Before Independent Hearings Commissioners
At Wellington

Under	the Resource Management Act 1991
In the matter of	Applications for resource consents, and a Notice of Requirement for a Designation by Wellington Water Limited on behalf of Upper Hutt City Council, for the construction, operation and maintenance of the structural flood mitigation works identified as the Pinehaven Stream Improvements Project

Statement of evidence of Peter Frederick Kinley for Wellington Water Limited (Flood Model Design)

Dated 20 July 2020

大成 DENTONS KENSINGTON SWAN
89 The Terrace
PO Box 10246
Wellington 6143

P +64 4 472 7877
F +64 4 472 2291
DX SP26517

Solicitor: N McIndoe/L D Bullen
E nicky.mcindoe@dentons.com/liam.bullen@dentons.com

Table of contents

Statement of evidence of Peter Kinley

1 Qualifications and experience

1.1 My full name is Peter Frederick Kinley.

1.2 At the time the applications for this project were prepared I was the Technical Leader for Surface Water and Hydrology at Jacobs. My role with Jacobs included providing technical direction of the efforts of network modellers and infrastructure planners at Jacobs working in the urban water infrastructure space. A key component of the work I was involved in was providing oversight and direction to urban flood studies.

1.3 Prior to working at Jacobs, I held various positions including the Principal Three Waters Planning Engineer at AECOM NZ Limited, a self-employed specialist in urban flood modelling and planning, the Modelling Team Leader at Metro Water Ltd, the Senior Engineer at Hauraki District Council and two roles at Hastings District Council including Development Engineer.

1.4 I hold a Bachelor of Engineering in Civil Engineering from The University of Auckland which was conferred in 1996. I have worked in relevant technical roles continuously since finishing university and have 24 years of experience.

1.5 My experience includes:

a Being responsible for the modelling of flood risk in the Awaruku catchment, the Taiaotea catchment, the Kyle and Orwell catchments, the Takapuna Beach catchment, the Shoal Bay catchment, the Hillsborough catchment, the Waiurutoa catchment, the Little Shoal Bay catchment, the Duck Creek catchment, the Opanuku catchment, the Meadowbank catchment and the Cockle Bay catchment for Auckland Council. I also provided modelling inputs to support improvement works programs in six of these catchments.

b As the Modelling Team Leader at Metro Water Ltd and later as the Technical Leader on the Integrated Catchment Study, I was responsible for directing the modelling and technical work associated with the flood risk identification and options analysis to support the development of remedial works for 39 catchments that make up the 160km^2 of the central Auckland isthmus from the Whau River in the west to Otahuhu in the south.

c I was Jacobs' Technical Leader for the Wellington Water Flood Modelling Panel and have been responsible for directing the development of flood risk

assessments for the Island Bay catchment, the Tawa Catchment, the Titahi Bay catchment, the Wilton catchment, and the Aotea catchment. I was also a peer reviewer for the updated hydrological specification for the Wellington Water Flood Modelling Panel, which was developed by Cardno in 2016. I was also the technical lead for the Kapiti Coast District Council flood modelling and maintenance project.

d I directed the flood risk assessments and the assessment of effects for the Roads of National Significance projects at Warkworth to Wellsford, the Northern Corridor Improvements which are connecting the Northern Motorway in Auckland to State Highway 18, the Huntly Bypass and the Christchurch Northern Corridor. I was the expert on flood modelling in the Principal's Representative role for the Puhoi to Warkworth Road of National Significance. I lead the flood assessments for the catchments on the route of the Transmission Gully project at the bidding phase in 2013.

1.6 My evidence relates to a Notice of Requirement ('**NOR**') for Designation and associated resource consent applications for the construction, operation and maintenance of the structural flood mitigation works identified as the Pinehaven Stream Improvements Project ('**the Project**'). Wellington Water Limited ('**WWL**') has lodged the resource consent applications and NOR on behalf of Upper Hutt City Council ('**UHCC**').

1.7 I am familiar with the area that the Project covers, and have been involved with the Project as a Principal Modeller (initially while at Jacobs) since September 2015.

2 Code of conduct

2.1 While these applications are not before the Environment Court, I have read and am familiar with the Code of Conduct for Expert Witnesses in the current Environment Court Practice Note (2014). I have complied with the Code in the preparation of this evidence, and will follow it when presenting evidence at the hearing.

