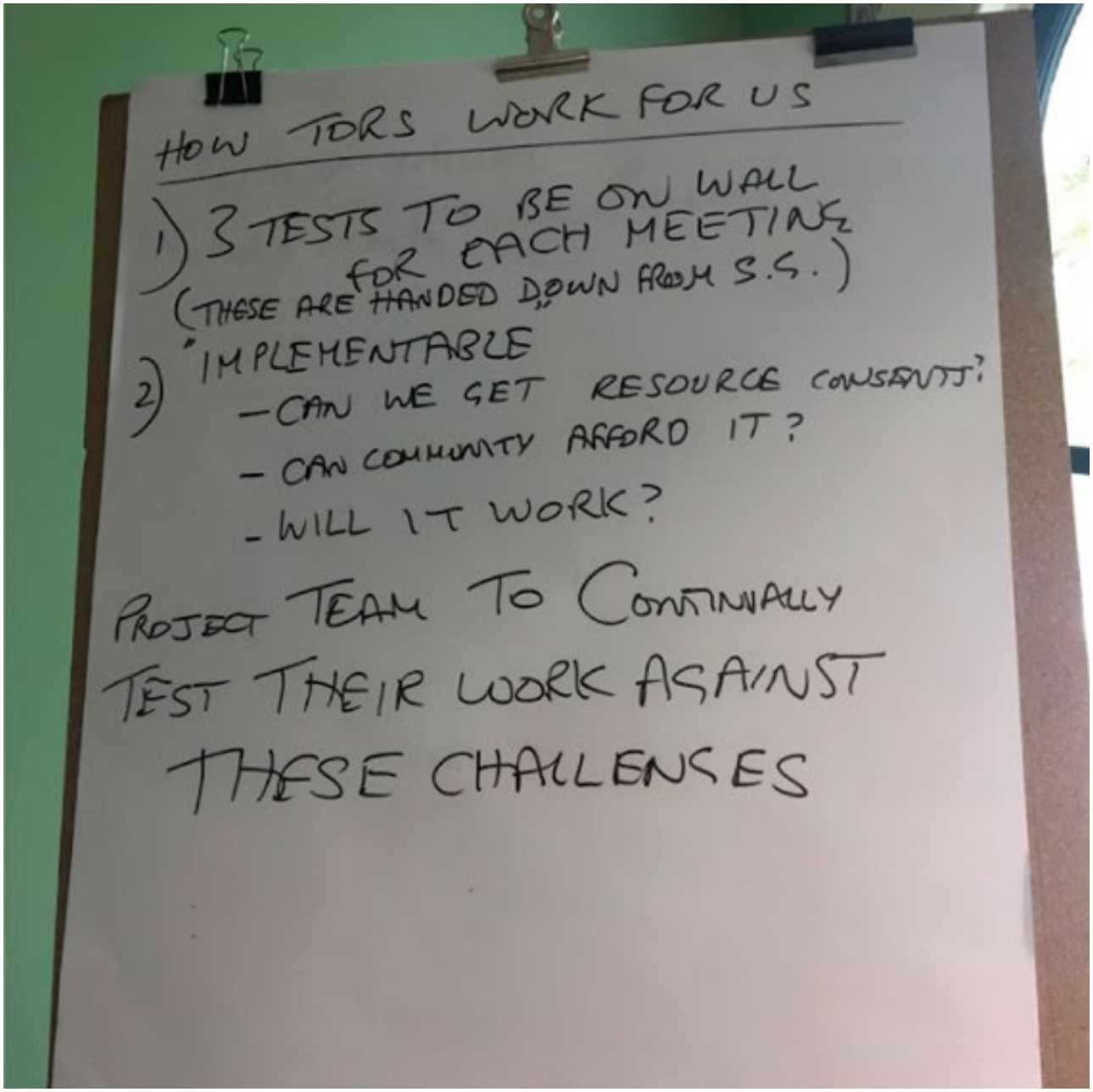


Figure 116: Setting up the project team and relating work practices to the Terms of Reference and community drivers.

Appendix G

Maps

Notes on the approach to mapping

"National flood risk maps are essential because we need accurate and comprehensive information about the impact and costs of flooding today and under different climate change scenarios so everyone can plan and adapt." NIWA

Maps were prepared by Land, Sea River Consulting Limited to requirements developed by the Project Team. The approach of analysis until it was reasonably believed that all known facts were revealed led to a larger than usual number of models and maps but perhaps a higher degree of confidence as a result and more opportunity to refine and test alternative solutions.

It was identified that the following Flood Maps would be needed For the River Plan as a minimum:

- Land that could be flooded today (20 [5%]/50[2%]/100 year[1%] {old CCH, new CCH}) [DFL]
- Land that could be flooded in future (climate change, etc...) [DFL]
- Current structural assets (banks, bridges, culverts, etc...) [DFL]
- Hazard (Low, Medium, High) risk to life [DFL]
- Future non-structural assets [END]
- Future structural assets (20/50/100) [END]
- Emergency management map [END]
- Time series map [END]
- Planning Map (including residual hazard- same as 5.)

Notes:

Inevitably as the project progressed and new questions were raised, requiring deeper investigation, the list of models and maps needed expanded to include all the editions listed below.

Flood hazard maps were prepared using the Australian Rainfall and Run-off Method (ARR).

When will these be needed?

[END] = Completion of FMP final maps

[DFL] = Draft flood map stage

As expected, this plan set was expanded as questions that arose during analysis and design tasks were undertaken. So, a far larger map set eventuated. We have catalogued these here and provided embedded links to online jpeg files of these maps.

