Before Palmerston North City Council

Under	the Resource Management Act 1991
In the matter of	a proposed plan change to rezone land at 611 Rangitikei Line to establish the Whiskey Creek Residential Area

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STATEMENT OF EVIDENCE OF [PAUL MICHAEL MITCHELL] IN SUPPORT OF FLYGERS INVESTMENT GROUP LIMITED ([STORMWATER MANAGEMENT])

[18 MAY 2022]

Counsel Acting
M J Slyfield
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INTRODUCTION

1. My full name is Paul Michael Mitchell

Qualifications and Experience

2. My name is Paul Michael Mitchell.

3. I am the sole Director and Hydrologist of Mitch Hydro Limited (Mitch Hydro).

4. I was employed as a field hydrologist by the (then) Manawatū Catchment Board from 1981 to 1989 and am very familiar with the Mangaone Stream catchment and Flygers Line Spillway.

5. I completed the requirements for New Zealand Certificate in Engineering (NZCE, Civil) at the Central Institute of Technology in 1987.

6. I obtained a post-graduate Diploma in Applied Science (Hydrology) from Victoria University (Wellington) in 1998.

7. Since 1994 I have worked as a consultant / corporate hydrologist.

8. I became a Chartered Professional Engineer (CPEng) with the Institution of Professional Engineers New Zealand (IPENZ, now Engineering New Zealand (EngNZ)) in 2003.

9. I am a member of the following professional organisations:

   (a) New Zealand Hydrological Society.

   (b) Engineering New Zealand (CPEng).

   (c) New Zealand Society of Large Dams (NZSOLD).

10. I have extensive experience in flooding and stormwater management projects overseas, throughout New Zealand and the Manawatū including:

    (a) Whakarongo Structure Plan Area – Review of Tamakuku Resource Consent Application Stages 1 & 2 (Palmerston North City Council (PNCC) 2020 to 2022). Review of stormwater management associated with the resource consent application for approximately 9.6 ha of residential development at 56 James Line, Kelvin Grove, Palmerston North.

(b) Palmerston North Airport Stormwater Management Plan (PNAL 2017 to 2021). Assessment of stormwater runoff effects from 31 ha of commercially zoned land owned by PNAL. Stormwater quantity and quality mitigation designs to provide hydraulic neutrality of discharges supporting resource consent and building consent applications.

(c) Pacific Heights Residential Development Stages 3A-8 (Palmerston North Industrial and Residential Developments Limited 2016 to 2022). Preparation of Stormwater Management Plans for approximately 30 ha of residential development. Stormwater quantity and quality mitigation designs to provide hydraulic neutrality of discharges supporting staged resource consent and building consent applications.

(d) Ashmore Trust Plan Change 36 / Freedom Drive Residential Development (Ashmore Trust 2008 to 2021). Stormwater management advice provided to support the residential Plan Change application (2008), stormwater quantity and quality mitigation designs (including constructed wetlands) and staged resource consent and building consent applications.

Involvement in Proposed Plan Change

11. I have been involved with the project since June 2017 including:

(a) Catchment walkover, assessment of the site drainage and overland flow paths and the connection with the downstream PNCC stormwater network adjacent to No. 91 Benmore Avenue.

(b) Meeting with Mr. Jon Bell (Horizons) on 27 March 2018 to discuss the proposed plan change area, the potential effects on the floodway and the preferred floodplain modelling approach.

(c) Input into the 2D floodplain modelling scope and review of DHI outputs.

(d) Project meeting (5 November 2019) with Mr. Grant Higgins (Flygers Investment Group Limited) and its project consultants; and Mr. David Murphy and Ms. Veni Demado (for PNCC); and Mr. Jon Bell (for Horizons).

(e) Recent (21 March and 2 May 2022) expert conferencing with Mr. Tim Prentice and Ms. Reiko Baugham (GHD for PNCC); and pre-hearing meeting with submitters (4 May 2022).

12. Where I have relied on other information to support my evidence I have included a reference to the relevant document.

Code of Conduct

13. I have read the Code of Conduct for expert witnesses in the Environment Court Practice Note 2014 and I have complied with it when preparing this evidence. Other than when I state that I am relying on the advice of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of Evidence

14. In this statement I will address the following:

(a) Outline my involvement in the project dating back to 2017.

(b) Provide an overview of the hydrological characteristics of the approximate 12.9 ha area to be rezoned.

(c) Describe the process for determining the stormwater runoff effects as a result of the proposed residential development.

(d) Summarise the proposed stormwater mitigation approach to provide stormwater quality treatment and hydraulic neutrality of discharges for the proposed development area.

(e) Provide context of the historical Flygers Line Spillway events.

(f) Respond to relevant matters raised by submitters.

(g) Respond to relevant matters raised by the peer reviewer in the PNCC Section 42a report.

EXECUTIVE SUMMARY

15. I have been involved with the project since 2017 and:

    (a) Have provided input into the 2-D floodplain modelling assessment undertaken by DHI.

    (b) Am responsible for the stormwater mitigation concepts proposed for the Plan Change area.

16. The relatively small 12.9 ha (0.13 km²) Plan Change catchment is located in the lower Whiskey Creek catchment and is currently being used for pastoral farming.

17. The ephemeral catchment is affected by localised catchment flooding, and Flygers Line spillway events discharging into Whiskey Creek.

