

APPENDIX E

STORMWATER AND FLOODING ASSESSMENT

BCD Group
220 Tristram Street, Level 1
Hamilton 3204
New Zealand

17 December 2019

Attention: Cameron Aplin

Dear Cameron,

SUB0165/19 - 635 Whatawhata Road Stormwater Management Plan & Flood Report Review

Purpose

Beca Ltd (Beca) has been commissioned by Waikato District Council (WDC) to carry out a stormwater compliance review of the proposed subdivision located at 635 Whatawhata Road, Dinsdale. We note BCD Ltd are acting as WDC's planner in this application. The scope of this review includes:

- Review of application documentation and methodology used
- Compliance with Waikato Regional Council's Plan
- Review of Stormwater Management Plan (SWMP) compatibility with the Flood Report,
- And any other issued considered relevant to the subdivision outcome.

Note that the review against the Regional Plan relates to management guidelines and performance requirements and is not intended to be a statutory or planning review. Comments related to the Regional Plan are made in regard to the permanent proposal and are not inclusive of temporary works required to develop the site.

This review is a continuation of our previous reviews of the Floodplain Analysis, (dated 10 September 2019) and the subsequent SWMP (dated 8 November 2019). The comment table from these previous reviews has been updated by both Beca and the applicant and is appended as Attachment 1.

The documents received from WDC for this review include the following:

- Stormwater Management Plan, Cheal Consultants Ltd, 22 October 2019
- Floodplain Analysis, Rev 4, Golovin, October 2019 (Appendix to the SWMP)
- M13246 Scheme Plan Sheet 1 of 8, Cheal/McCracken Surveys, September 2019.
- G&S Singleton – Extra Flood Hazard Analysis and Waikato Regional Council Consultation Reply (email from P Barrett to Cameron Aplin), 5 December 2019.

1.1 Updated Review

Following a meeting with WCD/BCD/Cheal/Golovin (26 November 2019) further information was provided by the applicant (email and attached SWMP Issues Memo, P Barrett to C Aplin & M Brown, 5 December 2019), expanding on the previous responses and allowing our review to be drawn to a conclusion.

Attachment 1 – Flood Report Comment Table

The attached table has been updated to reflect this.

Summary of Findings

Additional modelling and on-site discussions with WRC have been undertaken subsequent to our initial review of the flood model and SWMP. Several items can be deferred to Engineering Approval stage and we consider the remaining issues have otherwise been addressed. In summary, we note:

- Floor levels and freeboards have been identified and are considered appropriate.
- We infer from the modelling there will be a minor flood impact (tens of millimetres) on neighbouring land to the west of the drain however, this land is already subject to flooding (in parts over 1m deep). Climate change will provide a significant impact on flood levels irrespective of the development occurring or not.
- The applicant proposes to mitigate stormwater effects with rainwater tanks for flow/volume control and filter strips for water quality control. The performance criteria for these mitigation measures should be more clearly documented either by condition of consent or in an updated SWMP.
- Performance and detailed design calculations (for filter strips, culverts and the final access road levels etc) will need to be confirmed as part of Engineering Approval.
- A consent notice is proposed by the applicant to help manage the overland flow path across Lot 10. WDC will need to consider this and address it accordingly.
- WRC requests for easements are outside the power of WDC to require and therefore are an issue to be resolved between applicant and WRC; as such this item is outside the scope of this review. We understand there are no other features that WRC are seeking that are material to the SWMP.
- We understand the applicant is not proposing to update the SWMP with their additional information at this time. It is our suggestion that the SWMP is updated at this time, however, we defer to WDC's discretion on this matter. The SWMP could also be updated as part of a future Engineering Approval submission.

