IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of a submission in respect of the **PROPOSED WAIKATO DISTRICT PLAN** by **AMBURY PROPERTIES LIMITED** pursuant to Clause 6 of Schedule 1 of the Act seeking the rezoning of land at Ohinewai

STATEMENT OF EVIDENCE OF AJAY DESAI

1. INTRODUCTION

1.1 My full name is Ajay Desai. I am a Senior Technical Specialist – Three Waters at Wood and Partners Consultants Limited ("Woods").

Qualifications and experience

1.2 I hold a Bachelor of Civil Engineering (2011) and Master of Civil Engineering Degree (2014), specialising in Water Resources and Environmental Engineering, from the University of Pune, India. I am currently a member of Engineering New Zealand (MEngNZ), Chartered Institution of Water and Environmental Management (MCIWEM) and Institution of Civil Engineers (GMICE).

1.1 I have extensive stormwater, wastewater and water network modelling experience which includes projects in the United Kingdom, Middle East and more recently in New Zealand. I have a wide range of modelling and spatial analytical skills which include 3-water hydraulic modelling using a variety of software packages, model build and verification, irrigation modelling and master planning, flood risk assessment, GIS, options assessments, solution designing, and SuDS (water sensitive design) optioneering.

1.2 I have been the principal author and lead stormwater engineer for a wide range of flood modelling reports to support private land development, urban design and planning frameworks. I have been involved in and prepared numerous catchment scale flood models, detailed stormwater pipe models

and integrated catchment management plans for private clients as well as for district and regional councils.

1.3 Examples of project experience relevant to my evidence include:

(a) Lead stormwater engineer completing the Stormwater Modelling flood analysis and numerous stormwater runoff and overland flow path assessments for:

(i) Drury South Precinct Development – 361ha; and

(ii) Drury East Development – 231ha.

(b) One of the Lead Technical Reviewers for Auckland Council's Healthy Waters team, providing technical assistance and reviews of Flood Plains and Stormwater Models built using variety of modelling packages including InfoWorks and Mike by DHI. some of the reviews are –

(i) Cockle Bay (DHI – 3way coupled model);

(ii) Puhinui (DHI– 3way coupled model);

(iii) Mahurangi (InfoWorks ICM);

(iv) Oira Ngakoroa (InfoWorks ICM);

(v) Papatoetoe Tamaki (DHI– 3way coupled model);

(vi) Motions Central Rail Link (CRL) Modelling; and

(vii) Auckland region LiDAR 2016 Quality Assessment.

Involvement in project

1.4 Woods was engaged by Ambury Properties Limited ("APL") to complete a flood assessment of the Sleepyhead Estate site at at 52-56 Lumsden Road, 88 Lumsden Road and 231 Tahuna Road, Ohinewai ("Site") and wider catchment in order to inform the proposed Ohinewai Structure Plan Area ("OSPA") and Sleepyhead Estate Masterplan ("Masterplan").

1.5 I am the author of the Sleepyhead Estate Flood Assessment Report dated 21 November 2019 (V3) ("Flood Assessment Report") which was attached as Appendix F to the Assessment of Environmental Effects and Section 32AA Evalutation provided to the Hearings Panel on 6 December 2019**.**

1.6 My flood modelling work on this project has involved working collaboratively with Waikato Regional Council ("WRC**"**) technical representatives to discuss and agree on the key assumptions and decisions required. It has also involved consultation with the Tangata Whenua Working Group ("TWGG") and other stakeholders.

Purpose and scope of evidence

1.7 The purpose of my evidence is to provide an overview of the flood modelling and analysis undertaken to support the proposed Sleepyhead Estate development.

1.8 Specifically, my evidence will address the following:

(a) A description of the catchment (Section 3);

(b) A description of the proposed Sleepyhead Estate development (Section 4);

(c) An overview of the flood modelling methodology (Section 5);

(d) An overview of the model build process and key parameters (Section 6);

(e) A summary of the results of the flood modelling exercise (Section 7);

(f) A summary of the results of the stop bank breach scenario modelling (Section 8);

(g) Comments on the s 42A Report and expert conferencing (Section 9);

(h) A brief conclusion (Section 10).

1.9 A summary of my evidence is contained in Section 2.

1.10 My evidence should be read together with the evidence of:

(a) Mr Pranil Wadan, stormwater management.

(b) Mr John Olliver and Mr Stuart Penfold, planning.

Expert Witness Code of Conduct

1.11 I have read the Code of Conduct for Expert Witnesses, contained in the Environment Court Consolidated Practice Note (2014) and I agree to comply with it. I can confirm that the issues addressed in this statement are within

my area of expertise and that in preparing my evidence I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

2. SUMMARY OF MY EVIDENCE

The Site and its catchment

2.1 The Sleepyhead Estate is a mixed-use development comprising industrial, commercial and residential zones. The total area of the Site is approximately 178ha. To achieve appropriate finished floor levels, the importation of 2,000,000m^3 of fill to the Site is proposed (as set out in the evidence of Ben Pain) with approximately 400,000m3 of flood storage lost below the spillway level of Lake Waikare.

2.2 The Site is within the Lake Waikare catchment and affected by the Lower Waikato-Waipa Flood Control Scheme ("LWWFCS").

2.3 The Site is separated from the Waikato River by State Highway 1, the North Island Main Trunk Railway and Ohinewai North Road and Ohinewai South Road. There is very little or no interaction between the Waikato River and the Site as reflected in the Lower Waikato Zone Management Plan.

2.4 The Site drains to Lake Rotokawau which flows into Lake Waikare. Lake Waikare has a total contributing area of 20,800ha. The LWWFCS provides for flows from Lake Waikare to be discharged to Whangamarino Wetland via the Waikare Control Gate in a controlled manner.

2.5 The operational level for Lake Waikare is between 5.40 – 5.75mRL. The proposed Sleepyhead Estate involves fill in the development area to raise the development platforms above the flood levels observed within the Lake for various storm events.

Flood Modelling

2.6 Flood modelling was undertaken to understand the flood hazard associated with the development of the Site. This was undertaken in close collaboration with WRC.

2.7 At the outset, it was agreed with WRC that the existing WRC Waikato River model was not sufficiently reliable to provide a basis for analysis. Instead, a local model was developed using Mike by DHI. This is the same programme that WRC has used for the Waikato River Model which is currently being prepared by WRC.

2.8 The modelling process followed best modelling practices and guidelines, in particular the WRC Stormwater Runoff Modelling Guideline (TR2018/02) and Auckland Council's Technical Publication 108 (TP108).

2.9 The model extent was based on the areas contributing to Balemi and Tahuna drains which discharge to Lake Rotokawau and Lake Waikare.

Modelled Scenarios

2.10 A number of models were developed to assess the effects for the pre and post development scenarios with conservative water levels applied to Lake Waikare. All these models were tested with rainfall uplift to account for climate change.

2.11 In accordance with WRC's direction, a conservative water level of 8.0mRL was used which is the crest level for northern foreshore stop bank (approximately 0.6m above the spillway design level of 7.37mRL) for Lake Waikare. Additional modelling was undertaken with a water level of 5.4mRL which is the minimum operating level for the Lake to test flood effects for every day, i.e. non-severe storms.

2.12 An Emergency Management Plan Assessment ("EMPA") was completed to understand flood risk to the OSPA associated with stop bank breach along River Waikato. Subsequently, additional modelling analysis has been undertaken with refinements in and around the Site to capture the topographical features like roads, the railway line, depressions and overland flow paths

2.13 A blockage assessment was undertaken to understand the risk associated with blockage of Lumsden Road and Tahuna Road culverts that discharge through the Site and will be culverted through the Site (as directed by WRC).