2.2 The data, information, facts and assumptions I have considered in forming my opinions are set out in my evidence to follow. The reasons for the opinions expressed are also set out in my evidence to follow.

2.3 Unless I state otherwise, my evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

3 Scope of evidence

3.1 My evidence addresses the following matters:

a Flood model design and inputs;

b History of the model;

c Allowance for the effects of climate change;

d Assumptions used for the modelling;

e Application of the model to the Project;

f Results of the modelling;

g Responses to issues in submissions;

h Responses to section 42A reports;

i Evidence from other witnesses.

4 Executive summary

4.1 The flood modelling for the Project has two main parts – a hydrological model and a hydraulic model. The flood modelling provides information about flood water levels, depths, flow rates, and extent. It is particularly useful for comparing two scenarios to see which is better (e.g. the “with works” and “without works” scenarios), but can also be used to predict absolute flood levels and extents. The Project model is an updated version of the model which was used for the Pinehaven Stream Flood Management Planning process. It has been calibrated and validated, and is fit for purpose.

4.2 The use of flood modelling for the Project is primarily as a comparative tool. The effects of the proposed design were assessed using the 4% AEP flood event and the 1% AEP flood event for the "without works" scenario and the "with works" scenario, both with a 20% allowance for climate change and a 20% allowance for blockage at the Sunbrae Drive culvert and the Pinehaven Road culvert. The 20% allowance for blockage was implemented at the request of GWRC. The use of a blockage factor makes the model more conservative.

4.3 The modelling shows that:

a For the 4% AEP flood event, the proposed design will contain the flood within the main stream channel throughout the Project reach except for the section between and including 48 Blue Mountains Road and 2A Freemans Way. In the areas where the flooding is not contained the effects are no more than minor.

b For the 1% AEP flood event:

i The Project will reduce the flood extent, so that the number of habitable buildings within the floodplain will decrease from 75 to 22, and the number of non-habitable buildings within the floodplain will decrease from 37 to 12.

ii The Project will increase flood levels at four habitable buildings, but in all cases the peak flood level will be at least 0.30m below the floor level, so that none of these buildings would be flooded in either the "without works" or "with works" scenarios.

c The Project will integrate overland flowpaths into the wider stormwater network.

4.4 In summary, the Project will have extensive flood avoidance or mitigation benefits for many houses and streets in Pinehaven. The Project is predicted to increase flood levels at four properties in a 1% AEP flood event, but I consider this increase to be minor, given the floor levels of the buildings, location and extent of the increases, and that the increases will be no more than 0.06m.

4.5 The Save Our Hills submission provides extensive material relating to the hydrological modelling for the catchment. None of the information in this material has caused me to change my view of the Project's effects.

4.6 I have read the flood modelling sections of the Section 42A Reports for UHCC and GWRC, and have also read the evidence of Mr Law. I agree with all material aspects of these reports. I have suggested changes to condition 10 suggested in the report for GWRC.

5 Model Design and Inputs

5.1 The flood modelling provides information about flooding within the catchment, including water levels, flood depths, flow rates and velocities, and the extent (or area) of land that is flooded.

5.2 The flood modelling for the Pinehaven catchments has two main parts; a hydrological model and a hydraulic model. The hydrological model represents the rainfall on the catchment and describes how rainfall is converted to runoff before it enters the pipes and streams of the stormwater system. The hydraulic model represents the stormwater system, including the major pipes, culverts, the stream channel and the floodplain.

5.3 The inputs to the model include information on rainfall, catchment characteristics, stream and pipe network characteristics, a digital elevation model of the terrain, records of rainfall, stream flowrates, stream levels and observations of flood extents. Modelling was undertaken in industry standard software packages that use accepted mathematical formulae and techniques to replicate the physical processes.

6 History of the model

6.1 An earlier version of the model was used to provide absolute values for flooding in the 1% Annual Exceedance Probability ('**AEP**') and 4% AEP flood events, as part of the Flood Management Planning ('**FMP**') which was completed in 2016. WWL provided the model used for the FMP and I assessed whether it was suitable for use to support this Project. I determined that it is generally fit for purpose because:

a The modelling had been undertaken by reputable engineering firms using skilled and experienced local staff, and the reporting of their findings was issued after passing their internal quality processes.

b The methods used and processes followed are regularly implemented on similar projects around New Zealand.

c The model had been calibrated to an observed flood event. This means the model parameters had been adjusted to achieve a good fit of the model outputs to an observed flood event, and shows that the model accurately represents the physical processes within the catchment.

d The model had been validated against independent methods for estimating peak flood flows. Validating is the process of comparing model outputs to independent data sets and checking how similar the results are. The validation showed the calibrated model produces peak flowrates that are similar to outputs from the independent methods.

e The modelled flood extents had been validated to the flood extents observed during the 1976 flood event, which is one of the largest flood events in the recent history of the Pinehaven catchment. This validation showed that when the 1976 event was run through the model the model produces similar flood extents to those that were observed.

f The model was reviewed by two independent parties and found by them to be fit for purpose.