Yours sincerely,



Anna McKay

Stormwater Engineer

on behalf of

Beca Limited

Phone Number: +64 7 838 3828

Email: anna.mckay@beca.com

Attachment 1 Flood Report Comment Table

Attachment 2 Stormwater Management Report Comment and Response Table

Item No.	Floodplain Analysis Comments (WDC / Beca) (10 September 2019)	Response (October 2019)	Acceptance/Response (17 November 2019)																																																																																																																																																																																																																																																																								
1	We note that Waikato Regional Council's Runoff Modelling Guide (2018) was not used for the hydrology. Please comment on the difference this could make to the flood results and if WRC are satisfied with this methodology. We note WDC's preference is for WRC's method to be used to reasons of consistency with WRC.	I have updated the work for the new methodology	Accepted. Use of RCP8.5 from HIRDS V4 is slightly more conservative than WRC's current methodology so no issue there.																																																																																																																																																																																																																																																																								
2	What consideration was made for post development impacts on flood levels? Including external future catchment development contributing to flooding (or document why this does is not relevant). This may impact on setting floor levels, or alternatively it would show insensitivity to this.	See Sections 2.2 and 2.3	Accepted and refer comment 1 below of the SWMP review.																																																																																																																																																																																																																																																																								
3	Note that flood levels were verified through a video referenced on page 2. It would be helpful to include screen captures into the commentary on how this supports validation of the model.	I don't have video any more. Need to talk to owner. The report cover shows the flooding upstream of the culvert.	Accepted.																																																																																																																																																																																																																																																																								
4	Section 1.7 references Hamilton City Infrastructure Specifications? Do you mean the RITS?	This has been remedied	Accepted.																																																																																																																																																																																																																																																																								
5	HCC ITS is no longer valid, HIRDS V4 should be used in accordance with RITS. Please also confirm which climate change scenario is used. Refers to Table 4.9 but the depth in this flood report is different to the depth in this table Table 4-9: Incorporating 2.08 degrees Celsius Climate Change – For Assessing Post – Development Flows <table border="1"> <thead> <tr> <th rowspan="2">Start time hh:mm</th> <th rowspan="2">Time interval min</th> <th colspan="2">2-year ARI</th> <th colspan="2">5-year ARI</th> <th colspan="2">10-year ARI</th> <th colspan="2">20-year ARI</th> <th colspan="2">50-year ARI</th> <th colspan="2">100-year ARI</th> </tr> <tr> <th>Depth mm</th> <th>Intensity mm/h</th> </tr> </thead> <tbody> <tr><td>0:00</td><td>360</td><td>6.1</td><td>1.0</td><td>8.3</td><td>1.4</td><td>10.4</td><td>1.7</td><td>11.6</td><td>1.9</td><td>14.3</td><td>2.4</td><td>16.0</td><td>2.7</td></tr> <tr><td>6:00</td><td>180</td><td>6.3</td><td>2.1</td><td>8.2</td><td>2.7</td><td>9.5</td><td>3.2</td><td>10.6</td><td>3.5</td><td>12.6</td><td>4.2</td><td>13.4</td><td>4.5</td></tr> <tr><td>9:00</td><td>120</td><td>7.3</td><td>3.6</td><td>8.3</td><td>4.2</td><td>9.0</td><td>4.5</td><td>9.9</td><td>5.0</td><td>10.8</td><td>5.4</td><td>11.4</td><td>5.7</td></tr> <tr><td>11:00</td><td>30</td><td>3.1</td><td>6.2</td><td>4.1</td><td>8.2</td><td>4.8</td><td>9.6</td><td>5.4</td><td>10.8</td><td>6.3</td><td>12.6</td><td>6.9</td><td>13.9</td></tr> <tr><td>11:30</td><td>15</td><td>3.2</td><td>12.7</td><td>4.8</td><td>19.1</td><td>5.8</td><td>23.2</td><td>6.8</td><td>27.4</td><td>8.2</td><td>32.7</td><td>9.1</td><td>36.4</td></tr> <tr><td>11:45</td><td>5</td><td>1.7</td><td>19.9</td><td>2.5</td><td>30.3</td><td>3.1</td><td>37.8</td><td>3.7</td><td>44.9</td><td>4.5</td><td>54.4</td><td>5.1</td><td>61.1</td></tr> <tr><td>11:50</td><td>5</td><td>2.5</td><td>30.2</td><td>3.7</td><td>44.2</td><td>4.5</td><td>53.4</td><td>5.2</td><td>62.5</td><td>6.2</td><td>74.1</td><td>6.9</td><td>82.6</td></tr> <tr><td>11:55</td><td>10</td><td>11.8</td><td>71.0</td><td>15.5</td><td>92.7</td><td>17.9</td><td>107.2</td><td>20.2</td><td>121.0</td><td>23.2</td><td>138.9</td><td>25.4</td><td>152.3</td></tr> <tr><td>12:05</td><td>5</td><td>2.5</td><td>30.2</td><td>3.7</td><td>44.2</td><td>4.5</td><td>53.4</td><td>5.2</td><td>62.5</td><td>6.2</td><td>74.1</td><td>6.9</td><td>82.6</td></tr> <tr><td>12:10</td><td>5</td><td>1.7</td><td>19.9</td><td>2.5</td><td>30.3</td><td>3.1</td><td>37.8</td><td>3.7</td><td>44.9</td><td>4.5</td><td>54.4</td><td>5.1</td><td>61.1</td></tr> <tr><td>12:15</td><td>15</td><td>3.2</td><td>12.7</td><