18. The stormwater assessments undertaken at this preliminary Plan Change stage have informed the recommended stormwater mitigation approach.

19. Climate change effects on storm rainfalls have been considered over the life of the proposed stormwater infrastructure.

20. 'Hydraulic Neutrality' of stormwater discharges could be provided by:

    (a) An approximate 5000m² flood detention pond located in the south-west of the development discharging to Whiskey Creek providing approximately 3700m³ of storage at the spillway crest level.

    (b) Source controls including roof-water tanks, underground storages and / or reduced imperviousness reducing the size of the flood detention pond.

21. Stormwater quality effects as a result of the proposed development could be mitigated by:

    (a) Rain gardens in the road berms or

    (b) A constructed wetland downstream of the flood detention pond in the floodway.

22. The Flygers Line spillway:

    (a) Was designed with a 10% (1 in 10-year) probability of operating each year.

(b) Has operated three times over the last 37 years (approx. 1 in 12-year AEP).

23. During a 10% AEP or lesser probability (i.e. larger) flood event:

(a) The Mangaone Stream catchment at the Milson Line gauge (154 km²) has a time of concentration in the order of 30-40 hours.

(b) The much smaller Plan Change catchment (0.13 km²) has a time of concentration of approximately 30-40 minutes.

(c) There are no major differences in the timing of rainfall as observed in the upper Mangaone catchment and in the Palmerston North City catchment.

(d) The peak outflows from the proposed flood detention pond would be very unlikely to coincide with the peak discharge from the Flygers Line spillway.

24. The increased runoff volume in the 100-year ARI event as a result of the proposed Plan Change is in the order of 0.2% of the total spilled volume from the Flygers Line spillway during the February 2004 event.

25. The design of the stormwater network will be confirmed during subsequent consenting stages and will further consider the:

(a) Existing overland flow paths and the connections with the proposed stormwater network.

(b) Stormwater conveyance via grassed swales for discrete areas in conjunction with reticulated systems.

(c) Viability of introducing stormwater to the reserve at the northern end of the development to enhance stream revitalisation.

(d) Hydraulic connection with the proposed flood detention pond and outlet, and the downstream tailwater conditions in Whiskey Creek.

26. Stormwater issues raised by submitters have been considered in this Plan Change application, but will be addressed in greater detail during subsequent consenting stages.

27. In regard to the submission by Mr. Brian Kouvelis (S25), further examination of the flood detention preliminary design levels indicates that the pond embankment crest and spillway crest levels would provisionally need to be raised by 0.25m to 0.5m.

28. In regard to S42a Appendix D (evidence of Mr Preston) I disagree with Mr Preston's assessments that the:

(a) Flood detention pond volume is 'unconservative' as his assessment is focussed solely on the storm shape and does not consider the inherent conservatism of the primary rainfall inputs.

(b) The Groves et al Stormwater paper should be adopted as it is the responsibility of the PNCC to periodically review its design standards, their suitability for the Manawatū region, and the consideration of other major variables including rainfall and geology.

EXISTING DRAINAGE CHARACTERISTICS

29. The site is bounded by Rangitikei Line (SH 3) to the north-east, Flygers Line to the north-west, and the floodway stop-bank immediately north of Benmore Avenue and Meadowbrook Drive properties to its south-east.

30. The site is located in the lower Whiskey Creek catchment and is currently being used for pastoral farming.

31. The ground surface is generally in good condition with some erosion and pitting observed on the banks and slopes adjacent to the large, remnant open channels.

32. The area drains roughly east to west until it is intercepted by the remnant Whiskey Creek ephemeral channels draining to the south, which culminate at the floodway stop-bank adjacent to No. 91 Benmore Avenue, where the PNCC 900mm diameter stormwater main commences (Figure 1).

33. The catchment is affected by localised catchment flooding, but more significantly from Mangaone Stream / Flygers Line spillway events some 1.4 km upstream.

Figure 1: PNCC 900mm dia. stormwater connection at 91 Benmore Avenue

34. During Flygers Line spillway events there are multiple flow controls across the site, including the two ephemeral channels (Whiskey Creek and tributary) plus sheet flow across driveways and roads etc.

35. The February 2004 and June 2015 flood events both flooded across the Rangitīkei Line (SH3) / Flygers Line intersection.

36. Flygers Line spillway flow that bypasses the PNCC stormwater main drains downstream to the Taonui Basin and ultimately to the Ōroua and Manawatū Rivers.

FLOODPLAIN MODELLING

Modelling Approach

37. I initially met with Mr. Jon Bell (Manager Investigations and Design, Horizons) on 27 March 2018 at the Horizons Regional Council offices in Palmerston North.

38. At the meeting it was determined that:

(a) If the proposed earthworks were likely to have more than a minor effect on flood level in the floodway then a detailed quantitative 2-D (2-dimensional) assessment of the flooding effects would be required.

(b) The Horizons catchment-scale floodplain model would be suitable for this purpose but would require some refinement.

(c) The effect of climate change was included in the model through the assessment of the 0.5% AEP event as defined in Policy 9-2 of the Horizons One Plan.

39. Subsequent to the meeting, DHI was engaged to undertake the 2-D modelling assessment.

40. Feedback of the modelling approach including the proposed Mitigation Option 6 was sought from both PNCC and Horizons at the meeting at Resonant offices in Palmerston North on 5 November 2019.