All flood maps and models were prepared by Matthew Gardner – External Consultant. Chartered Professional Engineer with expertise in modelling flood risk, particularly in gravel river systems. Based in Christchurch with no ties in the Wairarapa, however, previously employed by GWRC in the Flood Protection department.

Overview maps showing the proposed solution:

1 This map shows the proposed inland stopbanks as blue lines. This scenario shows a 1% (one in one-hundred-year flood, plus 16% extra volume of water to account for climate change, as at 2100), with depths in colour. It also shows flood sensitivity i.e. flood risk that is eliminated once the stopbank is built, as a pale pink "ghost".

2 This map also shows the proposed inland Eastern (North Street) and Western (Kuratawhiti Street) Stopbanks as blue lines. It differs from the one above in that it shows one in one-hundred-year flood (includes 10% climate change), as at 2050, with depths in colour. Again, it shows flood sensitivity that is eliminated by construction of the stopbanks as a pale pink "ghost".

3 This map shows the proposed inland Eastern (North Street) Stopbank as a blue line. It shows 1% annual probability (one-in-one-hundred year flood), including an extra 10% flood water volume for climate change, as at 2050, with depths in colour. Again, this shows flood sensitivity that is eliminated by the proposed stopbank as a pale pink "ghost".

4 This map adds all the overlaid "sensitivity" run scenarios on top of the base model (1% annual probability) to show, in various colours, how much farther a flood might possibly spread if one or more of these scenarios occurs. The proposed new stopbanks are not shown, so it is possible to see the potential impact on the urban area too. It emphasizes the need for the proposed stopbanks, not just to offer some protection from a 1% annual probability, plus climate change flood but to also defend against these possible but unlikely contingencies. The flood sensitivity area is the area that if these possible but improbable events occurred might be flood affected if no flood defences are built. This is intended to help, for instance, local planners to understand where there might be some benefit to property owners in requiring new buildings to be slightly higher to guard against the possibility, however remote, of flood damage.

5 This map shows the maximum extent of a flood in the same circumstances as the above map. It offers a demarcation between the modelled flood and the extent of the flood sensitive area beyond the modelled flood.

6 This scenario shows the peak depth of a 1% (one in one-hundred-year flood, plus 16% extra volume of water to account for climate change, as at 2100), with depths in colour. It also shows flood sensitivity i.e. flood risk that is eliminated once the stopbank is built, as a pale pink "ghost".

River maintenance maps:

7 Maintenance Reach A: Gooseneck to the Rail Bridge

8 Maintenance Reach B: Rail Bridge to the Wire Shed

9 Maintenance Reach C: Wire Shed to State Highway 2 Bridge

10 Maintenance Reach D: State Highway 2 Bridge to Ruamahanga

Sheer stress modelling maps – used to see what risk might be posed by the power of flood waters at critical locations:

11 Sheer Stress modelling as at Saywells – i.e. the end of Greytown Stopbank and stretch below. This model was used to analyse risk to the Greytown Stopbank to help determine whether the bank needed to be

extended. No evidence that the bank would fail was found. No evidence that flooding around the end of the stopbank would cause significant additional issues inland. However, the use of tree planting along the toe of the Greytown Stopbank (first choice – to be verified) or right angle groins at the toe of the stopbank (second choice if first choice fails because tree roots might not find adequate purchase in the stony ground), to prevent scouring that could undermine the bank are deemed a necessary precaution. A Trigger has been created in the Living Plan in the event that evidence does come to light that Greytown Stopbank does in fact need to be extended.

12 Sheer Stress modelling as at Fullers – i.e. the stretch of both banks at and below Fullers Bend. This model was used to help determine whether the inside of Fullers Bend needs to be realigned in order to widen the river to remove pressure and stress on the outside of Fullers Bend. The study showed that there is presently no evidence that the True Right Bank would fail. Modelling of the sheer stress on the True Right Bank (Greytown side) of Fullers Bend would not cause significant additional flooding. In fact, modelling indicates that widening Fullers Bend would create higher sheer stress on the True Right Bank further downstream from the existing flood defences on the outside of the bend and therefore actually create a new flood risk there.

Hazard Maps – Designed to help the community and district council planning officers make informed decisions about future development and maintenance of the floodplain:

13 Hazard Map for proposed solution. This map divides the floodplain into degrees of hazard – to help to identify where District Council (S.W.D.C. and C.D.C.) planners may decide to allow certain activities – e.g. construction of dwellings, access drives etc..

14 Hazard Map for Base Scenario (i.e. is we do nothing and a one-in-one-hundred-year flood plus 16% extra volume of matter for climate change as at 2090/2100 occurs) – this shows relative risk by location and highlights ponded water versus fast moving water in the flood zone. This technique relies on GWRCs normal method.

15 Hazard Map for Base Scenario (i.e. is we do nothing and a one-in-one-hundred-year flood plus 16% extra volume of matter for climate change as at 2090/2100 occurs) – this shows relative risk by location and highlights ponded water versus fast moving water in the flood zone. This technique relies on the Australian Rainfall Runoff Guidelines method – which is preferred as being more informative for this plan.

Modelled Scenarios – these maps reflect the many "what-if" questions that were asked about what a flood might do if something unusual happened, over and above the base model (1% annual probability) flood. For example, what if river maintenance is neglected and gravel builds up the riverbed by a half metre?