2.14 Sensitivity analysis was undertaken for the 10year post development scenario to assess whether there is an increased flood risk to the development or downstream environment with any loss of storage associated with the proposed stormwater devices within the Central Park Area.

Flood Modelling Results

2.15 Modelling indicated that the development of the Site would result in a negligible increase in water levels or flood extents within the Site or any of the neighbouring lots. This is because the total Site area of 178ha, or 1.79sq.km, is insignificant when compared to the downstream floodplain

extents (34.66sq.km) and the total of the total contributing area to Lake Waikare (208sq.km).

2.16 The initial modelling (reported in the Flood Assessment Report) showed some ponding around Lumsden Road, but this was caused by the model representation in this area which does not include the existing culvert under the road. This results in 'no flows' through the culvert and flows backing upstream with no downstream conveyance. Subsequent modelling included the Lumsden Road culvert. This showed some local increased flood levels which can easily be managed at the detailed design stage: a new culvert at this location will be necessary to direct flows towards the Central Park Area to maintain the predevelopment flood levels.

2.17 Flooding is observed within the Site itself but limited to the low-lying Wetland Park Area adjoining Lake Rotokawau in pre and post development scenarios. There is no flooding observed in areas within the Site where development (buildings and roads) is proposed, as the proposed design involves fill within these areas to provide for the future development form.

2.18 The additional storage volume analysis undertaken to assess whether there is any increased flood risk arising from the loss of flood storage for Lake Waikare associated with the proposed importation of fill showed that the loss of storage would be:

(a) Less than 0.06% of the available storage capacity at a Lake level of 6.3mRL (maximum level observed at the Lake);

(b) Approximately 0.29% at a Lake level of 7.37mRL which is the design spillway level; and

(c) Approximately 0.45% at a Lake level of 8.0mRL which is the maximum water level that the Lake can ever achieve before the northern stop bank overtops.

Stormwater Management Approach

2.19 The general approach for the Site is to pass flows forward before the flows from the upstream catchment discharge to Lake Waikare. Holding flows from the development within the Site for a longer duration could result in coinciding of peak of flows from the Site and upstream catchment area resulting in higher risk to the development as well as neighbouring properties. Modelling undertaken indicates that flows from the Site can be

passed forward into the receiving environment. i.e. Lake Waikare / Lake Rotokawau without impacting on predicted flood levels within the lakes.

Emergency Management Plan Assessment

2.20 The stop bank breach scenario model showed flooding along State Highway 1, the North Island Main Trunk Railway and all properties along Ohinewai North Road and Ohinewai South Road leading towards the Site. The initial modelling undertaken (reported in the Flood Assessment Report) showed that a portion of the Site (in the area zoned Industrial) would be subject to flooding.

2.21 Additional detailed modelling undertaken subsequently confirms that the stop bank breach flows are generally contained to the west of State Highway 1 and flows crossing the State Highway 1 do not enter the Site, and instead flow along the northern boundary eastwards towards Lake Waikare.

2.22 Based on the latest modelling results, the proposed development is not at risk from stop bank breach from the Waikato River.

Culvert Blockage assessment

2.23 An additional blockage scenarios assessment confirmed that there is no overtopping across Tahuna Road and Lumsden Road and there are no increased flood effects on the proposed development in the event that the culverts under these roads are completely blocked.

Sensitivity Model Scenario

2.24 Sensitivity analysis was undertaken for the 10year post development scenario to assess if there is an increased flood risk to the proposed development or downstream environment with loss of storage within the Central Park Area, with the proposed stormwater devices to be located here. Modelling assumed that there is no storage available for flood flows within the Central Park Area as a worst-case scenario to understand if there are any detrimental effects. The model results confirmed that there is no increased flood risk within the Site or to the neighbouring properties and that there is also no increase in flood extents or flood levels within Lake Waikare. This suggests that the stormwater devices located within the Central Park area would not have any effect on flood extents or levels.

3. EXISTING CATCHMENT

Site location and characteristics

3.1 The proposed Sleepyhead Estate development area encompasses 52-56 Lumsden Road, 88 Lumsden Road and 231 Tahuna Road, Ohinewai. The site is approximately 178ha in area.

3.2 The Site lies to the east of the Waikato Expressway and the Waikato River. The Site holds four farmsteads, one active milking shed and two old inactive milking sheds. The predominant land use is currently dairy farming.

3.3 Ground surface elevations vary between approximately RL20m on the southern boundary with Tahuna Road and RL6m at the far eastern end of the site as set out in the evidence of Mr Nick Speight.

3.4 There is very little interaction between the Waikato River and the Site for events up to 1% AEP. Farm drains and overland flow paths on the Site discharge to Lake Rotokawau and Lake Waikare, suggesting that there is a hydraulic separation from the Waikato River for small more frequent events.

3.5 There are two farm drains / open channels associated with the Lower Waikato Land Drainage Scheme ("LWLDS") in the vicinity of the property:

(a) Balemi Road drain and

(b) Tahuna Road drain.

3.6 Mr Pranil Wadan addresses these drains and the LWLDS at Section 3.22 to 3.26 of his evidence. By way of summary, tthe Balemi Road drain runs along the north-eastern boundary along Balemi Road and then runs north to discharge into Lake Waikare. The Tahuna Road drain is currently culverted under Tahuna Road. The drain conveys runoff from the upstream catchment including Lake Ohinewai to Lake Rotokawau.

Wider catchment

3.7 The Site is located in the Lake Waikare catchment, which has a total contributing area of approximately 20,800ha. The Site accounts for approximately 0.86% of the total catchment area.

3.8 The Lake Waikare Catchment is influenced by the LWWFCS and falls under the Lower Waikato Management Zone. It is a comprehensive river control scheme designed to provide flood protection within the floodplains of the

Lower Waikato and Waipa Rivers. It is managed by the Land Drainage Team at WRC.

3.9 The scheme comprises stop banks, pump stations, floodgates and river channel improvement work which commenced in 1961 and were completed in 1982. The assets related to Lake Waikare include Lake Waikare Control Gate, Te Onetea Control Gate, Rangiriri Spillway, Whangamarino Control Gate and Wool Scourers to Fosters Landing Stop Bank (along the Waikato River near Rangiriri Spillway).

3.10 There is one inlet into Lake Waikare from the Waikato River located at the Rangiriri Spillway. The Rangiriri Spillway conveys flows from the Waikato River into Lake Waikare when the River reaches 8.8mRL – i.e. in extreme events. The Rangiriri Spillway, in conjunction with stop banks along the segment of the Waikato River which adjoins the Site have been designed to effectively manage floodwaters from the River in a controlled way. This means that in an extreme event Waikato River flood waters would not reach the Site and would instead be discharged to Lake Waikere via the spillway.

3.11 Te Onetea Control Gate (located at Rangiriri Spillway) operates when the Waikato River level is above the level of Lake Waikare and above 7.0mRL. This indicates that there would be no interaction between Lake Waikare and the Waikato River above 7.0mRL.