41. Mr. Philip Wallace (River Edge Consulting) will present evidence on the floodplain modelling.

RAINFALL RUNOFF MODELLING

Introduction

42. The United States Soil Conservation Service (SCS) method has been applied in the modelling, which is commonly used in New Zealand to demonstrate the runoff characteristics of both greenfield and existing urbanised catchments.

43. It is considered an industry standard method having been adopted by the (then) Auckland Regional Council (TP 108, 1999), and more recently by PNCC (2021 and earlier versions).

44. The modelling applied provides a preliminary level of understanding of the runoff effects as a result of the proposed Plan Change, which informs the recommended stormwater mitigation approach.

45. Section 6.9.2 of PNCC (2021) requires that HIRDS V4 RCP 6.0 (2081-2100) design rainfalls (Table 1) are applied to account for the estimated climate change effects over the life of the infrastructure (to 2100).

Table 1: Whiskey Creek Design Rainfall (including climate to 2100)

Average Recurrence Interval (ARI, Years)	Annual Exceedance Probability (AEP, %)	HIRDS V4 (RCP 6.0) 24-hour rainfall depth (mm)
2	39	57
5	20	73
10	10	86
20	5	98
50	2	116
100	1	130
200	0.5	144

46. The surficial soils (Figure 2) of the proposed site are mostly Kairanga silt loam and Te Arakura fine sandy loam, with coarser Karapoti sandy loam (gravelly phase) in the Whiskey Creek remnant stream channels.

47. Applying the United States Soil Conservation Service (SCS) rainfall-runoff method, the predominant silt and fine sandy loam soils are categorised as 'poorly draining' Class C soils.

Figure 2: Surficial Soils

Existing Runoff Characteristics

48. The existing land use is summarised in Table 2, which indicates that the impervious and bush areas are equally small with almost the entire site in pasture (CN 74.0).

49. The time of concentration (Tc) for the relatively flat (1 in 230) site is approximately 38 minutes.

Table 2: Existing Catchment Characteristics

Area (ha)					Weighted Curve Number (CN)	Slope (m/m)	Tc (minutes)	Initial Losses Ia (mm)
Roof / paved	Metal Driveway	Pasture	Bush	Total				
0.063	0.096	12.101	0.600	12.86	74.0	0.0043	38	5.0

Fully Developed Runoff Characteristics

50. The fully developed layout is based on the land use described in the McIndoe Urban 'Illustrative Masterplan' layout (refer McIndoe Urban Figure 21 in Appendix 3 of the application).

51. The layout includes approximately 170 lots ranging in size from 171m² to 1050m², with an average lot size of approximately 450m².

52. The land use for the fully developed catchment is detailed in Table 3, which indicates an increase in the weighted curve number as a result of the development from CN 74.0 to CN 87.1.

53. The time of concentration for the fully developed catchment has reduced from 38 minutes (existing) to 33 minutes.

Table 3: Fully Developed Catchment Characteristics

Land Use	Area m²	Area ha	CN
Road / footpath	21600	2.160	98.0
Lots	72975	7.298	89.1
Road berms	14025	1.403	74.0
Park / Reserve	13000	1.300	70.0
Flood detention area	7000	0.700	90.0
Total	**128600**	**12.86**	**87.1**

STORMWATER MITIGATION

Stormwater Quantity

54. Two flood scenarios have been considered:

    (a) Local storm events affecting the Palmerston North stormwater catchment.

    (b) Mangaone Stream flooding when the Flygers Line spillway operates.

55. The Stormwater Mitigation plan (Appendix A) provides an indicative pipe layout and probable secondary flow paths that are contained within the roading corridor.

56. A flood detention pond to attenuate the peak discharges is proposed in the south-western end of the development area.

    (a) 1.5m deep , 90m long by 50m wide with minimum 3:1 embankment batters.

    (b) Total area (including a 3m wide buffer zone) to be in the order of 5000m^2.

    (c) Storage volume of approximately 3700m^3 at the spillway crest level.

    (d) 300mm diameter primary outlet culvert.

    (e) 2.5m wide broad-crested spillway.

57. The pond has been provisionally sized to:

    (a) Operate in the 50-year ARI and greater events.

    (b) Pass the 100-year ARI event with 0.3m freeboard.

    (c) Pass the 200-year ARI event without overtopping in the event that the primary outlet is fully blocked / closed.

58. The pond outlet would discharge into the reserve and drain via an open channel swale, or similar, approximately 100m downstream to the remnant Whiskey Creek channel.

59. The PNCC 900mm diameter stormwater connection is a further approximate 110m downstream.

60. When Whiskey Creek is elevated as a result of the operation of the Flygers Line spillway:

(a) The primary outlet of the detention pond would likely need to close to prevent back-flow into the pond (e.g. culvert with flap-gate).

(b) The detention pond spillway crest level will also need to be sufficiently elevated to allow it to operate when the floodway is at its design flood (0.5% AEP) level.

61. Summary model outputs are included in Table 4 and Table 5, which indicate:

(a) 'Hydraulic Neutrality' of discharges with reductions in the peak discharges in all events up to the 100-year ARI event.

(b) An increase in runoff volume of approximately 3400m³ in the 100-year ARI event.