16 Scenario 1 – Base scenario – Q1700 (cubic metres per second flow) TP2 + 16% (for climate change) – showing depth

17 Scenario 2 – 20% increase of Mannings 'n' (a measure of bed "roughness" or friction)

18 Scenario 3 – 20% decrease of Mannings 'n'

19 Scenario 4 – IPCC climate change scenario RCP 8.5

20 Scenario 5 – IPCC climate change scenario RCP 2.6

21 Scenario 6 – Bed levels near Kuratawhiti St raised 0.5 metre

22 Scenario 7 – Bed levels near Kuratawhiti St lowered 0.5m

23 Scenario 8 – Blockage at bridges and Apple Barrell floodway

24 Scenario 9 – Small banks removed

25 Scenario 10 – 1% Flood @ 1500 cumecs (cubic metres per second of water) single peak plus climate change up to 2100

26 Scenario 11 – 1500 cumecs double peak plus climate change up to 2100
27 Scenario 12 – 1700 cumecs double peak plus climate change up to 2100
28 Scenario 12b – 1700 cumecs double peak plus climate change up to 2100 – showing change in depth
29 Scenario 13 – 1900 cumecs single peak plus climate change up to 2100
30 Scenario 14 – 1900 cumecs double peak plus climate change up to 2100
31 Scenario 15 – 20-year (5% probability in any year) event temporal pattern 1 (current climate)
32 Scenario 16 – 20-year event temporal pattern 2 (current climate)
33 Scenario 17 – 50-year event temporal pattern 1 (current climate)
34 Scenario 18 – 50-year event temporal pattern 2 (current climate)
35 Scenario 19 – Bank erosion 1
36 Scenario 20 – Bank erosion 2
37 Scenario 21 – 1700 cumecs single peak (current climate)
38 Scenario 22 – 50-year event temporal pattern 1 plus climate change up to 2100
39 Scenario 23 – 20-year event temporal pattern 1 plus climate change up to 2050
40 Scenario 24 – 20-year event temporal pattern 2 plus climate change up to 2050
41 Scenario 25 – 20-year event temporal pattern 2 plus climate change up to 2100
42 Scenario 26 – 50-year event temporal pattern 2 plus climate change up to 2050
43 Scenario 27 – 50-year event temporal pattern 2 plus climate change up to 2100
44 Scenario 28 – Base Scenario + Increase in Manning's 'n' by 20% between XS33 to XS38 12
45 Scenario 29 – 20-year event temporal pattern 2 plus climate change up to 2050 + Increase in Manning's 'n' by 20% between XS33 to XS38
46 Scenario 30 – 50-year event temporal pattern 2 plus climate change up to 2050 + Increase in Manning's 'n' by 20% between XS33 to XS38
47 Scenario 31 – Base Scenario + Increase in Bed LEVELS by 1m between XS27 and XS28 13
48 Scenario 32 – Base Scenario + Increase in Bed LEVELS by 0.5m between XS25 and XS18 14 – showing depth
49 Scenario 32 Version 2 – Base Scenario + Increase in Bed LEVELS by 0.5m between XS25 and XS18 14 – Showing difference in depth

Stopbank Option Runs – these are the maps for the six flood defence options and their variations. These were the scenarios shared with the community at public meetings and drop-in sessions from which they and subsequently the project team, selected the best (recommended) solution:

50 Scenario SB01 – Stopbank base scenario – 1700 cubic metres per second volume + 10% climate change (as at 2050) – showing speed
51 Scenario SB02 – Continuous stopbank – blue stopbank without Fullers Bend works – showing speed
52 Scenario SB02 Version 2 – Continuous stopbank – blue stopbank without Fullers Bend works – showing speed change
53 Scenario SB02 Version 2.2 – Continuous stopbank – blue stopbank without Fullers Bend works – showing depth change
54 Scenario SB03 – Continuous stopbank with Fullers Bend realignment -Blue stopbank with Fullers Bend works – showing speed
55 Scenario SB03 Version 3.2 – Continuous stopbank with Fullers Bend realignment -Blue stopbank with Fullers Bend works – showing speed change

56 Scenario SB03 Version 3.3 –Blue stopbank with Fullers Bend works showing depth change

57 Scenario SB04 – Black stopbank without Fullers Bend works – showing speed change

58 Scenario SB05 – Black stopbank with Fullers Bend realignment

59 Scenario SB05 Version 2 – Black stopbank with Fullers Bend realignment – showing speed

60 Scenario SB05 Version 2.2 – Black stopbank with Fullers Bend realignment – showing speed change

61 Scenario SB05 Version 2.3 – Black stopbank with Fullers Bend realignment – showing depth change

62 Scenario SB06 – Fullers Bend realignment shown in isolation from other works – showing depth

63 Scenario SB06 Version 2 – Fullers Bend realignment shown in isolation from other works – showing speed

64 Scenario SB06 Version 3 – Fullers Bend realignment shown in isolation from other works – showing change of speed

65 Scenario SB07 – Inland stopbank + North St stopbank – Small bunds and guide bank Beef Creek bridge removed – showing depth change

66 Scenario SB08 – Beban stopbank + North St stopbank – orange stopbank with bund 2 and left guide banks removed – showing depth change

67 Scenario SB09 – Vines (XS 28-30) stopbank + North St stopbank – yellow stopbank with bund 2 and left guide banks removed – showing speed change

68 Scenario SB10 – Beban stopbank + North St stopbank with Fullers Bend realignment

69 Scenario SB11 – Vines (XS 28-30) stopbank + North St stopbank with Fullers Bend realignment

70 Scenario SB12 – Continuous stopbank with Fullers Bend realignment (2100) – showing change in depth overview

71 Scenario SB13 – Beban stopbank + North St stopbank (2100) showing depth change

72 Scenario SB14 – Vines(XS 28-30) stopbank + North St stopbank with Fullers Bend realignment (2100)

73 Scenario SB15 – Inland stopbank + North St stopbank (2100) – change in depth

74 Scenario SB16 – Beban stopbank + North St stopbank with Fullers Bend realignment (2100)

75 Scenario SB17 – Extended Greytown Stopbank

76 Scenario SB18 – Extended Greytown Stopbank with 20% increase in Manning's 'n' between XS (river cross section) 33 and XS38

77 SH2 Crown Lowering – shows locations where **we recommend** that NZTA consider lowering the height of the crown of SH2 by 100mm in order to reduce the damming effect of the road increasing flood risk to adjacent properties on the Western side.