3.12 A plan of the catchment and Lower Waikato Zone Management Plan assets are shown in Figure 1.

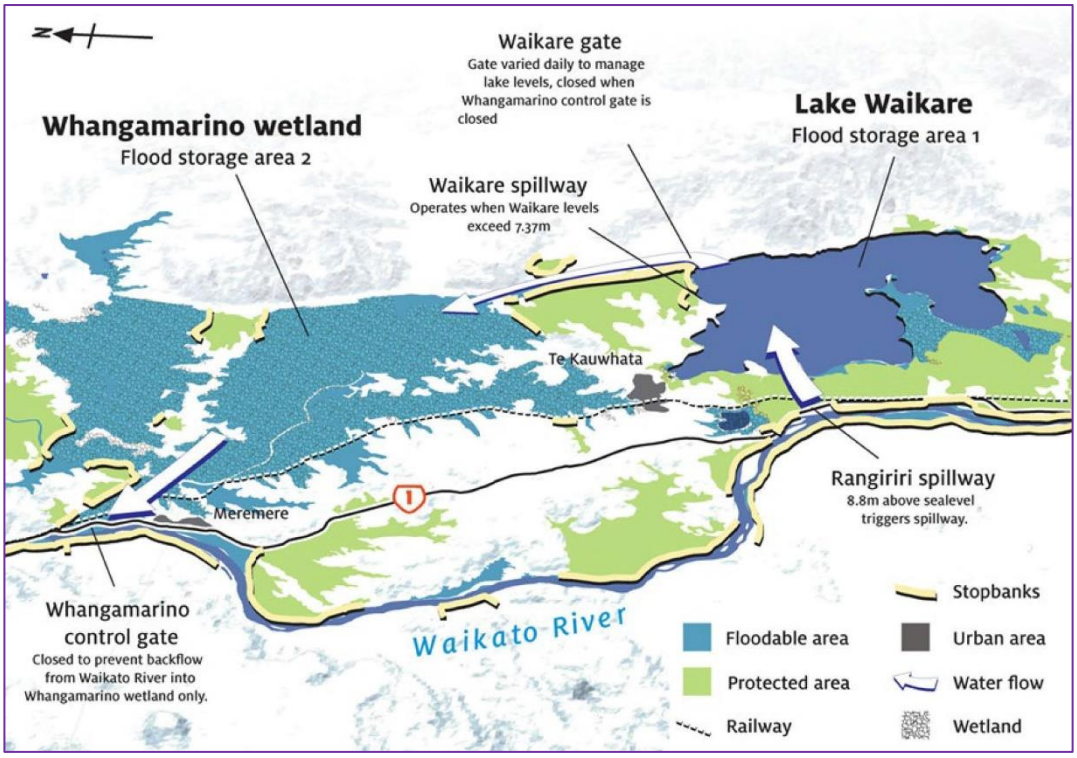

Figure 1: The Lower Waikato Waipa Flood Control Scheme

3.13 Lake Waikare acts as the first of two flood storage areas and receives flows in certain storm events as a result of a relatively complex system of flood control assets as described in the diagram of the Lake Waikare Community Gates Operation Procedures diagram attached as **Attachment A**.

3.14 To inform my flood assessment, WRC provided gate operation procedures for the assets related to Lake Waikare. The gate operation procedures specify operational water levels for each of these assets. If water levels increase by more than these levels, the gates are opened to pass water downstream.

3.15 The Waikare Spillway (which discharges water to Whangamarino Wetland) operates when the levels in Lake Waikare exceed 7.37mRL, the maximum water level that the Lake can achieve before the Waikare Spillway is operative would be ~8mRL. These figures have been confirmed by WRC Technical Reviewers and used in the model as boundary conditions for Lake Waikare.

4. PROPOSED DEVELOPMENT

4.1 The Masterplan provides for a mixed-use development form in the OSPA. The development includes industrial, business / commercial and residential land uses.

4.2 68ha of the Site is allocated to industrial use, including The Comfort Group's ("TCG") large manufacturing factory. Approximately 52ha of land is allocated for residential development.

4.3 Approximately 13ha of the Site is proposed for commercial development (per the proposed zoning). This area is intended to include a service station, convenience stores and a discount factory outlet.

4.4 Approximately 55ha of the development is allocated to open space that will include recreational facilities, ecological enhancement and stormwater management provisions.

4.5 To enable the proposed development and to account for the relatively low-lying nature of the existing landform, significant earthworks are required to provide for suitable levels above the 100year flood plain.

4.6 It is anticipated that development finished floor levels shall generally be located between RL8.5 to RL13.0 in order to minimise earthworks volumes while still providing overland flow from the Site.

4.7 The extent of the earthworks required are addressed in Section 4 of the evidence of Mr Ben Pain[1]. By way of summary, it is anticipated that approximately 500,000m^3 will be cut and 2,500,000m^3 will be filled, resulting in an approximate 2,000,000m^3 deficit in fill which will be imported to the Site.

4.8 The Stormwater Management Plan for the Site is addressed in detail in the evidence of Mr Pranil Wadan.

5. FLOOD MODELLING – OVERVIEW AND APPROACH

5.1 Flood modelling was undertaken to:

(a) Identify existing and proposed flood risk areas;

(b) Quantify whether there are any adverse flooding effects on properties upstream or downstream as a result of the proposed development in comparison to the pre-development / existing situation;

(c) Understand the extent of any risk associated with a stop bank breach scenario to inform future Emergency Management Plan provisions;

[1] Statement of Evidence of Ben Pain, Section 4.

(d) Understand any flood risk associated with blockage of upstream culverts under Tahuna Road and Lumsden Road; and

(e) Understand whether the loss of storage associated with stormwater devices in the Central Park Area has any increased flood risk to neighbouring properties or the downstream receiving environment.

Development of the flood hazard model

5.2 I worked closely with WRC in the development of the flood hazard model, including four face to face meetings in September and October 2019 and regular online meetings with the WRC technical team (Mark Pennington of Tonkin and Taylor and Rick Liefting of WRC) to discuss and agree on the key assumptions and decisions required. There has been agreement on all matters as the modelling exercise progressed. Minutes of the meetings are attached as Appendix C to the Flood Assessment Report.

5.3 The flood assessment has been formally reviewed by Tonkin and Taylor on behalf of WRC.[2] A copy of the review report was attached to the expert conferencing summary statement prepared by Ghassan Basheer on behalf of WRC, and is attached to this statement of evidence as **Attachment B**.

5.4 The peer review confirms that the work undertaken has resulted in a robust and satisfactory output.

5.5 WRC provided the following information to inform the modelling exercise:

(a) Waikato River Flood Hazard Model prepared by DHI.

(b) Survey information of Lake Waikare.

(c) LiDAR data in Digital Terrain Model ("DEM") format for the model extent.

(d) Stop bank with design crest levels.

(e) Channel drain locations (no survey data was provided, so an on-site survey was undertaken by Woods to be incorporated in the model and to support any future detailed design if needed.)

(f) Lake Ohinewai depth data.

[2] Ambury Development flood Assessment Review Report, Tonkin and Taylor to WRC dated 8th of June 2020.

5.6 As the Site discharges to Lake Rotokawau, which subsequently drains to Lake Waikare, any relevant data relating to Lake Rotokawau was requested from WRC. It was confirmed that there is no survey data available for Lake Rotokawau and that the two lakes are hydraulically interconnected. Based on this, modelling was undertaken using a boundary condition[3] to Lake Waikare based on the Northern Spillway level.

Constraints of the WRC supplied model

5.7 I initially considered using WRC's Waikato River Flood Hazard Model ("Waikato River Model") prepared by DHI to undertake the modelling exercise. This was provided as a draft by WRC. However, a high-level review of the model with WRC highlighted a number of significant issues in the model which would affect its performance in our area of interest around the Site. These issues were:

(a) The model produced a peak water level attained by Lake Waikare of approximately 8.5mRL, which is significantly higher than the spillway level and therefore not physically possible.

(b) The catchments delineated in the model exclude the Waikato River extent which would contribute to the flows to the River.

(c) The 2D domain extent was limited to the area that can be flooded with fluvial flooding only and did not cover the Site extent in entirety.

5.8 Given these issues it was agreed with WRC that we would develop a local model for flood assessment and use a conservative water level of 8.0mRL for Lake Waikare in the flood analysis. This is in excess of the design spillway level of 7.37mRL.