6.2 I found that the hydraulic model used in the FMP should be updated with new and more detailed information on the stream channel and floodplain topography. The updates to the stream channel used topographical survey data collected in 2015 to improve the accuracy of the representation of the stream channel. The updated floodplain topography used Light Detection and Ranging (LiDAR) data collected in 2013 to improve the resolution of the floodplain from a 5x5m grid to a 2x2m grid, which is approximately six times more fine-grained.

6.3 Further surveying of the main stream channel was undertaken to support the project in 2019, and the survey information was added to the model.

6.4 To assess the impact of the updates I compared the outputs for the "without works" scenarios from the updated hydraulic model to the outputs reported in the FMP. I found that the differences were a direct result of providing more detailed information and they were not significant. The modelling is at least as accurate as the modelling undertaken for the FMP.

7 Allowance for the effects of climate change

7.1 The hydrological model included an allowance for the effects of climate change on rainfall as a 16% increase to the rainfall depth, distributed evenly across the rainfall event (based on Ministry for the Environment ('**MfE**') guidelines from 2008). Updated guidelines issued by the MfE in 2018 were used to determine that the appropriate allowance for the effect of climate change on rainfall is 20% to 2120.

7.2 Jacobs assessed the hydrographs provided by WWL and determined that the change from a 16% increase to a 20% increase in rainfall depths due to climate change could be represented by scaling up the hydrographs, and that re-running the hydrological model was not required .

7.3 Jacobs scaled the hydrographs up by a factor of 1.034483 to accommodate the new guidelines from MfE. Accordingly, the flood extents presented in my

evidence include a 20% allowance for the effect of climate change on rainfall at 2120 consistent with the MfE guidelines.

7.4 The hydraulic model does not include an allowance for the effects of climate change because there are no effects of climate change that need to be allowed for directly in the hydraulic model.

8 Assumptions used for the modelling

8.1 The model relies on assumptions from a variety of sources, including assumptions associated with the software used to build and run the model, assumptions associated with the input data used to build the model, assumptions associated with the hydrological model and the original hydraulic model (developed by SKM and provided to Jacobs by WWL), and assumptions that were made as part of the scope of work of this Project.

Hydraulic model

8.2 Assumptions associated with the software used to build and run the original hydraulic model are documented in the manuals published with the software. I comment further on the robustness of the original hydraulic model in the next section below.

8.3 Assumptions associated with the hydraulic model are documented in the FMP. The hydraulic model was validated by SKM. The validation showed that the hydraulic model is capable of producing a good match of modelled maximum flood extents to the observed flood extents in the 1976 event. Jacobs was able to confidently proceed on the basis that the hydraulic model produces accurate estimates of flood extents in the area affected by the proposed works because SKM showed that the hydraulic model is validated. Accordingly, the upgrades to the hydraulic model described above should be seen as refinements to include better inputs, rather than necessary to address any fundamental flaw in the model itself.

Input data

8.4 It was also necessary to make some assumptions associated with the input data related to its fitness for purpose for use with the hydraulic model. The key assumptions include:

a The topographical survey data are suitable to accurately represent the features of the main channel in the hydraulic model

b The LiDAR data are suitable to accurately represent the ground surface in the floodplain area in the hydraulic model.

c The increased allowance for the effect of climate change on rainfall, from 16% to 20%, can be accurately represented by scaling up the flow rates. The hydrological model was not run with the increased rainfall depths.

d The approach to schematising the hydraulic components in the design scenarios is based on and is as close as reasonably possible to the approach used in the hydraulic model. The main model components affected by this assumption are the roughness of the channel and the losses at the inlet and outlet of culverts.

e Changes to flooding in areas that were expected to be unaffected by the proposed works (generally those areas above/south of Pinehaven Reserve/Fendalton Crescent and below/north of Dowling Grove) were assumed to be insignificant. Checks of model outputs showed that the assumption is valid.