78 Scenario SB10 – Depth Change Map for Beban stopbank + North St stopbank with Fullers Bend realignment

Appendix H

Glossary and other explanatory notes

Looking for a term to do with rivers not covered in the glossary below? Try here.

Active Bed or Riverbed – The part of a river channel which gets wet, always or sometimes. Apart from flood events, the active bed of a gravel bed river is normally only partially covered by flowing water.

Aggradation – or a rising riverbed – The increase in the general level of the riverbed as stuff accumulates on it: stones, gravel, grit (a.k.a. "fines") and other detritus. This may arise because a lot of bed material has moved through a reach or due to changes in river processes affecting the carrying of bed material.

ARR – Australian Rainfall and Runoff Guidelines – Australian Rainfall and Runoff (ARR) is a national guideline document, data and software suite that can be used for the estimation of design flood characteristics. More information can be found here.

Asset – an important structure or material, that is valued by the community & GWRC, such as stopbanks, rock lining material, bridges, roads, debris fences, natural or manmade features that help to manage flooding etc.

Avulsion – When the river leaves its existing river channel and the forms a new river channel

Bank or Stopbank – A shaped earth and gravel formation generally parallel to the river channel to confine floodwaters.

Beach – general term for an area of deposited material within the active bed or riverbed, that is relatively clear of vegetation, often lying between the wet channel and the riverbanks.

Berm – An area of relatively low-lying land within a waterway beyond the active bed, and generally from a bank landwards to a higher natural feature or stopbank. Berms usually have some vegetative cover. They flood easily and so help manage floods but allow some erosion and the bed to change naturally.

Buffer – An identified area, along the margin of the river, that may be prone to some erosion for river management purposes. Buffers planted with vegetation to control bank erosion are called "riparian planting" of buffers.

Catchment – The land area bounded by watersheds, draining through tributaries, into a river – comprising an FMU.

Code of Practice – The Code of Practice is a document developed by GWRC that guides all river management activities undertaken by GWRC for the purposes of flood and erosion protection across the Wellington Region. It is subordinate to this River Plan.

Community – In the context of this plan, "community" includes Iwi and other statutory bodies, mana whenua and other urban and rural dwellers in the Waiōhine catchment and all stakeholders, including but not limited to those identified. By definition: "community" *n.* A group of people living in the same locality and under the same government. *n.* The district or locality in which such a group lives. The community of the Waiōhine catchment is represented by the Waiōhine Living Plan Project Team (elected by public meeting of the community, as an advisory committee to the Wairarapa Committee of GWRC), representing WAG (Waiōhine Action Group) or organisations that may succeed it or their equivalent acting through the Waiōhine River Living Plan Project Team that may reasonably attempt to represent the whole rate paying community and other stakeholders interests.

Degradation – A lowering of the level of the riverbed, through removal of bed material such as stones and gravel. This happens from human extraction or naturally. It happens more when the river runs faster and higher. Vastly more material is moved down the river, and deposited, when a major flood occurs – such as a once-in-fifty-year (2%) or once-in-a-hundred year (1% flood).

Designation – This is an ability to reserve land under the District Plan, either to note a hazard or to note the location of a structure to provide protection from that hazard. There are generally strict rules which control what may happen in these areas and they can be used to reserve land for construction in the future.

ENSO – El Niño and La Niña (collectively known as El Niño-Southern Oscillation).

Flood Hazard Map – a map showing flood hazard in terms of depth of inundation, flow velocities or combinations of these for different types of events. The maps are produced based on computer modelling

Freeboard – https://www.fema.gov/freeboard *"Freeboard is a factor of safety usually expressed in feet (or metric equivalent) above a flood level for purposes of floodplain management. "Freeboard" tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed."*

Freshwater Management Unit (FMU) – This is an important concept for the understanding of where a river starts and stops for the purposes of guardianship, management, cultural consideration and catchment management. A Guide to Identifying Freshwater Management Units

In-Stream – means the wet river stream running between its banks.

In Stream Works – means anything done in the wet part of the river

IPO – Interdecadal Pacific Oscillation

Kaitiakitanga – Guardian or steward or to have guardianship or stewardship.

Level of service – Another important part of the risk evaluation stage is reaching agreement through community consultation and engagement on the minimum levels of service that you and your community want from your infrastructure. Many local authorities define minimum levels of service for new development, and some define intervention levels for existing development. The flood risk assessment process will enable local authorities to decide whether they will be able to maintain these levels of service under climate change, or whether it will be acceptable to reduce minimum levels of service over time. When considering whether the levels of service should be allowed to be reduced in the future, inter-generational equity should be considered. This will help ensure that decision-making is not unfairly burdening future generations with flood risk that will be unacceptable to them.

LIDAR – An optical sensing technology used to determine the position, velocity, or other characteristics of distant objects by analysis of pulsed laser light reflected from their surfaces.

Mauri – The life essence present in things. Beyond just quality and quantity – it's more than that – it's a respect and reverence for the water, it's natural behaviours, surrounds and ecosystems within its natural setting, context and time. It's how the "catchment" should naturally be or as close as you can restore it to be, were it not damaged or altered by man.

MCI – Macroinvertebrate Index

Natural Character – Natural character is the natural condition of the river before any modification has occurred. Natural character is referenced within section 6 of the Resource Management Act.