Table 4: Flood Mitigation Model Results

Event (ARI, years)	Peak Flow (m³/s)					Pond Level (RL, m)	Freeboard (m)
	Existing	Fully Developed (Unmitigated)	Pond Outflow				
			Culvert Flow	Spill Flow	Total Outflow		
2	0.15	0.37	0.13	0.00	0.13	26.67	1.08
5	0.24	0.54	0.16	0.00	0.16	26.89	0.86
10	0.31	0.66	0.18	0.00	0.18	27.06	0.69
20	0.39	0.80	0.20	0.00	0.20	27.24	0.51
50	0.51	0.99	0.21	0.19	0.40	27.37	0.38
100	0.61	1.1	0.22	0.38	0.60	27.45	0.30
200	0.71	1.3	0.23	0.61	0.84	27.52	0.23

Table 5: 24-hour Design Flood Runoff Volume

Event (ARI, years)	Runoff Volume (m³)		
	Existing	Fully Developed (Unmitigated)	Increase
2	2324	4033	1709
5	3663	5848	2185
10	4762	7270	2508
20	5934	8729	2795
50	7646	10793	3147
100	9107	12512	3406
200	10580	14210	3630

62. Stormwater quantity mitigation options for discrete areas that would reduce the size of the proposed flood detention pond would include source controls, such as reduced imperviousness per lot, roof-water tanks and / or underground detention storages.

63. The detailed design of the stormwater network will be confirmed during subsequent consenting stages and will further consider the:

(a) Existing overland flow paths and the connections with the proposed stormwater network.

(b) Stormwater conveyance via grassed swales for discrete areas in conjunction with reticulated systems.

(c) Viability of introducing stormwater to the reserve at the northern end of the development to enhance stream revitalisation.

(d) Hydraulic connection with the flood detention pond, the primary and spillway outlets to Whiskey Creek and the performance of the pond during high tailwater level conditions.

Stormwater Quality

64. Stormwater quality treatment options include:

(a) Bioretention devices (rain gardens) in the road berms; or

(b) A constructed wetland.

65. Table 4 of Wellington Water (2019) quotes estimated removal rates of specific contaminants for a range of treatment devices (Figure 3), which highlights the better treatment performance of rain gardens and constructed wetlands.

Table 4: Treatment performance of wetlands, bioretention (raingardens), swales and pervious paving (from NZTA Stormwater Treatment for State Highway Infrastructure).

Stormwater management devices	Estimated removal rates (%) for devices				
	TSS	Total Nitrogen	Total Phosphorous	Zinc	Copper
Wetlands	90	40	50	80	80
Bioretention (raingarden)	90	40	60	90	90
Swales*	60	20	30	65	50
Pervious paving	80	20	30	75	60

*Swale performance has been reduced to account for re-mobilisation of sediments in moderate to large events.

Figure 3: Contaminant Removal Rates (Table 4 from Wellington Water, 2019)

66. Rain gardens (bioretention devices) in the road berms could be applied to provide stormwater quality treatment of discrete residential and / or commercial areas or by providing catchment-wide 'source controls' for the entire development.

67. Ideally, the constructed wetland would be located upstream of the flood detention pond, however, there may not be sufficient area in the south of the site to locate both the wetland and the flood detention pond.

68. There is opportunity to consider the development of a constructed wetland downstream of the detention pond in the floodway draining to the remnant Whiskey Creek channel, however, its impact on flood levels in the floodway would need to be considered.

FLYGERS LINE SPILLWAY EVENTS

69. The Mangaone Stream 'Flygers Line' spillway (Horizons, 2020) was designed in 1982 to commence operation when the flow at the Milson Line flow gauge reaches 124m³/s (4.4m).

70. Horizons has categorised this flow as a 10% AEP (10-year ARI) event.

71. The spillway has operated four times since it was constructed in 1984 / 1985 (approx. 37 years):

    (a) 25 August 1986 (operated prematurely due to lupin growth in the downstream channel artificially raising water levels at the weir).

    (b) 24 July 1988.

    (c) 16 February 2004.

    (d) 20-21 June 2015.

72. Discounting the August 1986 event, the spillway would normally have operated three times in approximately 37 years i.e. slightly less frequently than the intended '1 in 10 year' design criteria.

16 February 2004 Event

73. The 16 February 2004 flood event (Figure 4) was a long-duration storm in the Mangaone Stream catchment.

74. Horizons estimated this event to be an approximate 1% AEP (100-year ARI) flood event in the Mangaone Stream catchment.

75. A total of approximately 135mm of rainfall was recorded at the Valley Road gauge over the critical 31-hour storm duration.

76. While the magnitude of rainfall varies between the Valley Road and Milson Line rain gauges, the temporal patterns appear to be very similar.

77. The data indicate that the Flygers Line spillway would have operated over an approximate 10-hour period i.e. commencing around 2.45am on 16 February 2004 and ceasing about 1pm later that day.