Hydrological model

8.5 The hydrological model is based on correlations between rainfall and stormwater generation, which have been calibrated and validated. The model makes use of information about soil infiltration and the percentage of impervious surface/development in the catchment to provide initial values for the model calibration. This information is also often used to guide the calibration by keeping the calibrated values within reasonable limits and preventing 'force-fitting' of the model. The hydrological model simply predicts that in particular rainfall events, a certain percentage of that rainfall ends up as stormwater in Pinehaven Stream. The model does not indicate why that is the case, or where the rest of the rainfall goes.

8.6 The hydrological model was calibrated by MWH. Calibrating a model is an effective method of demonstrating that assumptions are correct. Jacobs assumed that the hydrological model produces accurate estimates of runoff from the subcatchments of the Pinehaven Catchment for the 4% AEP flood event and the 1% AEP flood event because MWH showed that the hydrological model is calibrated.

8.7 While the modelling has been calibrated and validated using past events, in my view it is a good tool for predicting future events because:

a The allowance for climate change provides for the possibility that rainfall will increase as a result of climate change; and

b I understand that the District Plan restricts new buildings in the Pinehaven catchment, so that any large scale new development (which could lead to increased stormwater generation) would need a resource consent. This would allow the effects of increased stormwater generation to be assessed at that time.

Steps taken to verify robustness of previous work

8.8 I assessed the information provided to Jacobs and determined:

a The respective software used to build and run the hydrological model and the hydraulic model were suitable for use on the Project.

b By calibrating the hydrological model to observed data from within the catchment, MWH have shown that the hydrological model is capable of accurately representing the process of converting rainfall to runoff in the Pinehaven catchment.

c By validating the calibrated model results to alternative peak flow estimation techniques, MWH have shown that the hydrological model would produce similar outputs if a different hydrological method was used.

d By validating the calibrated model results from a run of the 1976 flood event to observations of flood extents during that event, SKM have demonstrated that the calibrated model is capable of accurately representing the flood extents.

e The method for including an allowance for the effect of climate change on rainfall was consistent with current practice in NZ at the time Jacobs received the model, and had been implemented consistently with the way it was reported by MWH.

f The topographical survey data was generally consistent with the data in the hydraulic model and was suitable for updating the 1-dimensional components of the hydraulic model with newer and more accurate data.

g The LiDAR data was generally consistent with the data in the hydraulic model and was suitable for updating the 2-dimensional components of the hydraulic model with newer data with an increased level of detail / resolution.

h An independent peer review of the modelling undertaken for the FMP was undertaken. I consider that this is consistent with good practice. The findings of the peer review are documented in the evidence of Mr Law. They show that the modelling for the FMP and the modelling undertaken to support this Project are fit for purpose, and the issues identified do not compromise the fitness for purpose of the model.

9 Application of the model to the Project

9.1 The use of flood modelling for the Project is primarily as a comparative tool. The effects of the proposed design were assessed using the 4% AEP flood event and the 1% AEP flood event for the "without works" scenario and the "with works" scenario, both with a 20% allowance for climate change and a 20% allowance for blockage at the Sunbrae Drive culvert and the Pinehaven Road culvert. The 20% allowance for blockage was implemented at the request of GWRC. The use of a blockage factor makes the model more conservative.

9.2 I created a hydraulic model of the existing "without works" stream network and used this to establish the base level of effects. I then updated with the hydraulic model with the proposed design to create a "with works" stream network and used it to identify the effects of the works. The proposed works do not affect the hydrological model, so the inflows from the catchments are the same for the "without works" and "with works" scenarios.

9.3 The design evolved, as described in **Mr Eric Skowron's** evidence. At key points throughout the design process, the proposed design was updated in the hydraulic model and the hydraulic model was re-run (otherwise using the inputs and assumptions and allowances describe above).

9.4 The design process was iterative. The model was used to support the design process by providing information on the effects of changes to the design on the flood extents and by identifying where changes to the design would help to meet the Project objectives.

9.5 The extent of the works is described in the evidence presented by **Mr Eric Skowron**. The performance standards for the design are captured in the project objectives for the Project, which are set out in evidence presented by **Mr Ben Fountain**.