Non-Structural Flood Defences – keep people away from floods

One in One Hundred Year Flood – sometimes we say it's a "1%" or "1% Annual Exceedance Probability" this is a flood event that has a one percent or one-in-100 chance of being equalled or exceeded in any one year. On average, this is expected to occur once in 100 years, based on past flood records and best estimations, though in reality it could happen at any time. This is far from an exact science but the best we can do until we collect more data to analyse.

Operational Management Plan – Operational Management Plans are developed by GWRC in partnership with the community, through the Living Plan Process. It will provide specific and detailed guidance on the short-term view of implementation of the River Plan, at a task by task, year by year, reach by reach, scale. The OMP identifies the management objectives and reach specific values that must be considered in the selection of the most appropriate river management methods to be used for each reach. It is subordinate to the living plan that is the Waiōhine River Plan (Incorporating Floodplain Management Plan.

Overflow Path or just Flow Path – Overflow paths (also known as flow paths) include areas in the river corridor and its adjacent floodplain, where a large volume of water could flow during a big flood. They are often areas of land which lead fast-flowing water away from the river corridor and over the floodplain. The depth and speed of flood waters are such that development could sustain major damage, and there may be danger to life. The rise of flood water may be rapid. Evacuation of people and their possessions would be dangerous and difficult, and social disruption and financial loss could be high. A blocked overflow path could potentially cause a significant change in flood flows to other areas of the floodplain. Due to water depths and velocities, overflow paths are generally unsuitable for development, unless adequate flood avoidance and/or mitigation provisions are made.

Pool, Riffle, Run – These are the areas in the river channel characterised by a diverse mix of flows and depths.

'Pool' is an area of low flow channel where depth is relatively greater, and velocity of the flow is lower, than in the surrounding parts of the river.

'Riffle' is an area of the low flow channel that is shallow and steep, with higher flow velocities and unbroken standing waves over the bed material.

'Run' is an area of the low flow channel with relatively fast consistent flow and shallow depths. Runs form downstream of riffles or between pools.

Residual Risk – Residual risk is the risk remaining after risk reduction measures have been put in place. Residual risk may be related to failure of the risk reduction measures, parts of the community that do not benefit from the risk reduction measures proposed, or risks from events that exceed the design standards of the structural risk-reduction options. Climate change may increase the amount of residual risk you need to manage over time. Examples of options for managing residual risk include insurance, emergency management planning, warning systems and community education.

Riparian – The border between land and a river or stream.

Riverbank – The side of a river acting as a barrier between the water and more level ground to either side.

Riverbed – The Resource Management Act defines a river bed as *'The space of land which the waters of the river cover at its fullest flow without overtopping its banks'.* Often the horizontal extent of a riverbed defined thus corresponds to the extent of the active bed.

Riverbed Level Envelope – A term referring to a theoretical area between defined limits that relate to the known natural highest and lowest levels the bed reaches, based upon historical evidence. This can be used as a guideline that helps decide whether or not the riverbed is rising (aggrading) or lowering (degrading) too much. This in turn helps in deciding whether gravel (stone) needs to be, or can safely be, extracted or moved in such a way to reduce risk of flood or change of direction by the river (avulsion); or whether this is in fact necessary and can be avoided or delayed, allowing the river, flora and fauna, to behave more naturalistically.

River Corridor – The river corridor includes land immediately next to the river channel. It is the minimum area able to contain a major flood and allow the water to pass safely downstream. The extents are identified based on modelled depth and velocities of a one-in-one-hundred year or 1% annual risk flood event. The depth and speed of flood waters in the river corridor are such that they represent a potential danger to people and structures.

Sill banks – provide a slightly higher edge to ground, or in many cases, reinstate a higher edge that had been lost by erosion. Not a stopbank.

Stopbank or stopbank – A shaped earth and gravel formation generally parallel to the river channel to confine floodwaters

Structural Flood Defences – keep floods away from people

Sustainable Management – As defined by Section 5 of the Resource Management Act: *"Managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while:*

- Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
- Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and avoiding, remedying, or mitigating any adverse effects of activities on the environment."

Taonga – treasure, anything prized – applied to anything considered to be of value including socially or culturally valuable objects, resources, phenomenon, ideas and techniques. Examples of the word's use in early texts show that this broad range of meanings is not recent, while a similar range of meanings from some other Eastern Polynesian languages support this (e.g. Tuamotuan). The first example sentence below was first published in a narrative in 1854 by Sir George Grey, but was probably written in 1849 or earlier.

Training bank – A training bank is used to direct the flow and speed of floodwater to a better path during a minor flood. A training bank may be used to protect low risk assets, such as open farmland, from high frequency events, but will allow the area to be flooded in a large flood event to alleviate pressure on higher risk assets.

Whaitua – https://www.gw.govt.nz/environment/freshwater/protecting-the-waters-of-your-area/

Appendix I

Links to supporting, reference and background documents

Floods: Things to Know

Climate Change Reference Impacts Assessment – MBE

Preparing For Climate Change for Local Government

New Reports Highlight Flood Risk Under Climate Change

Matauranga Maori – can be defined as 'the knowledge, comprehension, or understanding of everything visible and invisible existing in the universe' and is often used synonymously with wisdom. In the contemporary world, the definition is usually extended to include present–day, historic, local, and traditional knowledge; systems of knowledge transfer and storage; and the goals, aspirations and issues from an indigenous perspective

Independent Peer Review – Ian Heslop – Chartered Professional Engineer

Geomorphic Trends Assessment Report – Tonkin and Taylor

Waiōhine River – Hydraulic Modelling Summary of Sensitivity and Stopbank Runs

Conceptual Design – Cameron Fauvel Projects

Waiōhine FMP – Flood Modelling and Mapping Audit – February 2018 Update BECA

Ecological effects of flood management activities in Wairarapa rivers – Professor Russell Death and Fiona Death

Extreme Rain – NIWA Presentation Slides

NIWA – Climate Change Effects on Upper Ruamahanga Catchments – 2017

Aerial photographs of 1990 flood, which was used for developing the base model for this plan

Proposed Natural Resources Plan

2013 Boffa Miskell report on stopbank assessment.

GWRC Consent application form.