5.9 It was also agreed with WRC that I would extract the data from the Waikato River Model to inform my assessment of the risk of stop bank breach.

6. FLOOD MODEL BUILD PROCESS AND KEY PARAMETERS

6.1 In discussion with WRC, I developed a local model using Mike Flood[4] which could ultimately be incorporated into the Waikato River Model. The modelling process followed best modelling practices and guidelines, in particular the

[3] Boundary condition can be defined as the water level set to Lake Waikare during the storm event.

[4] Developed by Mike by DHI, it is a 1D-2D integrated couple modelling software package used in around 140 countries. This is being used by WRC for developing the River Waikato model and also preferred by most of the local authorities in New Zealand including Auckland Council.

WRC Stormwater Runoff Modelling Guideline (TR2018/02) and Auckland Council's Technical Publication 108 (TP108).

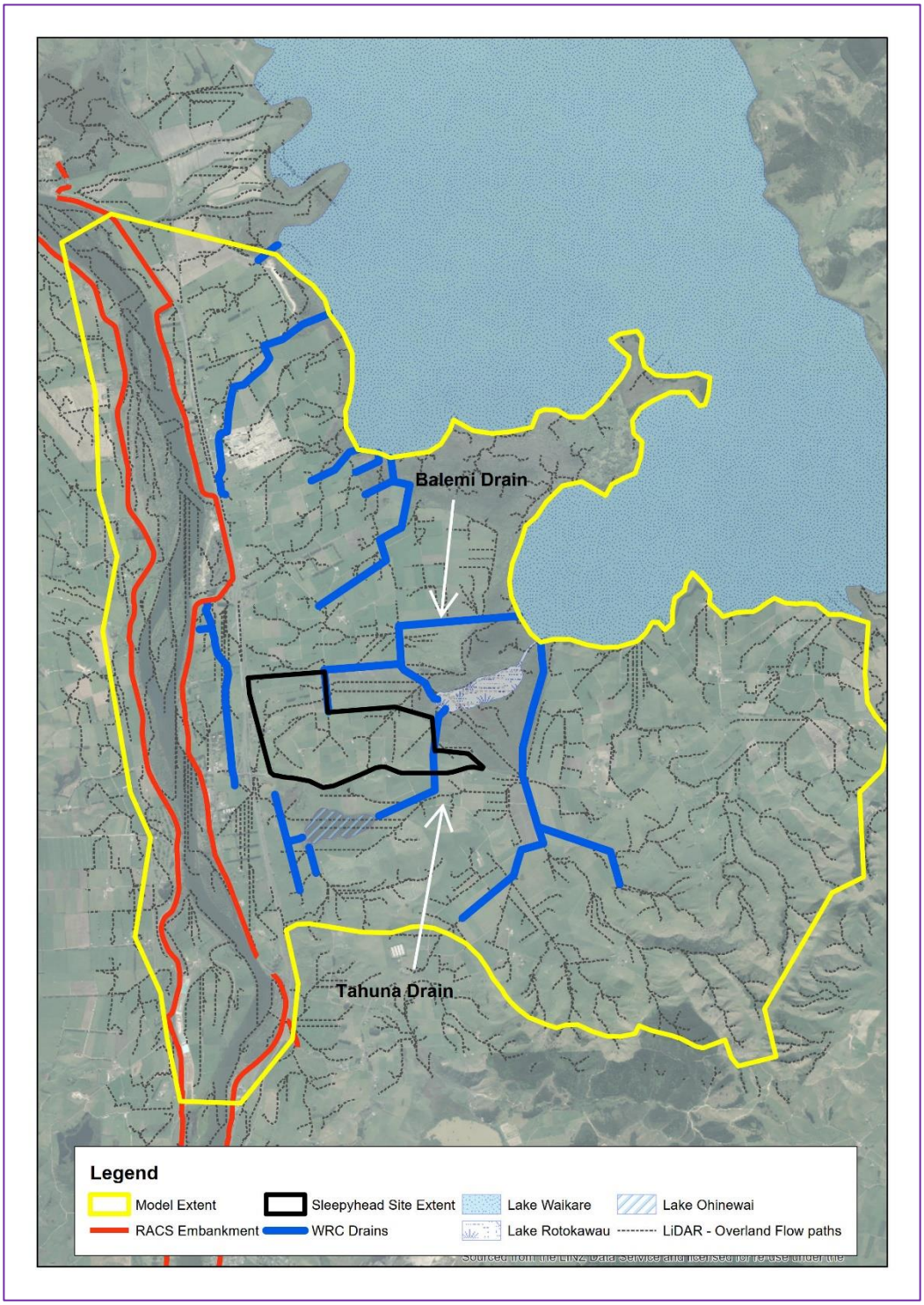

Figure 2: Model Extent

6.2 The model extent was defined based on an overland flow path assessment completed using the LiDAR data provided by WRC. The extent includes all areas contributing to Balemi and Tahuna drains which discharge to Lake Rotokawau and Lake Waikare, as shown in Figure 3.

6.3 Modelling was based on data provided by WRC including the Waikato River Model and latest LiDAR data provided as a DEM, and incorporates all the discussions / agreements made between Woods and WRC's Technical Reviewer.

6.4 Discussions and agreements between myself and WRC's Technical Reviewer are documented in the meeting minutes provided with the Flooding Assessment Report. Key decisions include:

(a) Use of Mike Flood by the DHI modelling software package to assist WRC in continual development of the Waikato River Model (built using Mike Flood by DHI) for major future developments

(b) Developing a local model by discarding the Waikato River Model with model issue findings

(c) Confirmed scenarios to run as detailed in Table 1 below:

Table 1: Modelled Stormwater Network

Modelled Scenario	Topography outside proposed site	Topography within proposed site	Climate Change Rainfall	Scenarios modelled
Pre-Development	Existing	Existing	Yes	2yr, 10yr and 100yr
Post Development – Sleepyhead Estate	Existing	Future	Yes	2yr, 10yr and 100yr
(Post Development – Maximum Probable Development	Future	Future	Yes	100yr
Emergency Management Plan Assessment	N/A	Future	N/A	Steady State Analysis
Sensitivity Model	Existing	Existing	Yes	100yr

(d) Modelling of Lake Waikare and Lake Rotokawau with boundary conditions based on a conservative water level of 8.0mRL to complete the effects assessment. This 8.0mRL was based on the maximum water level that Lake Waikare can achieve for an extreme event before the flows are expected to flow overland over the natural spillway to the north of the Lake. This is more conservative than the actual Waikare spillway level of 7.37mRL but ensures that the worst-case scenario is addressed.

(e) Additional scenarios were modelled to understand the flood risk to the Site and any effects on neighbouring properties for smaller events. These were modelled using a boundary condition of 5.40mRL, which is the minimum operating level for Lake Waikare.

(f) This boundary condition of 8.0mRL was conservative in comparison to the maximum level observed at Lake Waikare for any previous extreme event which was recorded as 6.3mRL in 1998 flooding.

Table 2: Modelled Boundary Summary Table

Boundary Condition	Reason
Lake Waikare water level set at – 8.00mRL (constant)	Directed by WRC as the maximum water level that Lake Waikare can achieve before the spillway to the north is operative
River Waikato water level set at – 10.20mRL (constant)	The 100year with Climate Change water level was extracted from the DHI Waikato River Model and applied at breach locations to complete the Emergency Management Plan modelling
Lake Waikare water level set at – 5.40mRL (constant)	Operating level as per WRC's Community Gate procedures as the minimum water level that Lake Waikare would operate at

7. FLOOD MODELLING RESULTS

7.1 The model results provide for four key outcomes:

(a) That in all scenarios there is a negligible increase in water levels and no increase in flood extents in neighbouring properties compared with the pre-development scenario except for one overland flow path around Lumsden Road which exhibits some ponding.