10 Results of the modelling

10.1 The modelling shows (in all cases with a 20% allowance for climate change, as well as allowances for blockage and culvert roughness):

a The existing or baseline situation is that the Pinehaven Stream is not contained within the main channel in the 4% AEP flood and spills from the channel enter private properties on both sides of the channel. In the reaches where channel works are proposed there are 75 habitable floors within the flood extents in the 1% AEP event.

b For the 4% AEP flood event, the proposed design will contain the flood within the main stream channel throughout the Project reach except for the section between and including 48 Blue Mountains Road and 2A Freemans Way. In the areas where the flooding is not contained the effects are no more than minor. The property at 48 Blue Mountains Road has been acquired, and the buildings will be demolished as part of this Project. At 50 Blue Mountains Road and 2A Freemans Way, flood water levels will be higher than the baseline by an average of 0.02m (and remain below the levels of buildings on these properties). Containing the flood waters to the main channel in the 4% AEP event provides significant benefits to public safety because it reduces the exposure of people to fast and deep floodwater (i.e. flood extent is reduced).

c For the 1% AEP flood event, the number of habitable floors within the floodplain will decrease by 53, from 75 to 22, and the number of non-habitable floors within the floodplain will decrease by 25, from 37 to 12. This shows the Project will have significant benefits.

d For the 1% AEP flood event there are four habitable floors that will experience increased flood levels (in addition to 48 Blue Mountains Road, which has been acquired). These properties are 54 Whitemans Road, 56 Whitemans Road, 9 Birch Grove, and 7 Pinehaven Road. For all four habitable floors the size of the increase is less than 0.06m and the peak flood level remains at least 0.30m below floor level, so none of these floors is flooded in either the “without works” scenario or the “with works” scenario. This shows the adverse effects of the Project on flooding have a limited extent and are no more than minor.

e The proposed works integrate overland flowpaths into the wider stormwater network by:

i Eliminating spills from the main stream channel at Sunbrae Drive and Birch Grove;

ii Reducing the flowrate and frequency of operation of the existing overland flowpath in Wyndham Road; and

iii Reshaping the ground to contain the overland flowpath in Clinker Grove.

11 Responses to issues raised in submissions

11.1 I have reviewed the submissions lodged in relation to the resource consent applications for the Project. Where I am able to respond to the matters raised, I do this below.

11.2 Most of the submissions were supportive of the consent application. Of those in opposition, the submission of Save Our Hills most comprehensively raises matters relating to modelling. I have therefore focused on the issues raised in the submission from Save Our Hills and, in responding to this submission, I will also have addressed flood modelling issues raised by other submissions.

11.3 Save Our Hills have submitted that the hydrological model (built by MWH) over-estimates runoff. Their submission includes:

a An assessment of the flood event of 8 December 2019;

b Reports on infiltration testing; and

c Reports on hydrological modelling that they have undertaken, which include discussion of the hydrological modelling that Jacobs used in the hydraulic modelling of the existing scenario and the modelling of the proposed design.

11.4 Save Our Hills identify that the storm that occurred on 8 December 2019 was a 1 in 30-year ARI rainfall event. I undertook an independent assessment of the rainfall on 9 December 2019 and I agree that the storm of 8 December 2019 was a 1 in 30-year ARI rainfall event. However, I also make the following comments:

a Save Our Hills provided photographs of the flooding they observed on the morning of 8 December 2019. Times provided with the photographs indicate that the general direction of the observers through the catchment as they took photos in different locations was upstream. Save Our Hills used their observations to produce a flood map. The methodology used to convert the observations to flood extents is not detailed in their submission.

b Due to the nature of flooding in the Pinehaven catchment, which tends to have a relatively short and sharp duration due to the steepness of the terrain, and the observers travelling in the opposite direction to the flood, it is likely that most of the observations and photographs do not show the peak of the flooding.

c The Save Our Hills observers have had limited access to private property. Most of the flooding that is to be eliminated by the proposed works occurs on private property, and so is not shown in the maps prepared by Save Our Hills. By not showing flooding that was not observed but could reasonably be inferred to have occurred the maps presented by Save Our Hills underestimate the real extent of flooding. This can be contrasted with the flood extent maps sourced from the model outputs developed by Jacobs, which show flooding wherever it is predicted to occur and therefore can reasonably be expected to show greater flood extents than maps of observed flooding and are therefore more accurate.