78. The total spilled volume during this approximate 1% AEP flood event is estimated at approximately 1.5 Mm³.

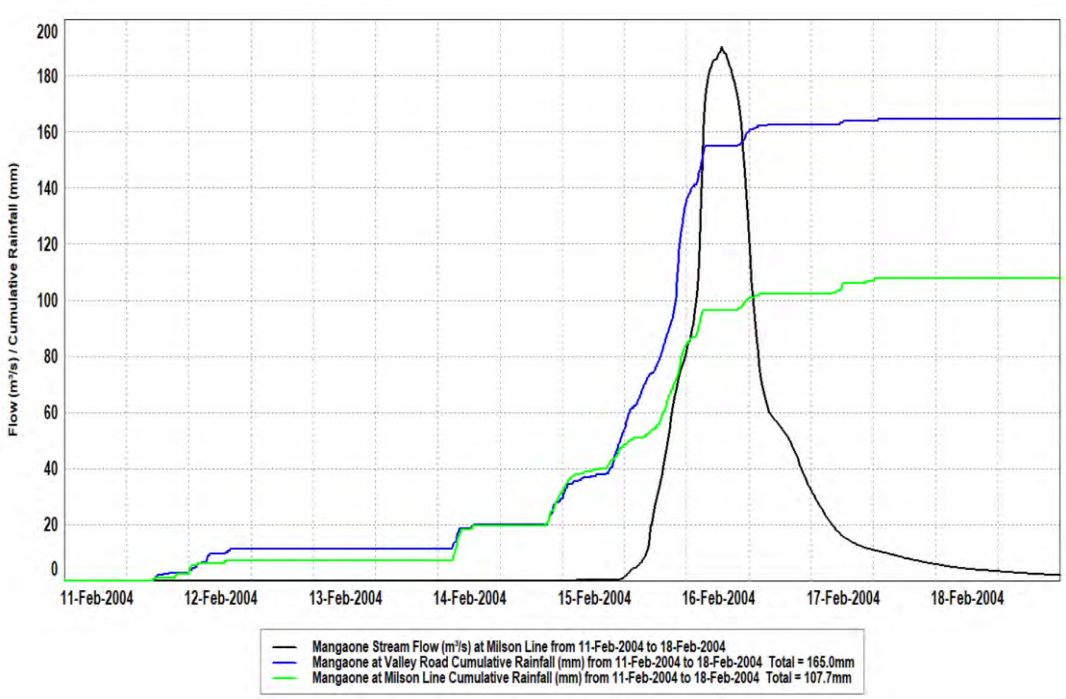


Figure 4: Mangaone Stream Flood (16 February 2004)

Design Considerations

79. The Flygers Line spillway:

(a) Was designed with a 10% (1 in 10-year) probability of operating each year; and has

(b) Has operated three times over the last 37 years (approx. 1 in 12-year probability).

80. During a 10% AEP or lesser probability (i.e. larger) flood event:

(a) The Mangaone Stream catchment at the Milson Line gauge (154 km²) has a time of concentration in the order of 30-40 hours.

(b) The much smaller Plan Change catchment (0.13 km²) has a time of concentration of approximately 30-40 minutes.

(c) There are no major differences in the timing of rainfall as observed in the upper Mangaone catchment (at Valley Road) and in the Palmerston North City catchment (at Milson Line).

(d) The peak outflows from the proposed flood detention pond would be very unlikely to coincide with the peak discharge from the Flygers Line spillway.

81. The total increased runoff volume in the 100-year ARI event as a result of the proposed Plan Change (3400m³) is in the order of 0.2% of the total spilled volume from the Flygers Line spillway (est. 1.5 Mm³) during the February 2004 (approx. 100-year ARI) flood event.

82. The design of the proposed flood detention pond would need to consider high tailwater conditions in Whiskey Creek during Flygers Line spillway 10% AEP and lesser probability (i.e. larger) flood events.

SUBMISSIONS

83. The stormwater issues referenced in the submissions relate to:

(a) Climate change / more frequent and greater flooding.

(b) Effect of new development on Mangaone Stream catchment / Flygers Line floodway i.e. additional flooding from Plan Change area and proposed Kiwirail yards.

(c) Increased risk of overland flooding of the proposed common boundary between existing Meadowbrook Drive properties and the Plan Change area.

(d) Cumulative adverse effects on freshwater values / water quality.

(e) Function of the proposed flood detention pond.

84. Detailed responses to the each of the submissions referencing stormwater related issues are included in Table 6 of Appendix B.

85. Each of the above issues have been considered in this Plan Change application, but will be addressed in greater detail during subsequent consenting stages.

86. In regard to the submission by Mr. Brian Kouvelis (S25), further examination of the flood detention preliminary design levels (refer Table 6 of Appendix 12 of the application) indicates that the pond embankment crest and spillway crest levels would provisionally need to be raised by 0.25m to 0.5m.

87. Flood Detention Pond key levels:

(a) 0.5% AEP flood level adjacent to pond	RL 27.6m.
(b) Existing stop-bank level	RL 28.0m.
(c) Existing Benmore Avenue properties	RL 27.6m.
(d) Modified spillway crest level +0.5m	RL 27.75m (i.e. 0.15m above 0.5% AEP flood level).
(e) Modified embankment crest level +0.25m	RL 28.0m (i.e. same level as existing stop-bank).

88. If the flood detention embankment crest level is formed at the same level as the stop-bank (RL 28.0m), this would result in a wider spillway and less freeboard for those events where the spillway operates (commencing at the 50-year ARI (2% AEP) event).

89. Alternatively, a service spillway at a lower level could be incorporated to enable the pond to provide greater freeboard during non-Flygers Line Spillway events, with a widened emergency spillway at RL 27.75m.

90. This highlights that the detention pond would operate as intended, albeit with slightly modified levels, but it also highlights the importance of undertaking more detailed design during the subsequent consenting stages.

SECTION 42A REPORT

91. PNCC commissioned a peer review of the Stormwater Management Plan, the findings of which are presented in Appendix D of the s42a report (evidence of Mr. Tim Preston).