td>4.8</td><td>19.1</td><td>5.8</td><td>23.2</td><td>6.8</td><td>27.4</td><td>8.2</td><td>32.7</td><td>9.1</td><td>36.4</td></tr> <tr><td>12:30</td><td>30</td><td>3.1</td><td>6.2</td><td>4.1</td><td>8.2</td><td>4.8</td><td>9.6</td><td>5.4</td><td>10.8</td><td>6.3</td><td>12.6</td><td>6.9</td><td>13.9</td></tr> <tr><td>13:00</td><td>120</td><td>7.3</td><td>3.6</td><td>8.3</td><td>4.2</td><td>9.0</td><td>4.5</td><td>9.9</td><td>5.0</td><td>10.8</td><td>5.4</td><td>11.4</td><td>5.7</td></tr> <tr><td>15:00</td><td>180</td><td>6.3</td><td>2.1</td><td>8.2</td><td>2.7</td><td>9.5</td><td>3.2</td><td>10.6</td><td>3.5</td><td>12.6</td><td>4.2</td><td>13.4</td><td>4.5</td></tr> <tr><td>18:00</td><td>360</td><td>6.1</td><td>1.0</td><td>8.3</td><td>1.4</td><td>10.4</td><td>1.7</td><td>11.6</td><td>1.9</td><td>14.3</td><td>2.4</td><td>16.0</td><td>2.7</td></tr> <tr><td>24:00</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td>72.2</td><td></td><td>95.0</td><td></td><td>112.1</td><td></td><td>126.9</td><td></td><td>148.9</td><td></td><td>162.9</td><td></td></tr> </tbody> </table>	Start time hh:mm	Time interval min	2-year ARI		5-year ARI		10-year ARI		20-year ARI		50-year ARI		100-year ARI		Depth mm	Intensity mm/h	0:00	360	6.1	1.0	8.3	1.4	10.4	1.7	11.6	1.9	14.3	2.4	16.0	2.7	6:00	180	6.3	2.1	8.2	2.7	9.5	3.2	10.6	3.5	12.6	4.2	13.4	4.5	9:00	120	7.3	3.6	8.3	4.2	9.0	4.5	9.9	5.0	10.8	5.4	11.4	5.7	11:00	30	3.1	6.2	4.1	8.2	4.8	9.6	5.4	10.8	6.3	12.6	6.9	13.9	11:30	15	3.2	12.7	4.8	19.1	5.8	23.2	6.8	27.4	8.2	32.7	9.1	36.4	11:45	5	1.7	19.9	2.5	30.3	3.1	37.8	3.7	44.9	4.5	54.4	5.1	61.1	11:50	5	2.5	30.2	3.7	44.2	4.5	53.4	5.2	62.5	6.2	74.1	6.9	82.6	11:55	10	11.8	71.0	15.5	92.7	17.9	107.2	20.2	121.0	23.2	138.9	25.4	152.3	12:05	5	2.5	30.2	3.7	44.2	4.5	53.4	5.2	62.5	6.2	74.1	6.9	82.6	12:10	5	1.7	19.9	2.5	30.3	3.1	37.8	3.7	44.9	4.5	54.4	5.1	61.1	12:15	15	3.2	12.7	4.8	19.1	5.8	23.2	6.8	27.4	8.2	32.7	9.1	36.4	12:30	30	3.1	6.2	4.1	8.2	4.8	9.6	5.4	10.8	6.3	12.6	6.9	13.9	13:00	120	7.3	3.6	8.3	4.2	9.0	4.5	9.9	5.0	10.8	5.4	11.4	5.7	15:00	180	6.3	2.1	8.2	2.7	9.5	3.2	10.6	3.5	12.6	4.2	13.4	4.5	18:00	360	6.1	1.0	8.3	1.4	10.4	1.7	11.6	1.9	14.3	2.4	16.0	2.7	24:00																72.2		95.0		112.1		126.9		148.9		162.9		Not in response – not addressed	Accepted. HCC rainfall no longer used so this item is no longer relevant.										
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6	Later Figures note 10yr ARI. If the 10yr ARI is to be reported on (we note this event is not significant for the setting of floor levels stated as the purpose of the model), then please include 10yr ARI rainfall and flows etc.	This has been remedied	Accepted.																																																																																																																																																																																																																																																																								
7	A map displaying existing road lines would be helpful, as would a topographical map to give more context to the above levels, and subsequently the rest of the report.	In Stormwater Management Plan by Cheals	Accepted.																																																																																																																																																																																																																																																																								
8	The Tc's have been rounded up to 20. It is noted that increasing the Tc can underestimate peak flows. However, this may not be significant if the flooding is driven by volumes. Please clarify or show that this would not impact on flood levels.	This has been remedied. Actual TC's used	Accepted.																																																																																																																																																																																																																																																																								
9	Please expand on the hydrology section to include parameters used (losses, % impervious, CN etc).	This has been remedied, see Section 2.5	Accepted.																																																																																																																																																																																																																																																																								
10	Is this a 1D model only? Please clarify.	Yes	Accepted.																																																																																																																																																																																																																																																																								
11	Was any topographic survey used for the stream sections, culvert and to check consistency of the LiDAR?	No survey as such as the flow is predominantly out of channel. The stream dimensions were measured on site	Accepted.																																																																																																																																																																																																																																																																								
12	The model does not contain many cross sections which can decrease the accuracy of the results. Was interpolation used in the model but not stated?	Yes	Accepted.																																																																																																																																																																																																																																																																								