d An example of this can be seen in figures on page 17 of the Save Our Hills report on the December 2019 flood event. The location is Deller Grove, and the figure shows two distinct sources of flooding at this location. The clear flood waters have come from the roofs and sealed surfaces such as driveways and patios of nearby properties and from the road carriageway. The muddy flood waters are from the upper catchment, upstream of Pinehaven Road, and have spilled from the main stream channel through the back of properties on the eastern side of Deller Grove and onto the road. The flood maps presented by Save Our Hills do not show this second source of flooding, and therefore under-estimate the flood extents in this area.

e The map of the 10-year ARI flood extents from the Flood Management Plan shows that most of the flooded area has maximum flood depths between 2mm and 150mm. It is not clear whether Save Our Hills used a minimum value to map their observed flood extents, and if a minimum value was used it is not stated what that value was. My interpretation of the map presented by Save Our Hills is that only flooding that is nuisance depth (or greater than approximately 50mm) is shown on their map. By excluding the flooding that is less than nuisance depth from their map, Save Our Hills have not provided a true comparison to the 1 in 10-year map from the FMP

f Overall, I consider that the comparison presented by Save Our Hills consistently under-estimates the actual extent of flooding on 8 December

2019, when compared to the 1 in 10-year ARI flood event floodplain extents because they:

i did not observe the full extent of the flooding;

ii did not observe the peak of the flood;

iii only mapped what they observed; and

iv used a higher depth threshold for mapping flooding than was applied to the map they compare to.

11.5 With respect to the hydrological model prepared by Mr Robert Hall for Save Our Hills:

a The method used by Mr Hall is based on the regional hydrological modelling method, which was introduced in 2016. This contrasts with the method used for the Project modelling, which is a local method. A key difference between regional methods and local methods is that regional methods are applicable to a wider area and allow comparison between catchments, whereas local methods are specific to a particular catchment and provide a more accurate assessment of the performance of the catchment. Regional methods usually allow for local methods to be used where data are available to support them, and the specification that Robert Hall relies on allows this in Wellington Water's Reference Guide for Design Storm Hydrology.

b Robert Hall has not attempted to calibrate his model. This contrasts with the model used to inform the design, which has been calibrated.[1]

c There are important differences between the regional hydrological method relied upon by Robert Hall and the local hydrological method used for the Project. These differences are not acknowledged in the submission from Save Our Hills, and Robert Hall treats the input parameters as being the same, despite these differences. This makes the findings of the report misleading.

d Save Our Hills discuss proposed development of the upper catchment (upstream of the Project extent) extensively. This development is not the subject of any consent application and it is not considered in my evidence. Nevertheless, Save Our Hills have used modelling of the development of the

[1] As described above at paragraph 8.8.

upper catchment as a basis for their submission that the hydrological modelling is not correct.

e The review of Robert Hall's work by Mr Macky is limited to assessing the parameter values input into Robert Hall's model; it does not consider whether the use of the regional method is appropriate when a local method can be used. Due to the limited scope of Mr Macky's review I believe his review adds little to the work presented by Mr Hall.

12 Response to section 42A reports

Recommended conditions

12.1 I have considered the conditions proposed by GWRC and UHCC that relate to the modelling.

12.2 In my view condition 39 proposed by UHCC is reasonable and I do not have any suggested changes.

12.3 I suggest that condition 10 proposed by GWRC be amended so that it reads as follows. The purpose of the amendments is to allow for a design which achieves improved flood management, and to provide for the design to be compared against the application design information (together with further information provided post-application). This removes the need for judgement about whether the Project objectives are being achieved:

"The consent holder shall submit a final Detailed Hydraulic Design Memorandum (DHDM) to the Manager, at least 20 working days prior to ~~works commencing~~commencement of construction. The purpose of the DHDM is to confirm compliance ~~and consistency~~ with or improvement on the information provided in the application.

The DHDM shall be prepared by a suitably qualified and experienced hydrologist or hydraulic modelling specialist, and shall confirm that the ~~25-year and 100-year return period flood event level project objectives~~ peak flood water levels for the 4% Annual Exceedance Probability flood event and the 1% Annual Exceedance Probability flood event as specified in the information provided in the application are achieved in the final design.

The consent holder shall not commence ~~works~~ construction until the DHDM has been confirmed in writing by the Manager as complying with this condition"

Issues raised in the Section 42A Reports

12.4 I am generally supportive of the sections on flood modelling in the Officer's Report from UHCC. I note that in section 10.22:

a The reference to climate change in the first bullet point should be "16%" rather than "15%".

b An additional bullet point "Including an allowance for culvert blockage" should be added.