(b) The development creates a marginal increase in flows to the lake but there is capacity in the LWWFCS to provide for it with no significant increase in water level.

(c) Sets the appropriate 100year event flood level to provide for detailed development planning and engineering design.

(d) Confirms that there is no increased flood risk associated with the stormwater devices within the Central Park Area. Details of the stormwater management and treatment devices are addressed in the evidence of Mr Wadan[5].

Flood level and flood extents

7.2 Modelling indicates that there is negligible increase in water levels and no increase in flood extents within the Site or any of the neighbouring sites. This is because the total Site area (178ha or 1.78sq.km) is insignificant when

[5] Statement of Evidence Pranil Wadan, Section 6.

compared to the downstream floodplain extents (34.66sq.km) and the total contributing area to Lake Waikare (208sq.km).

7.3 The ponding around Lumsden Road is caused by the model representation in this area which does not include the existing culvert under the road. This results in 'no flows' through the culvert and flows backing upstream with no downstream conveyance. An appropriate new culvert at this location will be necessary to direct flows towards the Central Park Area to maintain the predevelopment flood levels. I consider that it is appropriate to address this at the detailed design stage for the appropriate stage of development.

7.4 Flooding is observed within the Site itself but limited to the Central Park Area and the open space to the east of the Site adjoining Lake Rotokawau (i.e. the areas of the Site that will not be filled to raise finished floor levels). Water levels within these flooded areas are governed by water levels within Lake Waikare and Lake Rotokawau which receive water from the entire catchment. These flooded areas are inundated in pre and post development scenarios as these are low lying and affected by the level attained by the Lake with no increases outside the Site extent.

7.5 Additional modelling was completed outside of the agreed scenarios to understand if there is any flood risk to the receiving environment caused by the proposed development when the Lake Waikare has a water level within its regular operating level of 5.40 – 5.75mRL (which would be a lower tailwater level to represent the everyday scenario), in addition to the conservative approach scenarios modelled. The modelled results from these scenarios confirmed the same outcome, where flooding was limited to the Central Park Area and open space adjacent to lake Rotokawau for the pre and post development scenarios.

Lake Waikare levels

7.6 As the storage within Lake Waikare and Lake Rotokawau were not represented within the model, additional work was completed to compare the loss in flood storage as a result of the proposed fill within the development area.

7.7 This was primarily undertaken to demonstrate that the impact of the proposed development on the flood storage within the LWWFCS is inconsequential.

7.8 Table 3 gives the comparison of the displacement volume for the proposed development against the total storage within the contributing area of Lake

Waikare (includes storage within Lake Waikare but does not include storage within Lake Rotokawau as the data is unavailable).

Table 3: Lake Waikare Storage loss analysis

Lake Waikare Flood Level	**Storage at level in Lake Waikare**	**Lake Waikare Surface Area**	**Displacement Volume** *(Fill within development area)*	**Increased Flood Level within Lake Waikare**	**% of storage lost**
mRL	**m^3**	**m^2**	**m^3**	**mm**	*Fill volume / Lake Storage at respective level*
Data provided by WRC			*Calculated by APL*	*Infill volume/ Lake surface area at level of fill*	
5.40	47159005	34414886	200.0	0.006	0.00%
5.65	55874867	35368587	550.0	0.014	0.00%
6.3*	**81992354**	**46140589**	**47300.0**	**1.03**	**0.06%**
7.0	117670811	54457788	236500.0	4.34	0.20%
7.27	132618796	56250799	352400.0	6.26	0.26%
7.37**	**138275873**	**56880635**	**400700.0**	**7.04**	**0.29%**
8.0	175157225	60049354	783000.0	13.04	0.45%

**Between 11-20 July 1998, Lake Waikare steadily increased from 5.60m to peak at 6.29m, highest recorded flood level*

***The design flood level of the Lake Waikare/Whangamarino Wetland Gate Settings scheme (when lake floodwaters actually flow over farmland and into the wetland) is 7.37m*

7.9 This suggests that total storage lost in terms of volume is approximately 0.06% at 6.3mRL, 0.29% at 7.37mRL and 0.45% at 8.0mRL for extreme events (100year with climate change and higher) and no loss in storage at standard operating levels for Lake Waikare as per the gate operation procedures.

Peak flow analysis

7.10 The general approach for the Site is to pass flows forward (1.79sq.km) before the upstream flows reach Lake Waikare (206sq.km). Catchments discharging directly to Lake Waikare are shown in Figure 4 below.

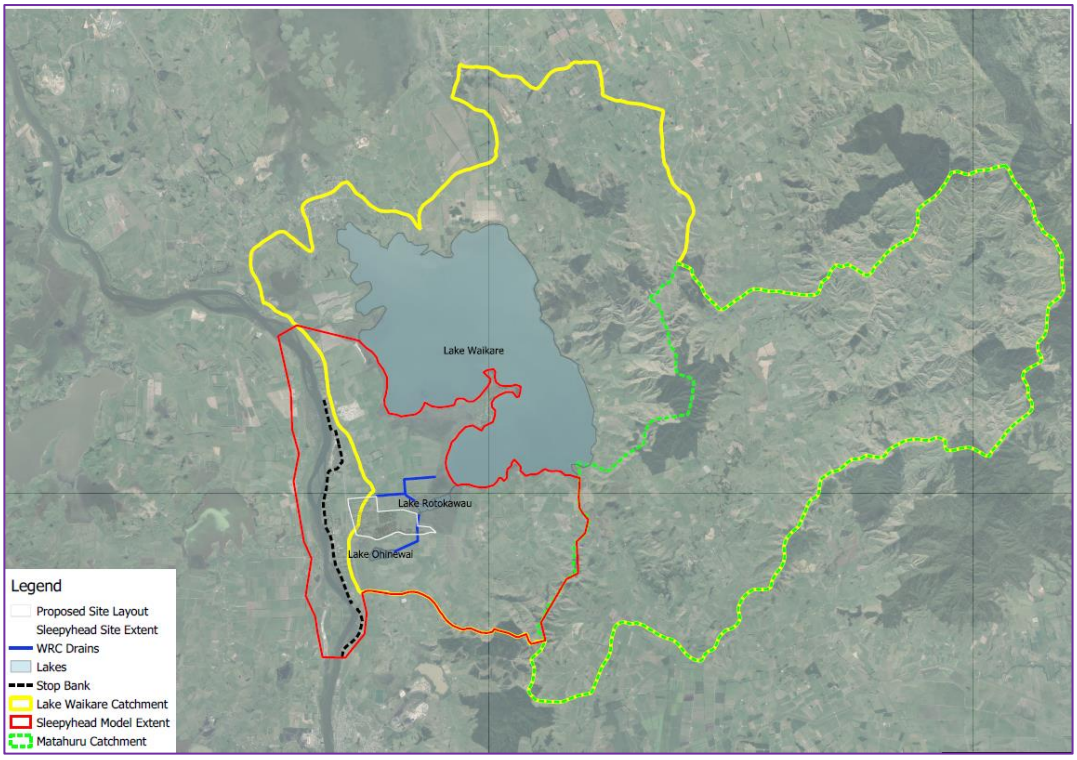

Figure 3: Lake Waikare catchments

7.11 Holding flows back could result in coinciding with peak flows of a storm resulting in higher risk to the Site as well as neighbouring properties. Modelling undertaken indicates that flows from the proposed development can be passed forward without impacting on predicted flood levels at Lake Waikare / Lake Rotokawau. This can be seen from Figure 5 below.