Attachment 1 – Flood Report Comment Table

Item No.	Floodplain Analysis Comments (WDC / Beca) (10 September 2019)	Response (October 2019)	Acceptance/Response (17 November 2019)
13	Floodplain bed – please clarify whether the Manning’s roughness for the “floodplain” bed is applied to the whole section (channel and floodplain). It appears that the floodplains to the east have more trees than the west. It is suggested that Manning’s be applied to reflect changing roughness in different areas of the floodplain and channel. How was the channel roughness determined (references used etc)? How sensitive are flood levels to roughness?	Used a Mannings n of 0.05 throughout the cross section. If the stream was modelled differently it would, technically, be smoother so this method is conservative. Given the bottom end is flooded it would not make a difference given the scale. Also see Section 3.4	Accepted.
14	Section 3.2 first paragraph – wording is unclear.	This has been remedied	Accepted.
15	Downstream boundary location is not show on map. Please show and clarify this is sufficiently far enough downstream	This has been remedied. Site inspection shows that downstream controls will be irrelevant. A Normal slope is fine and is shown by the HGL to fine due to the upstream flood levels.	Accepted.
16	Downstream boundary slope is set at 0.1%. Please clarify how this was calculated. Figure 3.3 shows a steep slope of 0.42. Downstream contours used to calculate a slope over 544m found it to be 0.007 (0.7%)	This has been remedied. See Section 3.2	Accepted.
17	Figure 3.4/3.5 please update. The legend/labels to state 10yr and 100yr flows/HGL are shown but are not in the figure. Figure 3.4 is not a HGL.	These have been remedied	Accepted.
18	Cross sections. Please confirm these all extend beyond the flood extents.	Yes	Accepted.
19	Upstream overland flows need to be considered in setting floor levels. Alternatively, it needs to be shown that this does not dominate setting flood levels. Presumably this would be addressed in the Stormwater Management Plan (i.e. not need modelling).	In Stormwater Management plan by Cheals	Accepted.
20	Freeboards noted are 500mm and will comply provided the above issues do not increase flood levels and freeboard is taken from flood level to underside of slab/floor joist.	FFLs have been adjusted accordingly in Table 4.1	Accepted.
21	Addendum – wastewater fields locations based on flood levels has not been addressed, although this is not a flood issue so is just noted here for WDC to act on. Presumably this has been addressed by the applicant separately.	In Table 4.2	Accepted.
22	Figure 5.2 – Show legend	Deleted	Accepted – extent shown in Figure 4.2
23	Table 5.1 mentions new lots. Include image to show location of new lots relative to floodplain and other proposed lots.	Deleted	Accepted
24	Paragraph below Table 5.1 is an incomplete.	Deleted	Accepted
25	Reference to AR&R Project 11 Stage 3 2015 was made. The most up to date AR&R guidelines are Book 6, Chapter 6, released in 2019. Please review and update reference.	This has been remedied	Accepted
26	Expect the SMP will cover checking the impacts of development on neighbouring properties and compliance with Rule 4.2.9.3 of the Waikato Regional Plan	Okay, not in my report.	Accepted