92. I respond to Mr. Preston's comments below.

93. Design rainfall shape or hyetograph (Preston 4.26).

(a) Section 5.1 of the Whiskey Creek Stormwater Management Plan (Mitch Hydro, Appendix 12 of application) references the application of the 1999 Auckland Regional Council (TP 108) methodology. The nested storm hyetograph applied in the Plan Change analysis is the Normalised 24-hour Design Storm hyetograph as detailed in Table 2.1 of the 1999 publication.

94. Application of nested storm hyetograph (Preston 4.28).

(a) Mr Preston states that Clause 6.2.2 of the PNCC Engineering Standards for Land Developments (2021) '*recommends*' the use of nested storm analyses.

(b) Clause 6.2.2 i) of PNCC (2021) does not 'recommend' the use of a nested storm approach, but rather it requires that the Stormwater Management Plan (SMP) must identify changes in stormwater quantities created by the development / land use 'using the HIRDS database and nested design storm approach.'

95. Unconservative assessment of flood detention volume (Preston 4.26, 4.29, 5.2).

(a) Mr Preston considers that the nested storm approach provides unconservative estimates of flood detention volume.

(b) I disagree with this assessment as it is focussed only on the storm shape and does not consider the primary rainfall inputs.

(c) Mr Preston has not considered that there are layers of conservatism built into the PNCC Engineering Standards for Land Development in particular the requirement to use HIRDSV4 design rainfalls.

(d) A comparison of 24-hour recorded rainfalls at PN Airport (1992-2020) and HIRDSV4 24-hour rainfall depths (Figure 5) indicates that for the 200-year ARI event 1) HIRDSV4 Historical rainfalls are 15% greater than recorded; and 2) HIRDSV4 RCP 6.0 rainfall depths are 32% greater than recorded.

(e) This comparison suggests that the major input into the design storm analysis and flood detention pond sizing i.e. HIRDSV4 design rainfalls, are inherently conservative relative to the historical rainfall recorded at the nearby PN Airport.

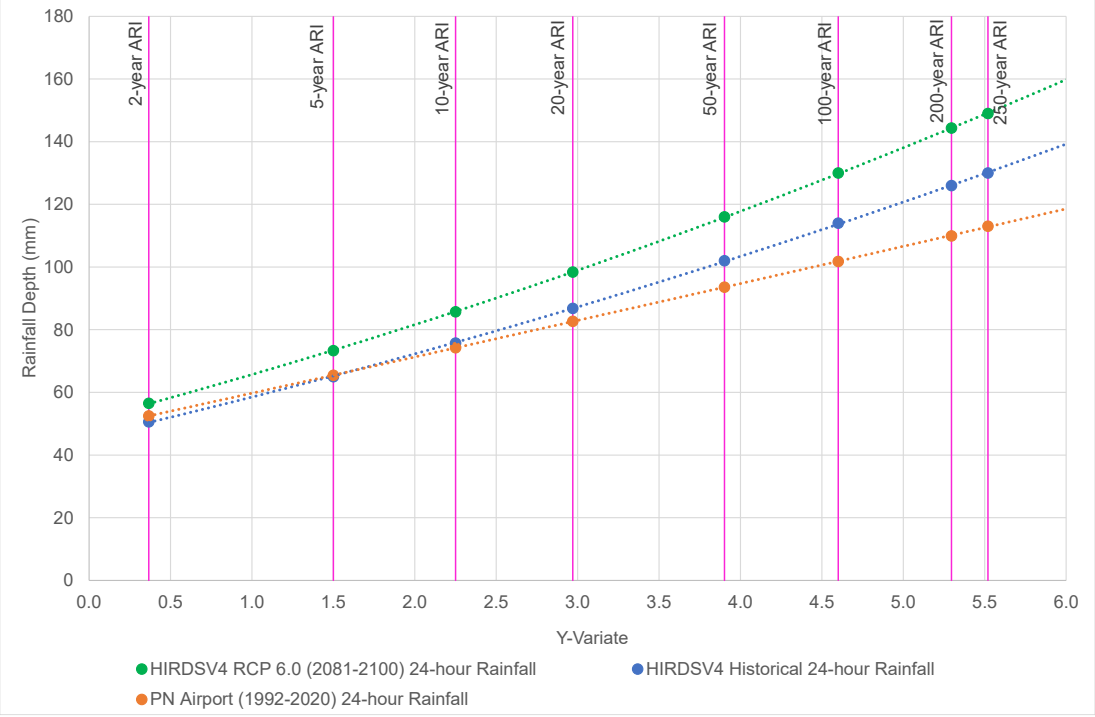


Figure 5: Comparison of PN Airport Recorded Rainfalls and HIRDSV4 Rainfalls

96. The adoption of the Groves et al Stormwater Conference paper (Preston 4.26).

(a) Mr Preston provides no evidence to support the Groves approach for this catchment other than his recommendation for its wholesale adoption.

(b) The merits of a specific methodology for assessing flood detention volumes in Christchurch or Tauranga may not be suitable for the Manawatū region, and should be subject to further rigorous assessment and / or peer review before being recommended as a national standard.

(c) It is my opinion that it is the responsibility of the PNCC to periodically review its design standards, and to undertake sensitivity analyses for specific case studies within the Manawatū to support its preferred design approach.