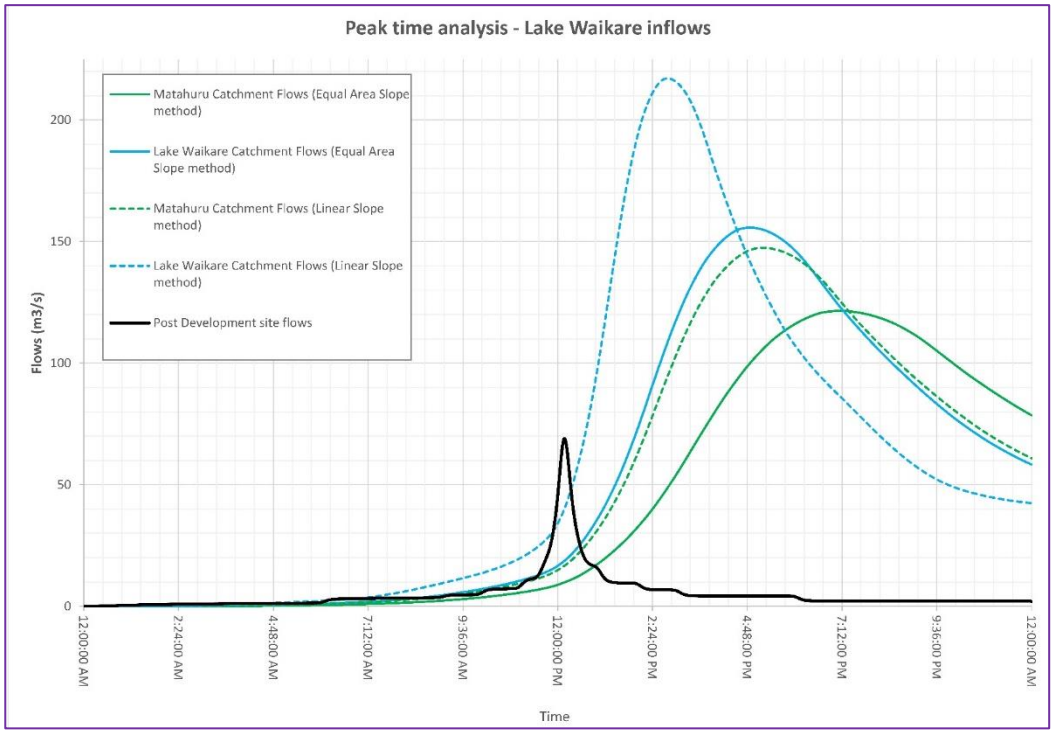

Figure 4: Time to peak Runoff

7.12 The Waikato River is 425km long and has an upstream contributing area of 14,250sqkm. The time of concentration for the River is in the order of two to three days, much greater than that compared to the flows discharging directly to Lake Waikare. Waikato River flows contribute to Lake Waikare via the Rangiriri Spillway in extreme events and as indicated in paragraph 2.19 above, the best practicable option for Lake Waikare would be to pass flows forward to accommodate these spill flows for extreme events.

7.13 As instructed by WRC, a volume-based analysis was undertaken to understand the effects of climate change on Lake Waikare. This was assessed by calculating flood levels achieved by Lake Waikare for various storm events, assuming Lake Waikare Control Gate is not operative and an initial water level of 7.37mRL using HiRDSv4 rainfall depths for 2year, 5year, 10year, 20year, 50year and 100year (Historic, RCP2.6, RCP4.5, RCP6.0, RCP8.5). This analysis confirmed that:

(a) The peak water level with the above assumptions within Lake Waikare Control Gate is approximately 7.98mRL and 8.0mRL for the 100year storm event with climate change adjustment as per TR2018-02 and HiRDS v4 RCP8.5 (2081 – 2100) respectively;

(b) This increase in water level with climate change uplift is a maximum of 111.3mm for the 100year storm event;

(c) The increase in water level with the proposed development is approximately 7.0mm at the design spillway level of 7.37mRL and approximately 13mm when the northern natural spillway at 8.0mRL is operative, which is considered negligible; and

(d) The increase in water level with the proposed development is approximately 1.0mm at 6.3mRL which is the highest recorded flood level at Lake Waikare.

7.14 This analysis confirms that there is no flood risk to the proposed development with increased Lake Waikare levels accounted for by climate change patterns in rainfall events.

8. STOP BANK BREACH SCENARIO (EMERGENCY MANAGEMENT PLANNING)

8.1 The Waikato River runs along the north of Ohinewai South Road (to the west of the Waikato Expressway, less than 1km from the Site) and the river flows

are contained by the Wool Scourers to Fosters Landing Stop Bank ("the stop bank").

8.2 As part of the modelling exercise we undertook a stop bank breach scenario to determine the risk to the Site from an uncontained Waikato River. While considered unlikely, the potential risk to property and life is significant enough in such an event that the assessment was required.

8.3 As directed by WRC's Technical Reviewer, the draft results from the Waikato River Model were reviewed and used to ascertain the maximum water level that the Waikato River could reach. This maximum level is highly conservative, given that there are inconsistencies between the real-life assets and the model data, as set out in paragraphs 5.5 to 5.9 above, but is the best available information at this stage for Waikato River water level for extreme events.

8.4 This assessment involved running a steady state analysis for 24hrs with the maximum water level of 10.2mRL and 8.0mRL applied along the River and Lake Waikare respectively with a 30m wall collapse (as agreed with WRC) simultaneously at three locations to understand the risk with overland flow paths directed towards the Site.

Breach scenario model results

8.5 The initial stop bank breach scenario model undertaken (reported in the Flood Assessment Report) showed flooding along State Highway 1, the North Island Main Trunk Railway and all properties along Ohinewai North Road and Ohinewai South Road leading towards the Site. A portion of the industrial land was also subject to flooding because of the overland flow from the breach.

8.6 Subsequent detailed modelling undertaken confirms that the stop bank breach flows are generally contained to the west of State Highway 1 and flows crossing the State Highway 1 do not enter any part of the Site, instead flowing along the northern boundary eastwards towards Lake Waikare.

8.7 The latest more refined stop bank breach scenario model showed flooding along State Highway 1, the North Island Main Trunk railway and all properties along Ohinewai North Road and Ohinewai South Road leading towards the Site.

8.8 There were three locations identified for possible breach based on water level differences and overland flow paths leading towards the Site. The effect of each breach location is as follows:

(a) Breach Location 1 (Ohinewai North Road): Breach flows from this location traverse eastwards along the northern boundary of the Site without entering the Site. There is no flooding within the Site. See figure 6 for more details.

(b) Breach Location 2 (Ohinewai Landing Road): Breach flows are contained within the area to the west of State Highway 1 and do not affect the Site.

(c) Breach Location 3 (Ohinewai South Road): Breach flows are directed along the flow path towards Lake Ohinewai and do not affect the Site.