GWRC Partnership with Tangata Whenua agreement.

Fish Communities of Wairarapa Rivers – Russell Death – Massey University [WRC doc 1136937]

Impact of Climate Change on Inflows to the Ruamahanga Groundwater Management Zone – NIWA for GWRC – February 2017

High Intensity Rainfall and Climate Change – Doctor Trevor Carey Smith – NIWA March 2016

Assessment of Kahikatea for Dendrochronology – Rob Kennedy

Buffer Management – Benefits and Risks – Russell Death – Massey university

Waiwhetu Stream – House Raising Options Review (provided as background to the concept of house raising – GWRC April 2014

Appendix J

Which cross section is where?

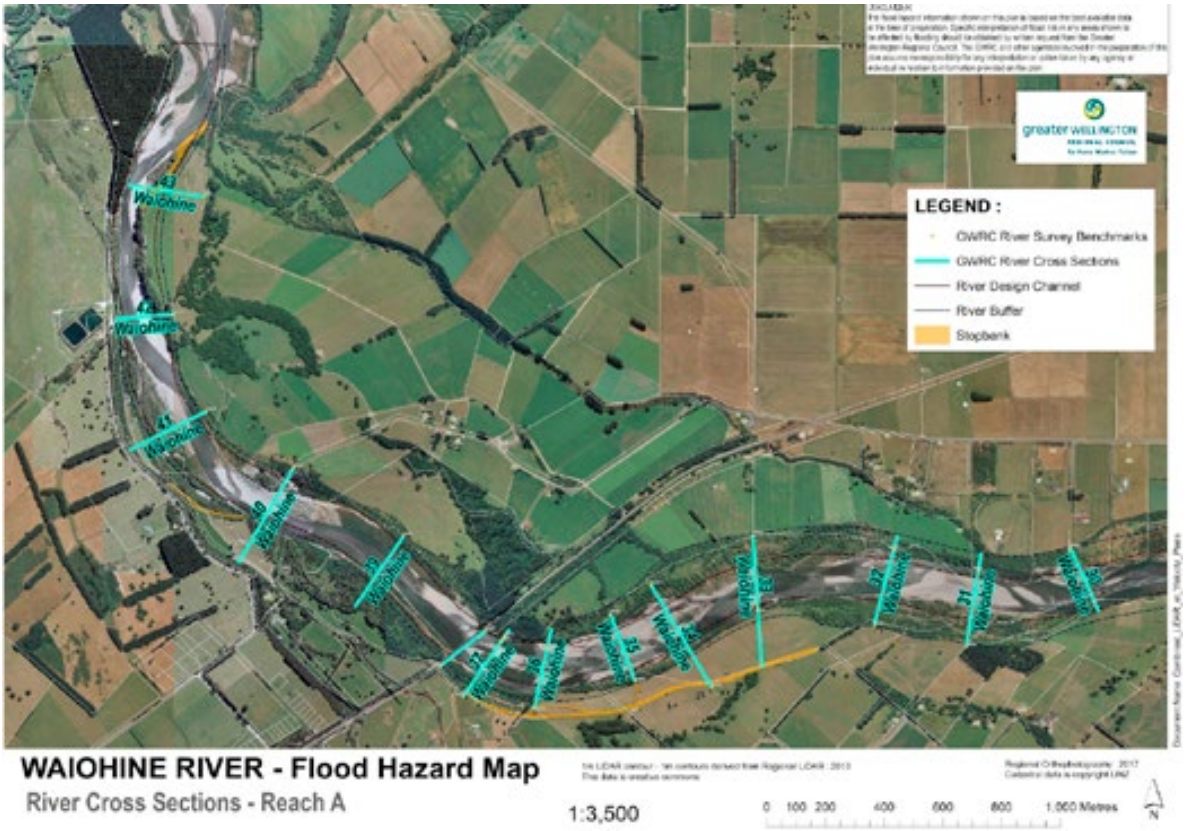


Figure 117: River Cross Sections – Reach A.