12.5 In the table in section 10.25 of the UHCC Officer's Report, for 7 Pinehaven Road and 9 Birch Grove it should be noted that:

a There is an overall decrease in the flooded area on the properties for both the 4% AEP flood event and the 1% AEP flood event; and

b There is an increase in peak flood level on a small of the area of residual flooding for the 4% AEP event and the 1% AEP event.

12.6 I am generally supportive of the sections on flood modelling in the Officer's Report from GWRC. My comments are confined to the points below.

12.7 The event of 8 December 2019, which is discussed in section 10.1.2 (f) of the Officer's Report, may have provided additional information to validate the model. However the model is already validated and the absence of further validation at this stage of the Project is not a flaw. My overall conclusions would be the same if the event had not occurred.

12.8 The Officer's Report includes the following statement from Mr Law about the event of 8 December 2019: "*Mr Law agreed that the hydrological inputs to the model did not need to be revisited solely for this project, noting that 'the key purpose of modelling is to demonstrate the relative effects (and betterment) of the streamworks over the existing condition', while bearing in mind his comments about the 8 December 2019 storm event being an opportunity to collect data for further model calibration.*" I agree with this statement, though I think it would be improved if the words "…or validation" were added at the end of the last sentence to allow the information to be used for either calibration or validation.

12.9 In section 10.1.2 (g) of the GWRC Officer's Report Mr Law is quoted as saying:

a "*Representing the hydraulic effects of bridges and other obstructions in the channel using an increased roughness coefficient is a reasonable approach*

for catchment scale models, and especially for smaller water courses and where survey is prohibitive .... A combination of these issues in the Pinehaven catchment meant that the approach was, and generally still is, appropriate for the catchment flood model.". I agree with this statement.

b "[*the] downside of this approach is that it is harder to model the effects of adding, removing or changing individual structures along the channel*"". I agree with this statement in principle.

c "*Mr Law stated he would expect the Jacobs modeller to quantify the effects of changing the crossings (possibly by incorporating the bridges and bank works at 54 and 56 Whitemans Road in the model re-run or by providing hand calculations for the individual crossings) for the pre-hearing discussions, expert conferencing and hearing so as to provide confidence in their response. Mr Law confirmed that while both methods are acceptable, if hand calculations are used then Jacobs would need to transpose those effects to the surrounding properties..*". I do not agree that quantifying the effects of changing the crossings is necessary. The approach used provides a conservative estimate of flood levels and the design either does not modify the crossings or improves them by raising them or removing. This approach means the flooding is either unchanged or reduced in the adjacent areas, albeit by an amount that is likely to be insignificant and limited to the immediate area. When the effort required to complete hand calculations or revise the model is compared to the effect on flooding, it is clear that there is no benefit to the extra works required.

12.10 I agree with the description of the flood hazard effects in section 10.1.3 of the GWRC Officer's Report.

12.11 I note that section 10.1.4 of the GWRC's Officer's Report states that further information on flood effects during the 1% AEP flood event for properties at 54 Whitemans Road and 56 Whitemans Road (which is also 15 Clinker Grove) is still to be provided. I have assessed the effects at the two main dwellings by identifying the affected corner of each building, estimating the floor height and comparing it to the relevant flood depth from the model. I found that for both buildings the floor is at least 0.30m above peak flood level in the 1% AEP flood event for both the "without works" and "with works" scenarios, so neither floor is flooded.

13 Evidence from other witnesses

13.1 I have read the evidence prepared by Mr Law, and I am generally supportive of it. I am supportive of Mr Law's overall conclusion that the modelling is fit for purpose.

13.2 In section 43.17 of his evidence Mr Law refers to the comparison of the outputs of the 1 in 10-year flood event to the flood event of 8 December 2019. I have previously noted in my evidence that an assessment of the flood event of 8 December 2019 is not necessary to support the modelling for the Project, and that my conclusions are unlikely to be different if such an assessment was undertaken.

14 Conclusions

14.1 The model used to predict the effects of this Project is fit for purpose.

14.2 The model shows that the Project will have significant benefits for many properties in the catchment. Four properties are predicted to have increased flood levels in a 1% AEP flood event as a result of the Project, but the effects of these increases will be minor.

Peter Frederick Kinley

20 July 2020