(d) If the PNCC design standards are to be meaningfully reviewed this should also include a review of the other major variables, namely the design storm rainfalls and catchment geology and the subsequent effect on stormwater runoff and flood detention requirements.

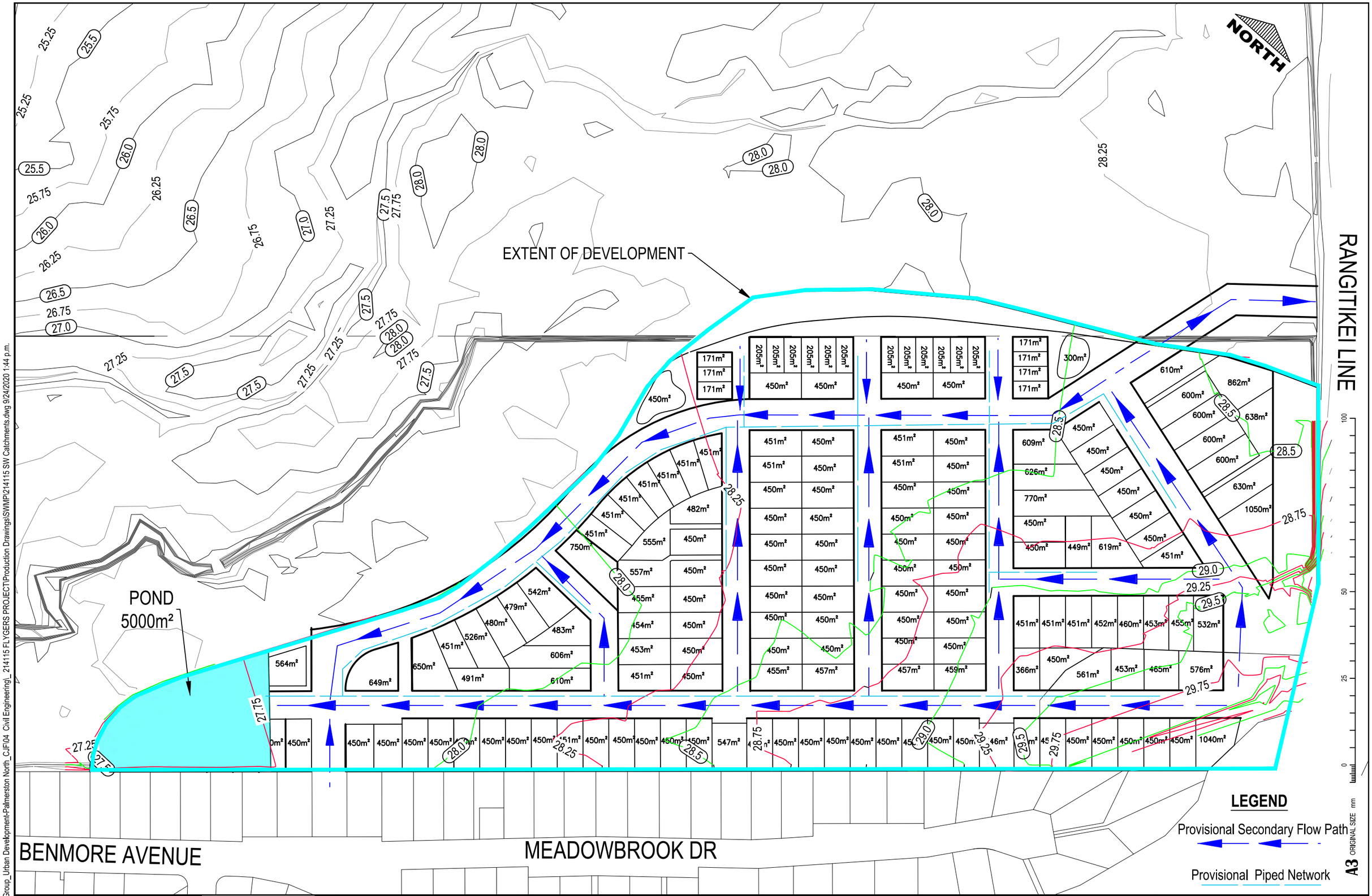
[Paul Michael Mitchell]

[18 May 2022]

REFERENCES

ARC TP108, 1999	Guidelines for stormwater runoff modelling in the Auckland Region, Technical Publication 108. Prepared for Auckland Regional Council by Beca Carter Hollings and Ferner Limited, April 1999.
Horizons, 2020	Flygers Line Spillway, Horizons Regional Council, 16 September 2020.
PNCC, 2021	Palmerton North City Council Fourth Edition Engineering Standards for Land Developments, Effective from 1 August 2021.
Wellington Water, 2019	Water Sensitive Design for Stormwater: Treatment Device Design Guideline, Wellington Water, Version 1.1, December 2019.

Appendix A Stormwater Mitigation Plan



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Rev	Details	Drawn	Date
1	ISSUED FOR DISCUSSION		24/9/20

Mitch Hydro

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The Contractor shall check all dimensions on site.