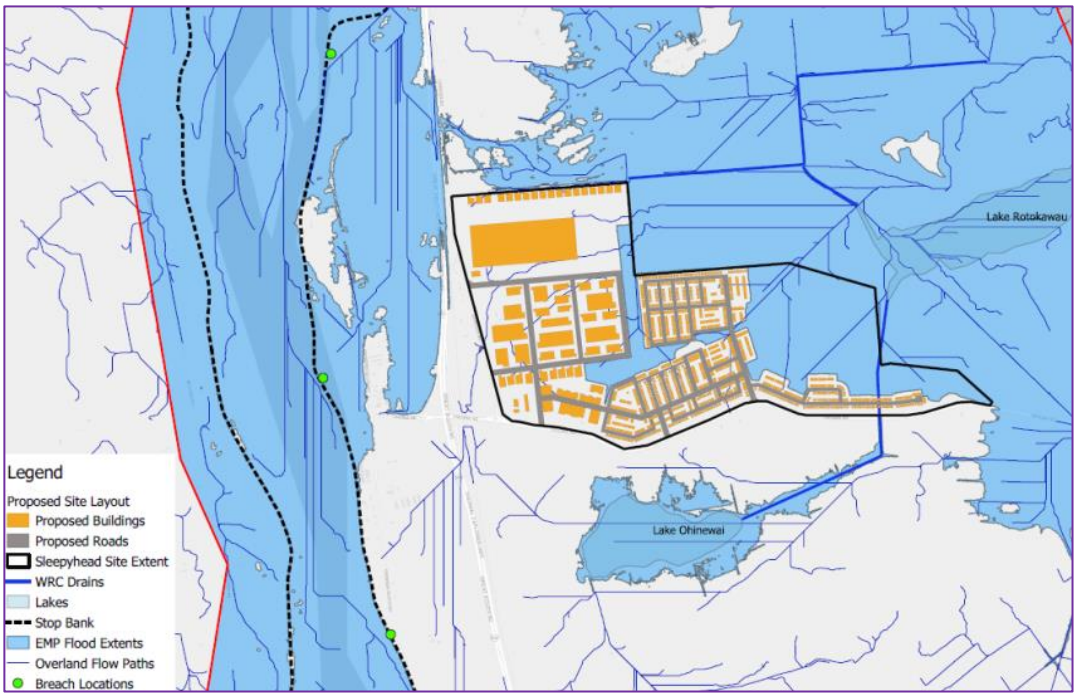

Figure 5: EMP Modelling (NB this is derived from the model and shows the original masterplan. This is of no consequence in terms of the modelling or results shown.)

8.9 Based on the original modelling results, the Flood Assessment Report included a recommendation that an evacuation plan be prepared at resource consent stage for the proposed TCG foam factory to ensure that employees are provided safe access to higher ground in the event of stop bank breach. However, subsequent detailed analysis has shown that there is no flood risk to the Site and therefore there is no need for such an evacuation plan.

9. COMMENT ON MATTERS RAISED IN THE SECTION 42A REPORT AND IN EXPERT CONFERENCING

9.1 I refer to matters raised in Waikato District Council's ("WDC") s 42A Report prepared by Chloe Trenouth and Stantec's technical report that informed the s 42A Report below as they relate to my flooding assessment.

9.2 Key matters raised were addressed through the expert conferencing process, which took place on 17 June 2020 and was attended by myself, Dr Grant Webby (for Mercury Energy), David Klee (for Fish and Game), Ghassan Basheer (for WRC) and Mark Pennington (for WDC), together with a number of observers.

9.3 Expert conferencing resulted in agreement between all parties on all issues discussed. These are addressed below.

Issue 1- Working of Lake Waikare Flood Storage Zone

9.4 All experts agreed with the description of the LWWFCS, including relevant operating levels, in the Tonkin and Taylor letter entitled "Ambury development flood assessment" dated 8 June 2020 which was appended to the summary statement prepared by Ghassan Basheer.

9.5 This is consistent with the flood modelling undertaken to date.

Issue 2 – Impact of APL development on Lake Waikare Flood Storage Zone

9.6 With respect to the loss of flood storage arising from the importation of fill in the development area[6], an assessment was completed and shared with Mercury Energy to quantify the loss in flood storage compared to the total storage available within Lake Waikare. This memorandum is attached as **Attachment C**.

9.7 This assessment also provided an understanding of the time to peak from the development and that of the catchment. The time to peak from the Waikare upstream catchment is >2hrs which is significantly higher than the time to peak for the development runoff, which is approximately 10-15 minutes. This confirms that the peak runoff from the development will be discharged downstream, thus avoiding coincidence of peaks.

9.8 To understand the worst-case effects, a conservative approach was adopted assuming that 100% of the Central Park Area storage is used by stormwater devices (i.e. no storage is available for flood storage) and the model was

[6] Para 157 and 158. S 42 Report, WDC.

simulated for the 10year with the lower tailwater level of 5.4mRL. The model results confirmed that there is no increased flood risk within the Site or to the neighbouring properties. There is no increase in flood extents or flood levels within Lake Waikare. Figure 7 shows the comparison of predevelopment flood levels against the post development scenario modelled with no Central Park Area storage. This figure shows an earlier version of the Masterplan layer used for undertaking modelling. The changes in building layouts do not affect the proposed terrain or imperviousness of the Site that are used in modelling and are of no consequence in terms of results.

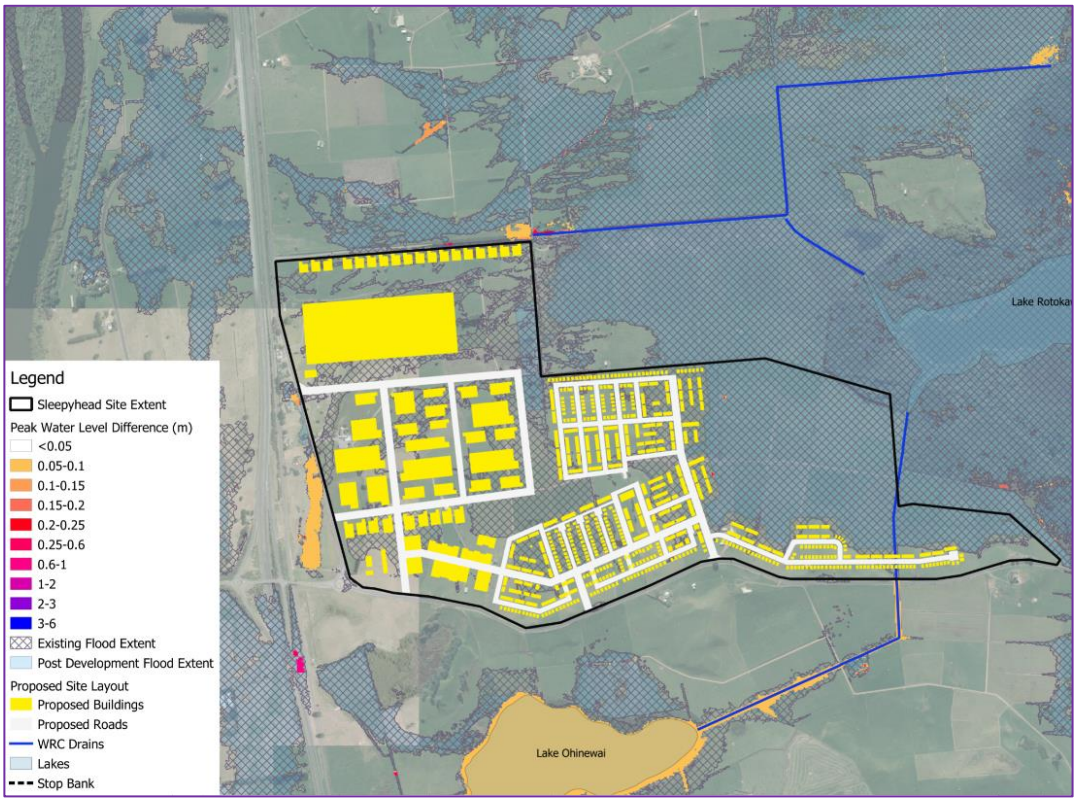

Figure 6: Sensitivity Analysis (10yr) – No central park storage

9.9 Modelling and subsequent analysis undertaken confirm that the loss in flood storage associated with the quantity of fill required for the development is negligible. There is no increased flood risk to the proposed development or neighbouring properties.

9.10 During expert conferencing, all experts agreed that although there will be additional stormwater runoff generated by the Site, this will be very small in relation to the natural catchment runoff and flood overflows from the Waikato River. Displacement volumes and storage levels associated with various flood levels were identified which have formed the basis for my analysis.