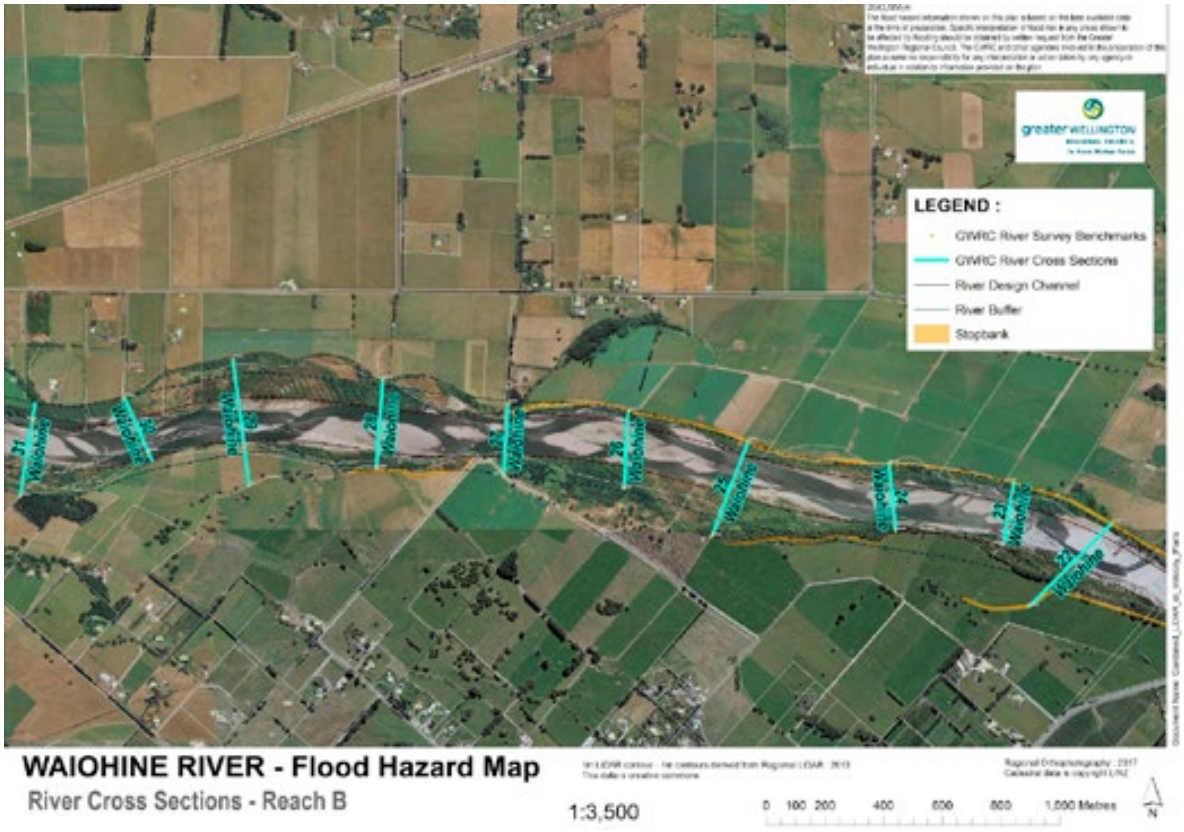


Figure 118: River Cross Sections – Reach B.

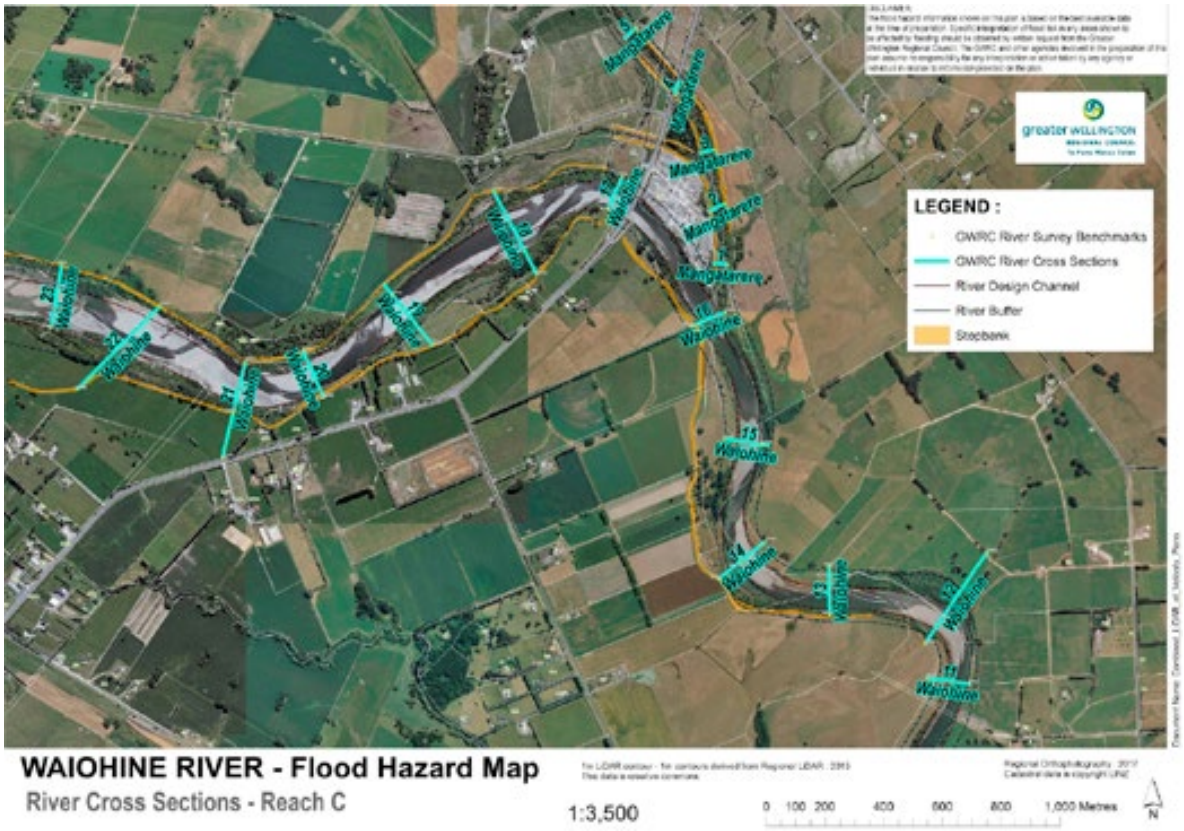


Figure 119: River Cross Sections – Reach C.