Item No.	SWMP Comments (WDC / Beca) (8 November 2019)	Response	Beca Response to Attached itemised comments
1	<p>The SWMP assesses the increase in impervious area as “insignificant” (0.66%) based on the total contributing catchment (256 ha). The assessment should consider the increase in impervious area relative to the on-site development area (45.7 ha), which will be significantly more than 0.66%. Assessment by means of area comparison is not an accepted method.</p> <p>Calculations need to be provided (i.e. the applicant needs to quantify and compare the pre- and post-development runoff flow rates / volumes) to support the SWMP assessment of effects. The post-development assessment should include an allowance for climate change and hydrological changes from soil compaction during site development (refer last paragraph of section 5.1 of TR2018/02 for compaction consideration).</p>	See SWMP Issues Memo: Item 1	Accepted. Additional modelling undertaken.
2	<p>Rainwater tanks are proposed to attenuate excess runoff, however the attenuation performance standard is not mentioned in the SWMP. Note that the RITS requires flow attenuation to predevelopment rates for the 2- and 10- year ARI events as well as 100-year if a flooding risk is present downstream. WRC’s standard practice is also to retain the initial abstraction volume. This needs to be quantified and documented.</p> <p>WDC may consider it appropriate to address attenuation requirement as a condition to be demonstrated during future engineering approval with a provision that 100yr attenuation may need to be provided depending on the outcome of such an assessment.</p>	See SWMP Issues Memo: Item 2	<p>Accepted.</p> <p>Note: if the tanks are to be used for detention as well as the planned water supply, then that part of the volume attributed to stormwater management / detention needs to be live storage. This will need to be demonstrated for Engineering Approval.</p> <p>We recommend that the tanks be sized to provide retention of the initial abstraction, provide extended detention and peak flow attenuation for the 2, 10 & 100 year ARI in accordance with WRC’s Stormwater Management Guideline. The SWMP should be updated to document this performance standard.</p> <p>The SWMP should be updated to document the performance standards to be used or a consent condition provided that specifies this.</p>
3	<p>Road runoff is proposed to be discharged to the grassed reserve areas, which will provide water quality treatment through, in essence, filter strips. This seems feasible given the large green areas available but should be demonstrated during future design and engineering approval stages. Treatment of roads and driveways will need to be in accordance with WRC’s TR2018/01.</p> <p>We note that runoff from areas close to the drains need to be treated prior to entering the watercourse and treatment areas should not be located in flood paths.</p> <p>Designated treatment areas and overland flow paths as well as supporting calculations (i.e. residence time, flow velocity, etc.) should be submitted for engineering approval to demonstrate compliance with water quality treatment standards. This could be addressed at Engineering Approval stage.</p>	See SWMP Issues Memo: Item 3	<p>Accepted.</p> <p>This will be undertaken at the Engineering Approval stage.</p>
4	<p>The proposal to size roadway culverts for the 10%AEP is not entirely consistent with RITS. Section 4.2.12 of the RITS specifies that culverts shall be designed for the 1%AEP post development event however lesser standards are allowed under table 4-14. 10% AEP may be appropriate, provided adequate overflow provision is designed to manage the hazard of such an event.</p> <p>The location of the proposed culverts has not been provided in the drawings. As such, we cannot comment whether a 1% or 10% AEP performance should be adopted. Similarly, depending on their location, the culverts may be subject to WRC’s regional plan culvert conditions which require capacity</p>	See SWMP Issues Memo: Item 4	<p>Accepted.</p> <p>As stated in the meeting (26 November 2019), there are no culverts proposed on the existing main drain and only under driveways however, the culvert locations remain undefined.</p> <p>Culvert location, final sizing, and performance will</p>