9.11 Alternate flood storage analysis was undertaken by Dr Webby following the experts conference using a different interpolation method. His calculations result in a slightly higher, but still minor, loss of storage - as the less than 0.18% at a Lake level of RL6.3, 0.49% at a Lake level of RL7.37and 0.66% at a Lake level of RL8.0. In my opinion, my calculation method presents the total storage lost within the Lake at any specific level based on the Lake survey data available compared to Dr Grant Webby's calculations which compares the percentage of net storage volume lost against the percentage of net storage in terms of volume above lake level of RL 5.65m. Both calculations confirm that the loss in flood storage is negligible compared to the storage available within the Lake.

Issue 3 – Current design flood level for the Lake Waikare Flood Storage Basin

9.12 During conferencing, all experts agreed that:

(a) The design flood level (RL7.37) is based on the original flood control scheme design from the 1960s;

(b) The level could change as a result of a review of climate change impacts by WRC; and

(c) The level is currently not marked on the planning map, and this is a matter for Stage 2 (Natural Hazards) of the Proposed District Plan hearing process.

9.13 All the experts agreed that it is not solely for us to determine how this carried through and the matter needs to be revisited in the Stage 2 Natural Hazards hearing.

Issue 4 – Lake Waikare levels used to undertake flooding assessment

9.14 This was a simple matter of clarification. During conferencing I confirmed that the flood modelling has considered the effects of stormwater from the development on Lake Waikare on neighbouring properties without inflows from the Waikato River using lake levels of 5.4mRL and 8.0mRL.

Issue 5 – Use of multiple lake levels for flood modelling

9.15 Although it was initially suggested that the modelling should have considered other operating levels of Lake Waikare, at the expert conferencing session it was agreed that this was unnecessary because both ends of the spectrum (i.e. 5.4mRL and 8.0mRL) have been considered.

Issue 6 – Cumulative effects

9.16 During conferencing, Mercury Energy raised a concern about the cumulative impact of the proposed Sleepyhead Estate development and other future developments in the area. All experts agreed that any development involving a volume of fill in the flood storage basin area will contribute to cumulative development effects on the flood storage capacity.

9.17 My analysis confirms that the loss in storage associated with the proposed Sleepyhead Estate development does not have a significant impact on Lake Waikare flood storage. Any other proposed development should similarly complete an assessment to quantify and effects in terms of loss of flood storage.

Issue 8 – Effects on the WRC land drainage scheme (NB there is no issue 7)

9.18 Mr Basheer raised a concern that the assessment has been based on the 5.4mRL level for Lake Waikare, despite the fact that it is usually above that level. The water level within Lake Waikare is generally between 5.50 – 5.75mRL.

9.19 This has been addressed by covering the extreme spectrums in modelling using water levels of 5.40mRL and 8.0mRL for Lake Waikare.

Tahuna Drain culvert

9.20 One other matter raised in the Section 42A report but not addressed at expert conferencing concerns the upgrading of the Tahuna Drain culvert. I concur with Ms Blackburn that the Tahuna Drain culvert is likely to require upgrading as part of the proposed development[7]. These works have been discussed with WRC and further engagement will continue as the development proceeds. In my experience, such infrastructure upgrades are common in greenfield development and it is appropriate for specific engineering solutions to be identified at the detailed design stage.

9.21 Additional work has been completed to assess a blockage scenario for Tahuna Road and Lumsden Road culverts to understand the flood risk to the proposed development.

9.22 The culverts are assumed to be 100% blocked and modelled with tailwater conditions of 5.4mRL and 8.0mRL applied to the receiving environment to understand the effects upstream due to additional backing up of flows.

[7] S 42 Report, WDC para. 153.

9.23 With both these modelled scenarios, there is no overtopping across Tahuna Road and Lumsden Road and there are no increased flood effects on the proposed development as shown in Figure 8 below. This figure shows an earlier version of the Masterplan layer used for undertaking modelling. The changes in building layouts do not affect the proposed terrain or imperviousness of the Site that are used in modelling and are of no consequence in terms of results.

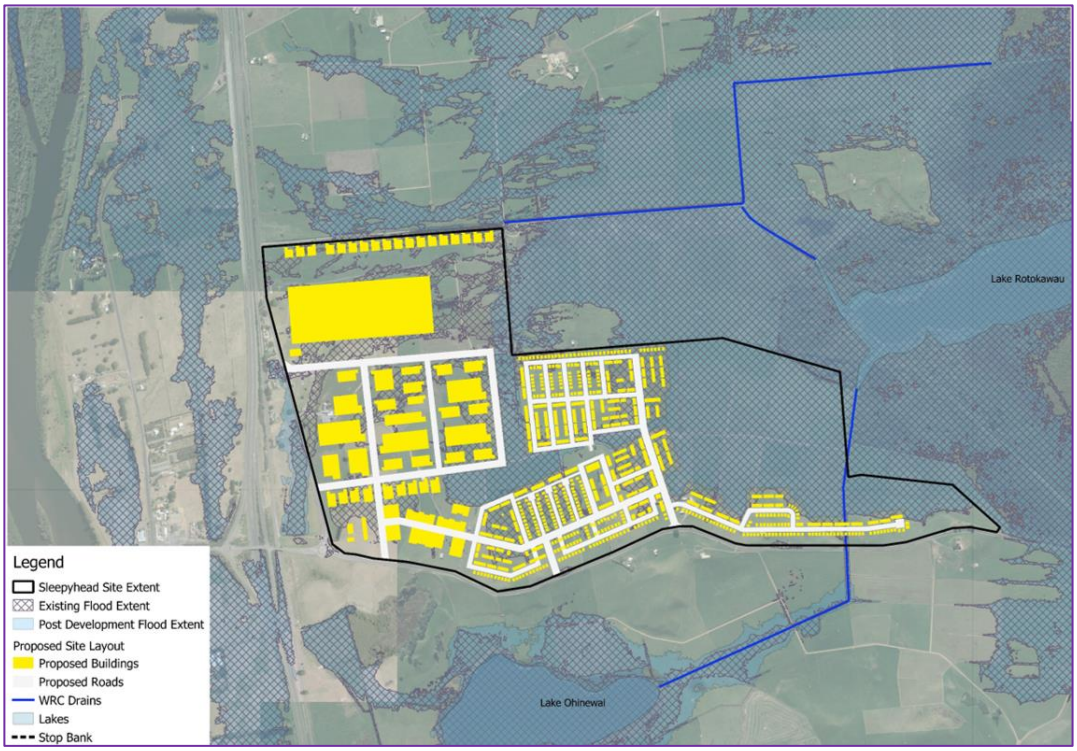

Figure 7: Blockage Modelling

9.24 To address the matters above, appropriate plan provisions are set out in the evidence of Mr Olliver.

10. CONCLUSIONS

10.1 In my opinion the flood modelling analysis undertaken has been sufficiently comprehensive to understand the flood risk associated with the Site. The modelling process has not identified any flood risk that cannot be managed during the detailed design phase of the project. Accordingly, from a flood management perspective, I consider that the Site is suitable for the proposed development.

Ajay Desai
9 July 2020

ATTACHMENT A

COMMUNITY GATE OPERATION PROCEDURES DIAGRAM

ATTACHMENT B

AMBURY DEVELOPMENT FLOOD ASSESSMENT REVIEW REPORT, TONKIN + TAYLOR TO WAIKATO REGIONAL COUNCIL DATED 8TH OF JUNE 2020

ATTACHMENT C

QUANTIFICATION OF THE LOSS IN FLOOD STORAGE COMPARED TO THE TOTAL STORAGE AVAILABLE WITHIN LAKE WAIKARE