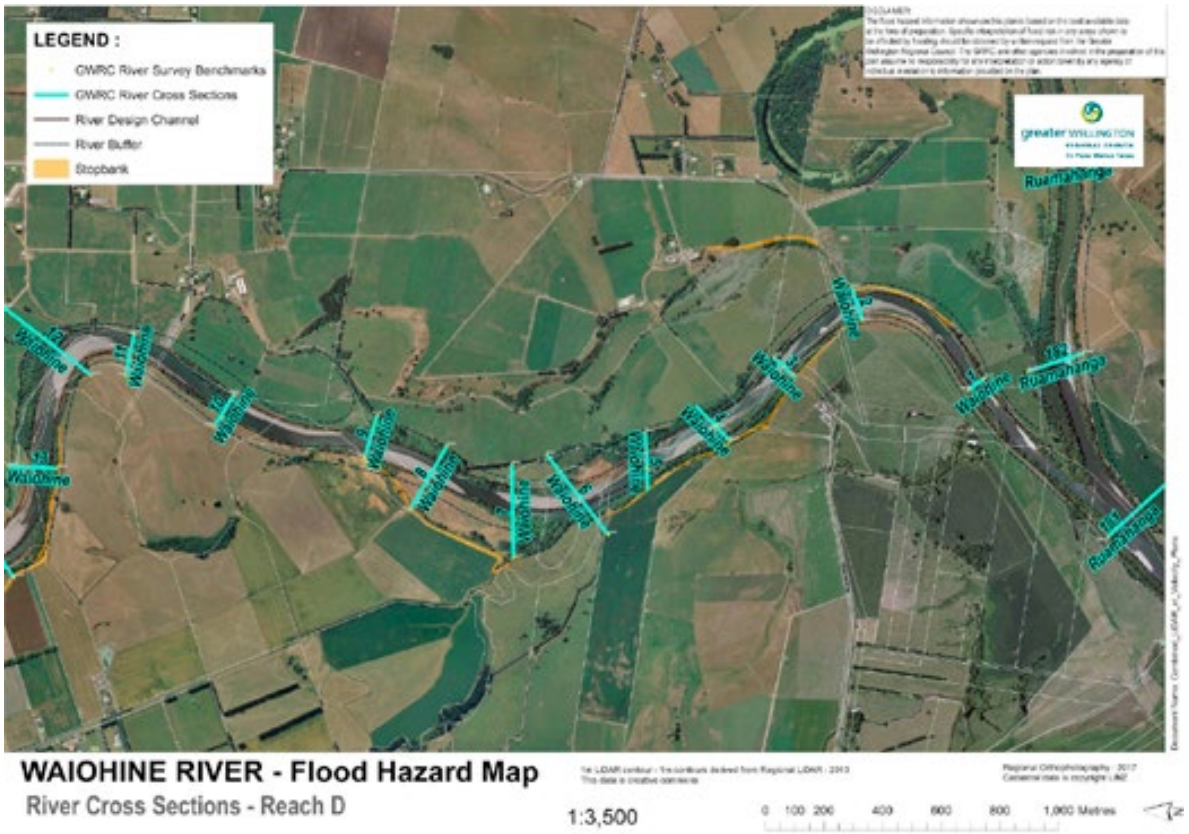


Figure 120: River Cross Sections – Reach D.

Appendix K

Ecological effects of flood management activities in Wairarapa rivers

Report prepared for Greater Wellington Regional Council by Russell Death and Fiona Death. Published by Massey University and Aquanet Consulting Limited, December 2013.

https://drive.google.com/file/d/16hfUW1PAeel3Mdua_f7Y9E3eYHDKFfIG/view?usp=sharing

Appendix L

Package of related gravel strategy documents

Earliest to latest, in order:

1 1st April 2016 Memorandum To Mark Hooker: **"Discussion document on methods to determine mean bed levels and gravel volumes"**

2 **"Gravel Management Review and Recommendations"** – Waiōhine River April 2019. Signed off by Jock McNaught – 10th July 2019, Reviewed by James Flanagan – 12th July 2019, reviewed by Graeme Campbell, Department Manager, Flood Protection 23rd August 2019. Instruction for external parties using the document to contact GWRC. NOTE that the following report was withdrawn from use by GWRC, in order that it should not be used to poorly inform WRT operational management of the Waiōhine River.

3 **"Independent Gravel Management Review – Wairarapa Regional Gravel Status"** – June 2020 written by Environmental Consulting Engineers. Author Laddie Kuta. Purpose is not to: "dictate gravel extraction decisions and operations..but provide sound evidence for discussion and decision planning", "shut down in-channel industry operations or encourage land based gravel extraction operations.", "Override existing planning documents; or provide immutable values for aggrading and degrading trends". It notes that "further work to understand an "optimum" bed level that is aligned with flood protection goals for each river is required".

   NOTE that all data and text and all references to the Waihone River were withdrawn from use by GWRC from the above report in order that it should not be used with regard to the operational management of the Waiōhine River.

   Significantly it states that "The gravel analysis for the Waiōhine River was separately completed by GWRC, with results interpreted by e2 in this report. A separate report with reach-specific detail is available for the Waiōhine River."

4 "Wairarapa Gravel Management Plan 2020/2021" Table describing itself as "Draft plan presented at the industry Workshop held in Masterton on 15 July 2020". Shows data taken from withdrawn documents used for public presentation.

5 A set of new cross sectional surveys as at December 2020 for the reach near Kuratawhiti Street. Undertaken using a more accurate technique than item 2 above and showing that rather than degradation (bed lowering), some aggradation (bed raising and river constriction) is occurring and significant constraint of the river flow.

Appendix M

Maps of restoration strategy

To be provided.

Appendix N

Interview with Bruce Slater and accompanying map of the river – August 2010 by Ian Gunn

Link to the interview:

Interview with Bruce Slater Part 1

Interview with Bruce Slater Part 2

Map that accompanies interview with Bruce Slater

Index of Illustrations