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STORMWATER CATCHMENTS
RANGITIKEI LINE - FLYGERS LINE
PALMERSTON NORTH
STORMWATER MITIGATION

HIGGINS GROUP

	Initials	Date
Surveyed	RSJP	04/19
Designed	KBJ	08/20
Drawn	JGR	08/20
Checked		
Approved		

DO NOT SCALE, If in doubt ask for dimensions

Scales A3	Job No.
1:2000	214115

CAD Path/File	Sheet	of	Sheets	Rev.
214115 SW Catchments	2		2	1

Appendix B Response to Stormwater Submissions

Table 6: Response to Stormwater Submissions

Number	Submitter	Address	Submission	Response (Paul Mitchell)
S1	Marion Anderson	23b Meadowbrook Drive, PN	Climate change / more frequent and greater flooding. Additional flooding from Plan Change area and new rail (Kiwirail) yards.	Climate change has been considered in the Stormwater Management Plan (Appendix 12 of the Application) where PNCC (2019) requires that RCP 6.0 (2081-2100) is assessed. This assessment accounts for the estimated climate change effect on storm rainfalls over the life of the infrastructure. The Flygers Line spillway was designed (1982) with a 10% (1 in 10-year) probability of operating each year; and has operated three times over the last 37 years i.e. 1 in 12-year probability (refer Section 7 of Appendix 12 of the Application). Appropriate freeboard will be considered in all designs. The new developments (Whiskey Creek PC and Kiwirail yards) are small relative to the larger Mangaone Stream catchment (154 km²), however, both developments be required by PNCC to demonstrate hydraulic neutrality of the stormwater discharge i.e. through flood detention storage or other mitigation.
S3	Paula Eyres	15a Meadowbrook Drive, PN	Concerned that flooding could occur if culvert running along 15a Medowbrook Drive is covered.	This assessment and design would be undertaken during the resource consent application and has yet to be completed. The resource consent application would be required by PNCC to consider existing catchment drainage including open channel drains, and overland / secondary flow. Further design details would also be provided during the building consent application.
S7	Michele D Mitchell	5 Meadowbrook Drive, PN	Concerns about property drainage during heavy rain.	See response to S3.
S11	Michael McCavana	15 Meadowbrook Drive, PN	Open drain at rear of property being replaced with pipe. Freshwater values / water quality.	See response to S3. Stormwater quality treatment will be included in the design either by the application of rain gardens or a constructed wetland. Re-vegetation of the ephemeral Whiskey Creek stream corridor is also proposed (McIndoe Urban - Appendix 3 of the Application).
S12	Maureen Haddock	17 Meadowbrook Drive, PN	Stormwater flooding from Plan Change area. Function of flood detention pond.	1) See response to S3. 2) There will be existing flooding issues in the Meadowbrook Drive area that are not related to the proposed plan change. These stormwater capacity constraints are common across Palmerston North where pipes have been sized to the 20% AEP (5-year ARI) or lesser capacity. 3) The proposed flood detention pond has been provisionally sized to attenuate (reduce) peak discharges into Whiskey Creek and the downstream (900mm diameter) stormwater network at 91 Benmore Avenue. The design of the reticulated stormwater network, including the hydraulic connection with the flood detention pond (including the primary outlet and spillway) will be undertaken during the resource consent stage. The pond primary outlet will need a flap-gate or similar to stop flow from the floodway entering the pond during high tailwater conditions. Similarly the spillway crest level will need to be sufficiently elevated to allow it to contunue to pass spill flow when the floodway is elevated. The pond volume has been provisionally sized to pass the 0.5% AEP (200-year ARI) when the primary culvert is fully blocked / closed. There will be timing differences, however, between the local residential catchment (about 30-40 minutes to peak) and the Mangaone Stream catchment (about 30-40 hours to peak) limiting the possibility of coincident peaks.
S13	Michael G Hermansen	125 Benmore Avenue, PN	Effect of new development on Flygers Line floodway.	See response to S1.
S14	Ngāti Turanga	Private Bag 11034, PN	Cumulative adverse effects on water quality.	See response to SO 11 regarding proposed stormwater quality treatment
S15	Anthony and Carolyne Cade	1 Meadowbrook Drive, PN	An existing storm drain along the common boundary will need to be re-engineered to ensure there are no adverse flooding effects on neighbours.	See response to S3.
S17	Waka Kotahi	Private Bag 11777, PN	That there is to be no additional stormwater discharge to the SH3 stormwater network as a result of this development.	The Plan Change area will discharge via the flood detention pond to Whiskey Creek and downstream to the PNCC stormwater network at 91 Benmore Avenue. There is no planned stormwater discharge to SH3.
S18	Horizons Regional Council	Private Bag 11-034, PN	Provision for stormwater management to achieve an outcome that is consistent with One Plan Rule 14-18.	Agree with Horizon comments. Refer response to S11 (i.e. proposed Stormwater Quality treatment) and S12 (i.e. proposed Flood Detention Pond function). Further design details would be provided during the resource consent application.
S20	John Anderson	25 Meadowbrook Drive, PN	Climate change / more frequent and greater flooding. Additional flooding from Plan Change area and new rail (Kiwirail) yards.	See response to S1.
S22	Murray and Sally Rasmussen	39 Meadowbrook Drive, PN	Flood risk from floodway and local stormwater.	See responses to S1 and S3.
S25	Brian Kouvelis	11 Green Rd Awahuri, RD6, PN	The application is not clear on the operation of the flood detention pond under Mangaone spillway operation and the flood-gating of the development causing internal flooding in the proposed development area.	See response to S12 (3).
S26	Irene Gladys Hamilton	3a Meadowbrook Drive, PN	Increased risk of flooding during heavy or continuous rain.	See response to S3.