Attachment 2 – SWMP Comment Table

Item No.	SWMP Comments (WDC / Beca) (8 November 2019)	Response	Beca Response to Attached itemised comments
	for the 2% AEP. All culverts on existing watercourses should provide for fish passage and include scour protection measures at the inlet and outlet.		need to be confirmed as part of Engineering Approval.
5	<p>Diversion drains are proposed to intercept runoff from the upper catchments and platform levels are proposed at least 500mm above adjacent flow paths (SWMP Section 4 a. ii.). In order to maintain compliant freeboard, the finished flood levels will need to be at least 500mm from the 1%AEP flood level to the underside of the building slab within those flow paths, not the ground levels of the flow paths themselves.</p> <p>Flood level analysis indicating the 1% AEP flood level in any existing or proposed flow paths should be provided during detailed design/engineering approval to confirm freeboard compliance. Based on regional LiDAR, this item is particularly applicable to Lots 2, 4, and 5.</p>	See SWMP Issues Memo: Item 5	Accepted.
6	Little consideration is given in the SWMP to the receiving waterbody and its current condition (although it is noted capacity and flood effects are discussed in Golovin's Flood Report). The drain is considered a modified channel according to RITS Table 4-5 and as such is subject to water quality treatment and extended detention controls.	See Cheal email.	Accepted. Addressed in the above items.
7	<p>The SWMP does not assess the proposal's potential flood hazard effects on the upstream and adjacent properties. The proposal states the roads will be raised, which could impact the flood depths on site as well as the flood extents on the property located on the other side of the drain (Lot 1 DPS86871) by impounding floodwaters, filling flood storage, and concentrating runoff in areas that may be susceptible to scour. Similarly, upstream flood impacts of raising Lot 7's access had not been assessed.</p> <p>More information is required to demonstrate the developments effects on post-development site flood levels and off-site flood hazards.</p>	See SWMP Issues Memo: Item 7	<p>Accepted.</p> <p>Modelling of raised driveways within the 100yr ARI flood extent showed a minor impact on neighbouring lots. Floor levels were adjusted accordingly.</p> <p>The floor levels and SWMP should be updated to account for this change.</p> <p>Design and performance to be confirmed during Engineering Approval.</p>
8	This development is within WRC's Waikato Central Land Drainage Area (Ohote Basin SRA). Assessment and comment is required as to how WRC's criteria will be met. Refer TR2018/01 Section 16. We suggest the applicant consult WRC at this stage.	See Cheal email.	<p>Accepted. This issue was raised in case WRC requirements materially affected the SWMP. This appears not to be the case.</p> <p>WDC to consider proposed consent notice relating to Lot 10 as proposed.</p>
9	Given the land use change from a golf course to residential housing, is any restoration/enhancement of the existing watercourse proposed as per the Waikato Regional Council's Healthy Rivers initiative?	See Cheal email.	Accepted (although we do not concur that Plan Change 1 only relates to farming activities. As the watercourse is not being modified and no Regional Consents are needed, then this will not have a material effect on the SWMP and so is considered closed).